United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240

In Response Refer To:
FWS/AES/DER/BCH/056189

Mr. Robert Wood
Director
Engineering and Analysis Division
Office of Water
U.S. Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Wood:

In accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), and the Interagency Cooperation Regulations (50 CFR 402), this transmits our final biological opinion (Opinion) on the U.S. Environmental Protection Agency's (EPA) issuance and implementation of the final regulations implementing Section 316(b) of the Clean Water Act (CWA). Section 7(a)(2) of the ESA of 1973, as amended (16 U.S.C. 1536(a)(2)), requires Federal agencies to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat. When a Federal agency's action may affect listed species or critical habitat, formal consultation with the National Marine Fisheries Service (NMFS) and/or the U.S. Fish and Wildlife Service (USFWS) is required (50 CFR 402.14(a)). EPA requested formal consultation even though EPA was of the opinion that its action would not cause adverse effects to listed species and critical habitat. After review of the proposed regulation, biological evaluation, and other available information we determined that the proposed action is likely to adversely affect threatened and endangered species and designated critical habitat.

Federal agencies may request a conference on a proposed action that may affect proposed species or proposed critical habitat. While the EPA request for consultation indicates proposed species were addressed in the biological evaluation, a conference opinion was not requested, nor was the information presented in the biological evaluation sufficient to complete a conference opinion for all proposed species. Therefore, we are not providing a conference opinion at this time.

EPA proposes to issue and implement final regulations (40 CFR 122 and 125; Rule) to establish requirements for cooling water intake structures (CWIS) at existing facilities under section 316(b) of the CWA. This document transmits a joint NMFS and USFWS Opinion on the proposed action and its effects on ESA-listed species and designated critical habitat. We based our Opinion on information provided in the draft Rule and Preamble, the Services' interpretations of that rule as agreed upon by EPA on April 8, 2014, the biological evaluation for the CWA section 316(b) Rulemaking provided by EPA on June 18, 2013, consultation meetings, peer-reviewed publications, recovery plans, government reports, grey literature, scientific and commercial data, and other sources of information. We prepared our Opinion in accordance with section 7(a)(2) of the statute (16 U.S.C. 1536(a)(2)), associated implementing regulations (50 CFR 402), and agency policy and guidance (USFWS and NMFS 1998).

We appreciate your commitment in the conservation of endangered species. If you require further assistance or have any questions, please contact Ms. Cathy Tortorici, Chief, Interagency Cooperation Division, NMFS, at 301-427-8495 or by e-mail at cathy.tortorici@noaa.gov, or Ms. Patrice Ashfield, Chief, Branch of Consultations and Habitat Conservation Planning, USFWS, at 703-358-2478 or by e-mail at patrice_ashfield@fws.gov.

Sincerely,

Donna S Wieting

Donna Wieting
Director for
Office of Protected Resources

Paul Souza for

Gary Frazer
Assistant Director for
Ecological Services

Attachment

Endangered Species Act Section 7 Consultation

Programmatic Biological Opinion

on the

U.S. Environmental Protection Agency's

Issuance and Implementation of the Final Regulations

Section 316(b) of the Clean Water Act

U.S. Fish and Wildlife Service
Endangered Species Program
Division of Environmental Review
Arlington, Virginia

National Marine Fisheries Service
Office of Protected Resources
Endangered Species Act
Interagency Cooperation Division
Silver Spring, Maryland

May 19, 2014

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1.0 Consultation History

On July 9, 2004, U.S. Environmental Protection Agency (EPA) promulgated regulations establishing requirements for Cooling Water Intake Structures (CWIS) at existing facilities (69 FR 41576). On January 25, 2007, the Second Circuit remanded parts of the regulations to EPA (Riverkeeper, Inc., v. EPA, 475 F.3d 83 (2nd Circuit2007) holding that EPA impermissibly balanced costs and benefits in developing the requirements. On July 9, 2007, EPA suspended the regulations (72 FR 37107). On April 1, 2009, the U.S. Supreme Court reversed, holding that EPA could consider costs and benefits in its regulatory decisions under section 316(b) (Entergy Corp. v. Riverkeeper, Inc., 556 U.S. 208 (2009).

On November 22, 2010, EPA signed a settlement agreement with Riverkeeper, Inc. to establish rulemaking dates, which included final action by July 27, 2012. On July 17, 2012, the parties agreed to an amendment to extend the date for the final Rule until July 27, 2013.

On April 20, 2011, pursuant to section 316(b) of the Clean Water Act (CWA), EPA proposed regulations establishing requirements for CWISs at existing facilities (76 FR 22174). In its proposed Rule, EPA replaces with amendments the suspended regulations establishing requirements for CWISs at existing facilities.

On July 20, 2012, EPA met with the National Marine Fisheries Service (NMFS) to commence informal ESA Section 7(a)(2) consultation.

On October 1, 2012, EPA met with the U.S. Fish and Wildlife Service (USFWS) to commence informal ESA section 7 consultation. The USFWS and NMFS (i.e., the Services) met with EPA numerous times to discuss their action, its impacts to listed species, and measures to minimize impacts.

On April 4, 2013, EPA sent the Services an early draft of the Rule.

On April 12, 2013, the Services provided comments on the early draft of the Rule.

On June 18, 2013, EPA submitted a section 7 consultation initiation package, which included the draft Rule, draft Preamble, and biological evaluation. We initiated formal consultation on June 18, 2013.

On June 27, 2013, EPA signed a modified settlement agreement with Riverkeeper, Inc. to extend the date for the final Rule until November 4, 2013, to allow for the completion of formal section 7 consultation with the Services. This deadline was subsequently extended to January 14, 2014 and then to April 17.

Between June 27 and November 4, the Services met with EPA frequently to discuss EPA's action.

On November 4, 2013, we received a revised version of the proposed 316(b) Rule from Office of Management and Budget.

On November 15, 2013, we sent the Description of the Action to EPA for review.

On November 26, 2013, EPA sent corrections and comments on the Description of the Action and we incorporated their edits into the final Description of the Action.

From December 6, 2013, through March 11, 2014, the Services and EPA engaged in numerous exchanges about possible revisions to the processes embodied in EPA's draft final Rule.

On March 14, 2014, EPA sent the Services the final Rule and Preamble.

On March 31, 2014, the Services provided EPA with a document seeking clarification on the Services' understandings of key elements in EPA's proposed action).

On April 8, 2014, EPA provided confirmation on the Services' description and understanding of the key elements of EPA proposed action. (Attached as Appendix A)

2.0 Description of the Proposed Action

EPA proposes to issue and implement a final Rule to establish requirements for CWIS at existing facilities and modify certain requirements for new facilities under an existing rule. EPA will amend specific parts of the Rule, which implement section 316(b) of the CWA, that had previously been suspended (72 FR 37107) in response to the 2nd Circuit Court of Appeals' decision in Riverkeeper, Inc., v. EPA. These parts include: 40 CFR 122.21 (r) (1)(ii) and (5), 125.90 (a), (c), and (d), and 125.91 through 125.99. In response to the Court's remand, EPA in its final regulation also proposes to remove the restoration-based compliance alternative and associated monitoring and demonstration requirements for new facilities (125.84(c) and (d)(1))[1]. In addition, EPA proposes to modify other parts of its regulations implementing section 316(b) to establish new requirements for all existing power generating facilities and existing manufacturing and industrial facilities that withdraw more than two million gallons of water per day (mgd) from waters of the United States and use at least 25 percent of the water they withdraw exclusively for cooling purposes (76 FR 22173). In summary, in response to litigation, EPA will issue a final Rule to establish modified or new requirements for facilities that withdraw water for CWIS.

Section 316(b) of the CWA requires that the location, design, construction, and capacity of CWIS reflect the best technology available (BTA) for minimizing adverse environmental impacts. Under the regulation, the term "cooling water intake structure" means the total physical structure and any associated waterways used to withdraw cooling water from waters of the United States. For purposes of the final Rule, adverse environmental impacts include, but are not

[1] The removal of the restoration-based compliance alternative and associated monitoring and documentation requirements for new facilities are non-discretionary actions on the part of EPA and therefore, the effects of these actions are not being addressed in this biological opinion.

limited to, impingement and entrainment at CWIS, including adverse effects to federally-listed species (species listed as threatened or endangered under the ESA or ESA-listed species) and designated critical habitat, and changes in flow regime, caused by the withdrawal of water. Impingement is defined as the entrapment of any life stages of fish and shellfish on the outer part of an intake structure or against a screening device during periods of intake water withdrawal. Entrapment is defined as the condition where impingeable fish and shellfish lack the means to escape the cooling water intake. Entrainment is defined as any life stages of fish and shellfish in the intake water flow entering and passing through a cooling water intake structure and into a cooling water system, including the condenser or heat exchanger.

EPA tailored the Rule toward the protection of fish and shellfish. However, federally-listed aquatic organisms that do not fall into the classification of fish and shellfish are also impacted by impingement, entrainment, and entrapment (e.g., manatees, turtles). The Rule provides that the Director may establish in the permit additional control measures, monitoring and reporting requirements that are designed to minimize incidental take, reduce or remove more than minor detrimental effects (as defined on page 4 of this Opinion) to federally-listed species and designated critical habitat, or avoid jeopardizing federally-listed species or destroying or modifying designated critical habitat. As such, and based on communication received from EPA on April 8, 2014, (Appendix A), the Rule's application to "fish and shellfish" and the Director's authority to establish additional measures to protect listed species and habitat will encompass all taxa of listed species, including their critical habitat. This consultation also considers the direct and indirect effects to federally-listed species caused by facilities operating CWIS under requirements of the Rule, including but not limited to; impingement, entrainment, loss of prey, changes in water quality, and flow alteration.

The Rule regulates existing facilities and new units at existing facilities that withdraw cooling waters from waters of the United States and have, or require, a National Pollutant Discharge Elimination System (NPDES) permit, issued under section 402 of the CWA. The NPDES permit program is administered by State Directors in authorized States. However, EPA retains the NPDES permit program for facilities located in: Idaho, Massachusetts, New Hampshire, New Mexico, District of Columbia, American Samoa, Guam, Johnston Atoll, Midway Island, Northern Mariana Islands, Puerto Rico, and Wake Island, as well as certain Federal facilities and facilities located on Tribal Lands.

The Rule applies to owners or operators of existing facilities with CWISs that withdraw > 2 mgd and use at least 25 percent of the water for cooling purposes. It also applies to the State or EPA Regional Director (i.e., the Director[2]), who establishes controls under CWA Section 316(b) authority on withdrawals through the NPDES permitting process. Regulatory requirements are described in full in the Rule (40 CFR 122 and 40 CFR 125) and further explained in the Preamble. Here, we summarize the Rule, Preamble and relevant correspondence from EPA to describe EPA's action with sufficient detail to evaluate its impact on ESA-listed species and designated critical habitat.

[2] See 40 CFR 122.2 for the Definition of Director as used in the Rule.

2.1 EPA Requirements

When EPA is the NPDES permitting authority and has determined the issuance of the permit may affect ESA-listed species or designated critical habitat, they then must request consultation under section 7(a)(2) of the ESA. As discussed in Section 2.3, regarding State or Tribal-issued CWIS permits, in the Preamble, EPA reaffirms its commitment to the procedures stipulated in the 2001 Memorandum of Agreement (MOA) signed by EPA, and the Services (66 FR 11202). EPA has incorporated as part of its action relevant sections of the MOA, as described in the Preamble to the Rule and, based on correspondence with EPA received on April 8, 2014 (attached as Appendix A), EPA commits to the following implementation of their NPDES oversight authorities in situations where the Services contact EPA with concerns that a State or Tribal permit will have more than minor detrimental effects on federally-listed species or critical habitat that cannot be resolved with the State or Tribal permitting authority:

i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;
ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and
iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
    - Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

EPA has stated adverse environmental impacts include adverse effects to listed species (USEPA 2013f), and Section 316(b) of the CWA requires that the location, design, construction, and capacity of CWIS reflect the BTA for minimizing adverse environmental impacts. Further, the phrase "more than minor detrimental effects" as used in the Rule, Preamble to the Rule, the 2001 MOA, and in EPA's commitment to the implementation of their NPDES oversight authorities as described above, means "adverse effects" as that term is used in the ESA implementing regulations, consultation handbook, and MOA (66 FR 11207) and is one type of "adverse environmental impact" as that term is used under section 316(b) of the CWA. EPA has also defined minimize in the Rule as "to reduce to the smallest amount, extent, or degree reasonably possible." In summary, EPA will exercise its oversight authority on proposed/draft permits where the Services contact EPA with concerns that a State or Tribal permit will have more than minor detrimental effects on Federally-listed species or designated critical habitat. Such situations may include where a permit does not minimize adverse effects to listed species to the smallest amount, extent, or degree reasonably possible.

2.2 Owner or Operator Requirements

In the Rule, EPA establishes certain requirements of the owner or operator of an existing facility with CWIS by indicating the owner or operator "must" or "shall" perform some action. EPA also allows discretion by indicating that the owner or operator "may" or "should" perform some optional task. For the purposes of this biological opinion (Opinion), we focus on requirements of the rule because we must evaluate the Federal action (not the discretionary decisions of owners, operators, or Directors) and whether EPA has met their obligations under section 7(a)(2) of the ESA. Therefore, we focus on the requirements (i.e., "must" or "shall") established in the Rule; however, we describe and consider optional tasks (i.e., "may" or "should") to characterize discretion allowed in the Rule.

2.2.1 Permit Application

EPA requires the owner or operator of a facility with CWIS to submit information to the Director, as described in Table 1.

Table 1. Summary of information requirements, based on facility and unit type. For details, see 40 CFR 122.21(r) and 125.95. Numbers 2 – 14 refer to sections in §122.21(r), described in brief below table; "X" means required. Abbreviations: million gallons per day (mgd); actual intake flow (AIF); design intake flow (DIF).

Information required	**Existing facilities**			
	Closed cycle*	**Open cycle**		
		Existing units		**New units**
		≤125 mgd	**>125 mgd**	
2-Source water physical data	X	X	X	X
3-CWIS data	X	X	X	X
4-Source water baseline biological data	X	Applicable provisions	Applicable provisions	Applicable provisions
5-CWIS system data	X	X	X	X
6-Impingement mortality standard method	X	X	X	Applicable provisions
7-Entrainment performance studies		X	X	Applicable provisions
8-Operational status	X	X	X	X
9-Entrainment characterization study	Unless waived		X	X if > 125 mgd or if 125.94(e)(2)
10-Comprehensive technical feasibility and cost evaluation	Unless waived		X	X if > 125 mgd

Information required	Closed cycle*	Existing facilities		
		Open cycle		
		Existing units		New units
		≤125 mgd	>125 mgd	
study				
11-Benefits valuation study	Unless waived		X	X if > 125 mgd
12-Non-water quality environmental and other impacts study	Unless waived		X	X if > 125 mgd
13-Peer review	Unless waived		X	X if > 125 mgd
14-Method of compliance for new units				X
Additional information required			See §125.98	See § 122.21(r)(14), 125.95(d), and 125.98(i)

*Closed-cycle recirculating system is defined by EPA as a system designed and properly operated using minimized make-up and blowdown flows withdrawn from a water of the United States to support contact or noncontact cooling uses within a facility, or a system designed to include certain impoundments; it passes cooling water through the condenser and other components of the cooling system and reuses the water for cooling multiple times. It may include a facility with wet, dry, or hybrid cooling towers; it withdraws new source water (make-up water) only to replenish losses that have occurred due to blowdown, drift, and evaporation. The definition also includes a system with impoundments of waters of the U.S. where the impoundment was constructed prior to the effective date of this rule and created for the purpose of serving as part of the cooling water system as documented in the project purpose statement for any required Clean Water Act section 404 permit obtained to construct the impoundment.

2. Water body description, characterization, and drawings/maps; 3. Configuration, coordinates, operation schedule, flow regime, and drawings; 4. Species, life stages, abundance, reproduction/recruitment, impingement/entrainment potential, protective measures; 5. Description, calculations, performance, impingement/entrainment technology performance; 6. Impingement mortality standard compliance method and studies; 7. Entrainment technology efficacy, entrainment survival data; 8. Description of units, capacity, upgrades, operating status; 9 – 13. For facilities with an actual intake flow of greater than 125 mgd. 14. Compliance method for new unit.

In lieu of the information required at 122.21(r)(4)(vi), the owner or operator of an existing facility or new unit at an existing facility must, based on readily available information at the time of the permit application, identify all federally-listed species and/or designated critical habitat that are or may be present within their action area. In correspondence received from EPA on April 8, 2014, EPA verified the following clarifications to the preceding statement:

i. "Readily available information" means information that is publicly available information, and includes information obtained from the Services. "Readily available information" is not limited to information that is in the facility's possession; however, facilities are not required to create new information (e.g. new studies or surveys) in order to identify federally-listed threatened and endangered species and/or designated critical habitat in their action area; and

ii. In the Preamble to the Rule, EPA describes the phrase “action area” in the following way: “The action area can generally be considered the area in the vicinity of the cooling water intake structure.” In the April 8, 2014, correspondence, EPA verified that whenever the phrase “action area” is used in the Preamble and Rule, it is to be interpreted in a manner consistent with the definition as found in the Services’ regulations implementing ESA Section 7 at 50 CFR 402.02. In other words, “action area” includes all areas that may be directly or indirectly affected by the operation of a facility’s CWIS.

The owner or operator of a facility may, in subsequent permit applications, request to reduce the information required, if conditions at the facility and in the water body remain substantially unchanged since the previous application so long as the relevant previously submitted information remains representative of current source water, intake structure, cooling water system, and operating conditions. Any habitat designated as critical or species listed as threatened or endangered after issuance of the current permit, whose range of habitat or designated critical habitat includes waters where a facility’s intake is located constitutes potential for a substantial change that must be addressed by the owner/operator in subsequent permit applications, unless the facility received an exemption pursuant to 16 U.S.C. 1536(o) or permit pursuant to 16 U.S.C. 1539(a) or there is no reasonable expectation of take. The owner or operator of a facility must submit a request for reduced information requirements regarding cooling water intake structure and waterbody information to the Director at least two years and six months prior to the expiration of its current NPDES permit. The owner or operator’s request must identify each element that it determines has not substantially changed since the previous permit application and the basis for the determination. The Director has the discretion to accept or reject any part of the request. The owner or operator of a facility must certify that its permit application is true, accurate and complete pursuant to § 122.22(d).

The Director may waive some or all information requirements of 40 CFR 122.21(r) if the intake is located in a manmade lake or reservoir and the fisheries are stocked and managed by a State or Federal natural resources agency or the equivalent. If the man-made lake or reservoir contains federally-listed threatened or endangered species or designated critical habitat, such a waiver shall not be granted.

2.2.3 BTA Standards for Impingement Mortality

EPA requires owners or operators to comply with one of following BTA Standards for Impingement Mortality, explained in detail in 40 CFR 125.94(c) and summarized below:

1) Closed-cycle recirculating system and daily monitoring of actual intake flows; or
2) Demonstrated ≤ 0.5 ft/sec through-screen design velocity; or
3) Demonstrated ≤ 0.5 ft/sec through-screen actual velocity* and daily monitoring of velocity; or
4) Existing offshore velocity cap and daily monitoring of intake flow; or
5) Modified traveling screens, optimized to minimize impingement mortality; or
6) BTA** systems of technology, management practices, and operational measures; or

7) 12-month impingement mortality performance standard and monthly monitoring:

$$\frac{\text{\# fish killed***}}{\text{\# fish impinged}} < 24 \text{ percent}$$

*Director may authorize the operator to exceed 0.5 fps for brief periods

**Determined by the Director

***After collected or retained in ≤ 0.56 inch sieve and held for 18 to 96 hours, or other Director specified period

Pursuant to the Rule, the owner or operator must also comply with any additional measures for shellfish and fragile species, as established by the Director. Fragile species as defined in the Rule means those species of fish and shellfish that are least likely to survive any form of impingement and have an impingement survival rate of less than 30 percent. The owner or operator of an existing facility with CWIS used for electric generating unit(s), each with an annual average capacity utilization rating of less than 8 percent (averaged over a 24-month contiguous period), may request that the Director establish site-specific BTA standards for impingement mortality that are less stringent than the Impingement Mortality Standards described above.

The Rule includes provisions for *de minimis* rates of impingement. In limited circumstances, rates of impingement may be so low at a facility that additional impingement controls may not be justified. In correspondence received from EPA on April 8, 2014 (attached as Appendix A), EPA verified that "where a Director determines, pursuant to §125.94(c)(11), that a facility's rate of impingement is so exceptionally low as to not warrant additional impingement controls, the Services may still consider the detrimental effects of the facility operation to be more than minor if Federally-listed threatened or endangered species are subject to impingement." The Services may therefore still recommend species protection measures. For threatened and endangered species, all unauthorized take is prohibited by the ESA.

Where required by the Director, the owner or operator must implement any requirements for additional control measures, monitoring, and reporting that are designed to minimize incidental take, reduce or remove more than minor detrimental effects to federally-listed species and designated critical habitat, or avoid jeopardizing federally-listed species or destroying or adversely modifying designated critical habitat (e.g., prey base). Such control measures, reporting, and monitoring requirements may include measures or requirements that may have been identified by the Services during their 60 day review of the permit application or the public comment period.

Prior to the effective date of this rule , the owner or operator of an existing facility with a cumulative design intake flow (DIF) greater than 2 mgd is subject to site-specific impingement mortality and entrainment requirements as determined by the Director on a case-by-case Best Professional Judgment basis. On or after the effective date of this rule, the owner or operator of an existing facility with a cumulative design intake flow (DIF) greater than 2 mgd is subject to the BTA standards for impingement mortality under paragraph 125.94(c) of the rule, and entrainment under paragraph 125.94(d) of the rule including any measures to protect Federally-listed threatened and endangered species and designated critical habitat established under paragraph 125.94(g) of the rule. After issuance of a final permit that establishes the entrainment requirements, EPA requires the owner or operator of an existing facility to comply with the impingement mortality standard as soon as practicable. The owner or operator of a new unit at an existing facility must comply with the BTA standards in paragraph § 125.94(e) with respect to the new unit upon commencement of the new unit's operation.

2.2.4 BTA Standards for Entrainment

The Rule requires the Director to establish requirements that reflect the BTA standards for entrainment for each CWIS on a site-specific basis that must reflect the maximum reduction in entrainment warranted by §125.98 of the Rule. The owner or operator of an existing facility must comply with BTA standard for entrainment, as determined by the Director.

The owner or operator of a new unit at an existing facility must achieve the impingement mortality and entrainment standards by: (1) reducing design intake flow for the new unit, at a minimum, to a level commensurate with that which can be attained by the use of a closed-cycle recirculating system for the same level of cooling for the new unit; or (2) demonstrating to the Director that they will operate and maintain technologies for the intake flow serving the new unit that demonstrate entrainment reductions equivalent to at least 90 percent of the reduction that could be achieved through compliance with intake flow commensurate with a closed-cycle system (i.e., 125.92(c)(1)). Exceptions are described in the Rule, and the Director may establish alternative requirements or additional BTA standards for entrainment on a site-specific basis.

Where required by the Director, the owner or operator must implement any requirements for additional control measures, monitoring, and reporting that are designed to minimize incidental take, reduce or remove more than minor detrimental effects to federally-listed species and designated critical habitat, or avoid jeopardizing federally-listed species or destroying or adversely modifying designated critical habitat. Such control measures, reporting, and monitoring requirements may include measures and requirements that may have been identified by the Services during their 60 day review of the permit application or the public comment period.

Prior to 42 months after the effective date of the rule, the Director determines on a case-by-case basis when the facility becomes subject to site-specific entrainment requirements; after 42 months after the effective date of the rule, the owner or operator is subject to the entrainment standard. After issuance of a final permit that establishes the entrainment requirements, EPA requires the owner or operator of an existing facility to comply with the entrainment standard as soon as practicable, based on a schedule of requirements established by the Director. The owner or operator of a new unit at an existing facility must comply with the impingement mortality standard upon commencement of the new unit's operation.

2.2.5 Monitoring

EPA has established monitoring requirements for some of the BTA Standards for Impingement Mortality, described above. The owner or operator complying with the 12-month impingement mortality performance standard (§125.94(c)(7)) may request the Director to reduce monitoring requirements after the first full permit term in which these monitoring requirements are implemented, if the facility's CWIS does not directly or indirectly affect federally-listed species or designated critical habitat. To do so, the results of the monitoring to date must demonstrate that the owner or operator of the facility has consistently operated the intake as designed and is meeting the impingement mortality standard. In addition, the Director will determine entrainment monitoring requirements on a site-specific basis, as appropriate, to achieve the maximum reduction in entrainment warranted. The Director may require additional monitoring for a variety of reasons as specified in §125.96 of the Rule, including additional monitoring for federally-listed species. Where the Director requires additional monitoring for federally-listed species or critical habitat, the owner/operator must implement such monitoring.

The owner or operator of a new unit at an existing facility must either: (option 1) monitor flow intake daily and under normal operating conditions, to determine whether the levels are commensurate with that which can be attained by the use of a closed-cycle recirculating system; or (option 2) continue monitoring entrainment, to demonstrate entrainment reductions are commensurate with a closed-cycle recirculating system. If an owner/operator chooses to continue monitoring entrainment (option 2), the owner or operator of a new unit at an existing facility must monitor entrainable organisms at a proximity to the intake that is representative of the entrainable organisms in the absence of the intake structure. They must also monitor the latent entrainment mortality in front of the intake structure. Latent mortality is defined as the delayed mortality of organisms that were initially alive upon being impinged or entrained but that do not survive the delayed effects of impingement and entrainment during an extended holding period. Mortality after passing the cooling water intake structure must be counted as 100 percent mortality, unless the owner or operator has demonstrated to the approval of the Director that the mortality for each species is less than 100 percent.

Monitoring must be representative of the cooling water intake when the structure is in operation. In addition, sufficient samples must be collected to allow for calculation of annual average entrainment levels of all life stages of fish and shellfish. The Director will determine specific monitoring protocols and frequency of monitoring. The owner or operator of a new facility must follow the monitoring frequencies identified by the Director for at least 2 years after the initial permit issuance. After that time, the Director may approve a request for less frequent monitoring in the remaining years of the permit term and when subsequent permits are issued. The monitoring must measure the total count of entrainable organisms or density of organisms, unless the Director approves of a different metric for such measurements. In addition, the owner or operator must monitor the actual intake flow for each intake. The actual intake flow must be measured at the same time as the samples of entrainable organisms are collected. The Director may require additional monitoring necessary to demonstrate compliance with the entrainment standard.

EPA requires an owner or operator of an existing facility to either conduct visual inspections or employ remote monitoring devices during the period the cooling water intake structure is in operation. The owner or operator must conduct such inspections at least weekly to ensure that any technologies operated to minimize adverse environmental impact using BTA standards are maintained and operated to function as designed, including those installed to protect federally-listed species or designated critical habitat. The Director may establish alternative procedures if this requirement is not feasible (e.g., an offshore intake, velocity cap, or during periods of inclement weather).

2.2.6 Reporting

EPA requires the owner or operator to submit to the Director the following information:

- Monitoring Reports (Discharge Monitoring Reports or equivalent state reports and results of all monitoring; demonstrations, and other information required by the permit sufficient to determine compliance with the permit conditions and requirements established under § 125.94(g);
- Status reports required by the Director;
- Signed annual certification statement and report (indicating substantial modifications, if any);
- Additional supplemental permit reporting, as determined by the Director; and
- Where the Director requires additional reporting for federally-listed species or critical habitat, the owner/operator must provide such reporting.

In addition, the Director may require supplemental recordkeeping, such as compliance and other monitoring or supplemental data collection required in the permit application.

The owner or operator of a facility must keep records of all permit application submissions until the subsequent permit is issued to document compliance. If the Director approves a request for reduced permit application studies, the owner or operator of a facility must keep records of all submissions that are part of the previous permit application until the subsequent permit is issued. The owner or operator must keep all records supporting the Director's determination of BTA for the entrainment standard until it is revised by the Director.

2.2.7 Incidental Take

The Rule does not authorize take of endangered or threatened species. Under the ESA, take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 USC 1532(19)), of endangered or threatened species. Harm is defined by the Services to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is further defined by the USWFS as actions that create the likelihood of injury to listed species by annoying them to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering (50 C.F.R. 17.3). Because EPA defines impingement as entrapment and entrainment as entering or passing through a CWIS and into the cooling water system, and we interpret these as examples of "trap," "capture," and "harass," we have determined that any impingement or entrainment of federally-listed species constitutes take. As cited in the Rule, incidental take of endangered species (and threatened species, as applicable, under 16 U.S.C. 1533(d)) is prohibited under the ESA (16 U.S.C. 1538), unless it is permitted (16 U.S.C. 1539(a)) or exempted (16 U.S.C. 1536(o)) by the Services. Absent such exemption or permit, any facility operating under the authority of this Rule must not take federally threatened or endangered species.

2.3 Director Requirements

In the Rule, EPA establishes many requirements of the Director by indicating that the Director "must" or "shall" perform some action. EPA also provides discretion by indicating that the Director "may" or "should" perform some optional task. For the purposes of this Opinion, we focus on requirements because we must evaluate the Federal action (not the discretionary decisions of Directors) and whether EPA's action is not likely to jeopardize the continued existence of any federally-listed species or result in the destruction or adverse modification of designated critical habitat. Therefore, we focus on the requirements ("must" or "shall") established in the Rule; however, we describe and have considered the optional elements of the Rule ("may" or "should") to characterize the extent of discretion allowed in the Rule.

2.3.1 Permit Application

EPA requires the Director to review the materials submitted by the applicant (see Table 1) for completeness at the time of initial permit application and before each permit renewal or reissuance.

2.3.2 Permitting Requirements

Section 316(b) requirements are implemented through a NPDES permit. EPA requires the Director to determine the requirements and conditions to include in the permit, based on the information submitted in the permit application, and EPA's 316(b) regulations. Under the regulation, the permit must include:

- The following language as a permit condition: "Nothing in this permit authorizes take for the purposes of a facility's compliance with the Endangered Species Act."
- At minimum, the monitoring and reporting requirements described above.
- For permits issued after 42 months after the effective date of the rule:
    - At a minimum, conditions to implement and ensure compliance with the impingement mortality and entrainment standards, including any measures to protect ESA-listed species and designated critical habitat required by the Director.
    - Conditions, management practices, and operational measures necessary to ensure proper operation of any technology used to comply with the impingement mortality standard and the entrainment standard.
- For permits issued before 42 months after the effective date of the rule, or permits issued after but applied for before the effective date of the final rule, the Director must establish interim BTA requirements in the permit on a site-specific basis, based on the Director's best professional judgment.
- If modified screens or BTA systems of technology, management practices, and operational measures are selected as the BTA Standard for Impingement Mortality, the permit must include operational measures and best management practices identified in the impingement technology performance optimization study as described in §122.21(r)(6) of the Rule and deemed as necessary by the Director to ensure optimized operation of the modified traveling screens or other systems of technologies.

The permit may include requirements for the protection of federally-listed species and designated critical habitat, including:

- Additional control measures, monitoring requirements, and reporting requirements that are designed to minimize incidental take, reduce or remove more than minor detrimental effects to federally-listed species and designated critical habitat, or avoid jeopardizing federally-listed species or destroying or adversely modifying designated critical habitat (e.g. prey base). Such control measures, monitoring requirements, and reporting requirements may include measures or requirements identified by the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service during the 60 day review period pursuant to 125.98(h) or the public notice and comment period pursuant to 40 C.F.R. 124.10;

- o As described in the Preamble of the Rule and further clarified in correspondence received from EPA on April 8, 2014, in situations where the Services have provided the Director control measures, monitoring, or reporting recommendations for the protection of federally-listed species or designated critical habitat, and the permit will have more than minor detrimental effect on federally-listed species or critical habitat that cannot be resolved with the State or Tribal permitting authority:
  - i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;
  - ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and
  - iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
    - o Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

The Director may require additional permit requirements if:

- There are migratory or sport or commercial species subject to entrainment that may be directly or indirectly affected by the CWIS, based on information submitted to the Director by any fishery management agency or other relevant information; or
- It is determined by the Director, based on information submitted by any fishery management agencies or other relevant information, that the facility, after meeting the entrainment standard of this section, would still result in undesirable cumulative stressors to ESA-listed and proposed species and designated and proposed critical habitat.
- For permits expiring prior to or on the date 42 months after the effective date of the rule, for which the Director has established an alternate schedule for submission of the permit application information (see Table 1), permit conditions to ensure that, for any subsequent permit, the Director will have all the information required to establish BTA impingement and entrainment requirements.
- For permits applied for before, but issued after the final Rule, the Director may include permit conditions to ensure that all the information necessary to establish BTA impingement and entrainment requirements for the subsequent permit is included.
- For new units at existing facilities, the Director may establish alternative requirements if: 1) the data specific to the facility indicate that compliance with the requirements is commensurate with closed cycle recirculating system design intake flow; 2) or entrainment reductions for each new unit would result in compliance costs wholly out of proportion to the costs EPA considered in establishing the requirements at issue, would

result in significant adverse impacts on local air quality or local water resources other than impingement or entrainment, or significant adverse impacts on local energy markets:
    - The alternative requirements must achieve a level of entrainment reduction that is equivalent to 90 percent or greater of the reduction that could be achieved with closed cycle recirculating system, as described above;
    - The alternative requirements must ensure compliance with these regulations other provisions of the CWA and state and tribal law;
    - The burden is on the owner or operator of the facility requesting the alternative requirement to demonstrate that alternative requirements should be authorized for the new unit.
- Additional measures are needed, such as seasonal deployment of barrier nets, to protect shellfish;
- Additional technologies are needed for protection of fragile species; and
- Additional study and monitoring if a threatened or endangered species has been identified in the vicinity of the intake.

The Director may waive some or all of the information requirements (see Table 1) if the intake is located in a man-made lake or reservoir and the fisheries are stocked and managed by a State or Federal natural resources agency or the equivalent; however, if the man-made lake or reservoir contains federally-listed species or designated critical habitat, such a waiver shall not be granted.

2.3.3 Impingement

When the Director establishes a schedule of BTA requirements, the schedule must provide for compliance with impingement mortality and entrainment standards as soon as practicable.

If the owner or operator chooses to comply with the BTA Standard for Impingement Mortality with modified traveling screens or systems of technology, management practices, and operational measures, and the Director concludes that the study does not establish that the proposed technology is the best technology available for impingement reduction for the site, then the Director must determine other impingement reduction controls for the facility. The Director may request further monitoring and information as part of the "impingement technology performance optimization study," including extending the study period beyond two years. The Director may waive all or part of the impingement technology performance optimization study after the first permit cycle after the rule wherein the permittee is deemed in compliance with the BTA Standard for Impingement Mortality.

Depending on a facility's choice to comply with the BTA Standard for Impingement Mortality, the Director may approve of impinged fish being returned to water sources other than the original source water, taking into account any recommendations from the Services with respect to endangered or threatened species. Based on correspondence received from EPA on April 8, 2014, EPA verified that Directors will address any concerns from the Services regarding the return of aquatic species to waters other than their source waters. If the Services' concerns are not addressed and the permit would cause more than minor detrimental effects, the permit will be subject to the EPA oversight provisions as described above.

2.3.4 Entrainment

When the Director establishes a schedule of BTA requirements, the schedule must provide for compliance with impingement mortality and entrainment standards as soon as practicable.

The Rule requires the Director to establish BTA requirements for entrainment for each intake on a site-specific basis. The Director must establish site-specific requirements for entrainment after reviewing the information submitted by the owner or operator (see Table 1). These entrainment requirements must reflect the Director's determination of the maximum reduction in entrainment warranted after consideration of factors relevant for determining the BTA for minimizing adverse environmental impact at each facility. These entrainment requirements may also reflect any control measures to reduce entrainment of federally-listed species and designated critical habitat (e.g. prey base). The Director may reject an otherwise available technology as a basis for entrainment requirements if the Director determines, among other things, there are unacceptable adverse impacts, including: impingement, entrainment, or other adverse effects to federally-listed species or designated critical habitat. Prior to any subsequent permit issuance after the date 42 months after the effective date of the rule, the Director must review the performance of the facility's installed entrainment technology to determine whether it continues to meet the requirements of the BTA entrainment standards for existing facilities.

The Director must provide a written explanation of the proposed entrainment determination in the fact sheet or statement of basis for the proposed permit. The written explanation must describe why the Director has rejected any entrainment control technologies or measures that perform better than the selected technologies or measures, and must reflect consideration of all reasonable attempts to mitigate any adverse impacts of otherwise available better performing entrainment technologies. The proposed determination in the fact sheet or statement of basis must be based on consideration of any additional information required by the Director and the following factors:

- Numbers and types of organisms entrained, including, specifically, the numbers and species (or lowest taxonomic classification possible) of ESA-listed species and designated critical habitat (e.g., prey base);
- Impact of changes in particulate emissions or other pollutants associated with entrainment technologies;
- Land availability inasmuch as it relates to the feasibility of entrainment technology and remaining useful plant life; and
- Quantified and qualitative social benefits and costs of available entrainment technologies when such information on both benefits and costs is of sufficient rigor to make a decision.

The proposed determination in the fact sheet or statement of basis may be based on consideration of the following factors:

- Entrainment impacts on the waterbody;
- Thermal discharge impacts;
- Credit for unit retirements occurring within the past 10 years;
- Impacts on water consumption; and/or
- Availability of process water, gray water, waste water, reclaimed water, or other waters of appropriate quantity and quality for reuse as cooling water.

In implementing their responsibilities under the entrainment requirements, the Director is authorized to inspect the facility and to request additional information needed to determine permit conditions and requirements.

2.3.5 Monitoring and Reporting

At a minimum, the Director must require the permittee to monitor as required at § 125.94 (BTA standards compliance requirements for owners and operators), § 125.96 (monitoring requirements for owners and operators) and report as specified at §125.97 (reporting requirements for owners and operators). The Director shall determine monitoring requirements for entrainment on a site-specific basis. The Director may establish additional monitoring and reporting requirements, including monitoring and reporting requirements monitoring for federally-listed species. The Rule requires State Directors submit at least annually the results of such monitoring and reporting in facilities' annual reports, to the appropriate EPA Regional Office.

- EPA verified on April 8, 2014, that in circumstances where the Services have provided State Directors recommendations for control measures or monitoring and reporting requirements designed to minimize incidental take, reduce or remove more than minor detrimental effects to Federally-listed species and designated critical habitat, or avoid jeopardizing Federally-listed species or destroying or adversely modifying designated critical habitat, and the Services are concerned that without such control measures or monitoring and reporting requirements the permit may result in more than minor detrimental effects to federally-listed species or designated critical habitat, a State Director's failure to include these recommendations or requirements will subject the permit to EPA oversight provisions as outlined in the Preamble of the Rule, the April 8, 2014, correspondence from EPA, and in section 2.1 of this Opinion.

The Director may reduce monitoring requirements as follows:

- For new units at existing facilities, after 2 years following the initial permit issuance, the Director may approve a request for less frequent monitoring for impingement and entrainment in the remaining years of the permit term and when the permit is reissued.
- Where the facility's CWIS does not directly or indirectly affect federally-listed species or designated critical habitat, an owner or operator choosing the impingement mortality performance standard, may request the Director to reduce monitoring requirements after the first full permit term in which these monitoring requirements are implemented, on the condition that the results of the monitoring to date demonstrate that the owner or operator of the facility has consistently operated the intake as designed and is meeting the impingement mortality standard requirements.

2.3.6 Incidental Take

EPA requires the Director to include the following language as a permit condition: "Nothing in this permit authorizes take for the purposes of a facility's compliance with the Endangered Species Act."

2.3.7 Permit Notification

EPA requires the Director to transmit all permit applications received from existing facilities to the appropriate Field Office of the U.S. Fish and Wildlife Service and/or Regional Office of the National Marine Fisheries Service upon receipt for a 60 day review prior to public notice of the draft or proposed permit. Directors may not propose/publish the draft permit until the 60 day Service review period has ended. Under current EPA NPDES regulations, Directors are also required to provide for public notice and a public comment period (40 CFR §§ 124.10 & 124.11) and to submit a copy of the fact sheet or statement of basis (prepared in the case of EPA-issued permits), the permit application (if any), and the draft permit (if any) to the Services. This includes notice of specific CWIS requirements and notice of the draft permit and any specific information the Director has about threatened or endangered species and critical habitat that are or may be present in the action area, including any proposed control measures and monitoring and reporting requirements for such species and habitat.

2.3.8 Permit Modification

As described in the Preamble, "the NPDES regulations also allow a Director to modify a permit during the term of the permit, consistent with the Federal regulations at 40 CFR sections 122.62, 122.63, 122.64, and 124.5. Among other things, under 40 CFR 122.62, causes for permit modification include new information, not available at the time of permit issuance, including information on newly listed threatened or endangered species or federally-designated critical habitat (or unanticipated impacts thereto) received that would have justified the application of different permit conditions at the time of issuance."

3.0 Approach to the Assessment

Section 7(a)(2) requires every Federal agency, in consultation with and with the assistance of the Services, insure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any ESA-listed species or result in the destruction or adverse modification of critical habitat (16 U.S.C. 1539). During the consultation summarized by this Opinion, we reviewed all relevant information provided by EPA to describe the action, including interrelated and interdependent actions. Interrelated actions are part of a larger action and depend on the larger action for their justification. Interdependent actions have no independent utility apart from the proposed action (50 CFR 402.02). We also described the action area, which includes all areas affected directly or indirectly by the action (50 CFR 402.02) and evaluated the current status of ESA-listed and designated critical habitat that may be affected by this proposed action.

We evaluated the direct and indirect effects of the action on ESA-listed species and designated critical habitat. Indirect effects are caused by the proposed action and are later in time, but still are reasonably certain to occur (50 CFR 402.02). We assessed the exposure to physical, chemical, or biotic stressors produced by the proposed action, whether such exposure is likely to reduce the survival and reproduction of individuals, and whether fitness reductions would threaten the viability of populations and species. We assessed whether the action would appreciably reduce the likelihood of recovery of listed species. We assessed whether the action is likely to reduce the conservation value of critical habitat. We did not rely on the regulatory definition of "destruction or adverse modification of critical habitat (50 CFR 402.02); instead, we relied upon the statutory provisions of the ESA to complete our critical habitat analysis. We also searched for data on cumulative effects of non-Federal activities (i.e., State and private) that are reasonably certain to occur within the action area. For all analyses, we used the best available scientific and commercial data. For this consultation, we relied on information submitted by the action agency, government reports, and the general scientific literature.

We used the above process to formulate this Opinion. Because we are consulting on the issuance and implementation of a Federal Rule, which regulates many activities conducted over several geographic areas and long periods of time, there is substantial uncertainty about the number, location, timing, frequency, and intensity of individual activities. Therefore, we conducted a programmatic consultation to determine whether EPA's issuance and implementation of the Rule as described in the Description of the Proposed Action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

4.0 Action Area

Under section 7 implementing regulations, action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). As the effects of CWIS can extend well beyond the footprint of the structure, for purposes of this consultation, the action area consists of waters over which EPA has jurisdiction, see Section 502(7-10), 33 U.S.C. 1362(7-10), from which existing facilities withdraw water for cooling purposes (Figure 1).

Although not necessarily regulated by EPA, the action area also includes other wetland or aquatic sites that do not meet the definition of "Waters of the U.S." and/or adjacent upland areas that may be affected by water intake associated with CWIS (i.e., impingement, entrainment, or other adverse effects caused by resultant environmental changes, including but not limited to loss of prey, changes in water quality, and flow alteration).

The location of all facilities that may be within the action area of the rule is unknown. From a survey that EPA conducted, however, EPA knows the names and location of 575 electric generating facilities and 230 manufacturers that may be within action area of the rule. The survey was a census of electric generating facilities. For manufacturers, however, a weighted sample was collected. For the purpose of analyzing the rule, EPA estimated that 544 electric generating facilities and 521 manufacturing facilities, or a total of 1,065 facilities, will be subject to the rule (ABT 2014).

While EPA is confident that in its estimate that there are 1,065 total facilities with one or more cooling water intake structures, because of the sample of manufacturers, EPA does not know the location of roughly 315 of these facilities (ABT 2014). Consequently, in order to produce a better sense of manufacturers' locations for the purpose of the biological evaluation, EPA developed an upper-bound set of manufacturers. This set included all manufacturers that may potentially be within the Agency's action area of the rule, found by searching its permit database for facilities that hold a NPDES permit and share a North American Industry Classification code with manufacturing facilities that responded to the survey that they had a CWIS. This search identified the location of an additional 2,925 manufacturing facilities that may be within action area of the rule. EPA added the 2,925 additional manufacturing facilities to the 575 electric generating facilities and 230 manufacturers with known locations to estimate that a total of 3,730 facilities may potentially be within the action area of the rule. It is important to note that EPA is confident that only 1,065 of these 3,730 facilities have a cooling water intake structure (ABT 2014). Nonetheless the set of 3,730 facilities, which represents an upper bound estimate of the number off facilities that may possibly have cooling water intakes, allows the Services to identify the broadest set of ESA-listed species that may be affected CWISs.

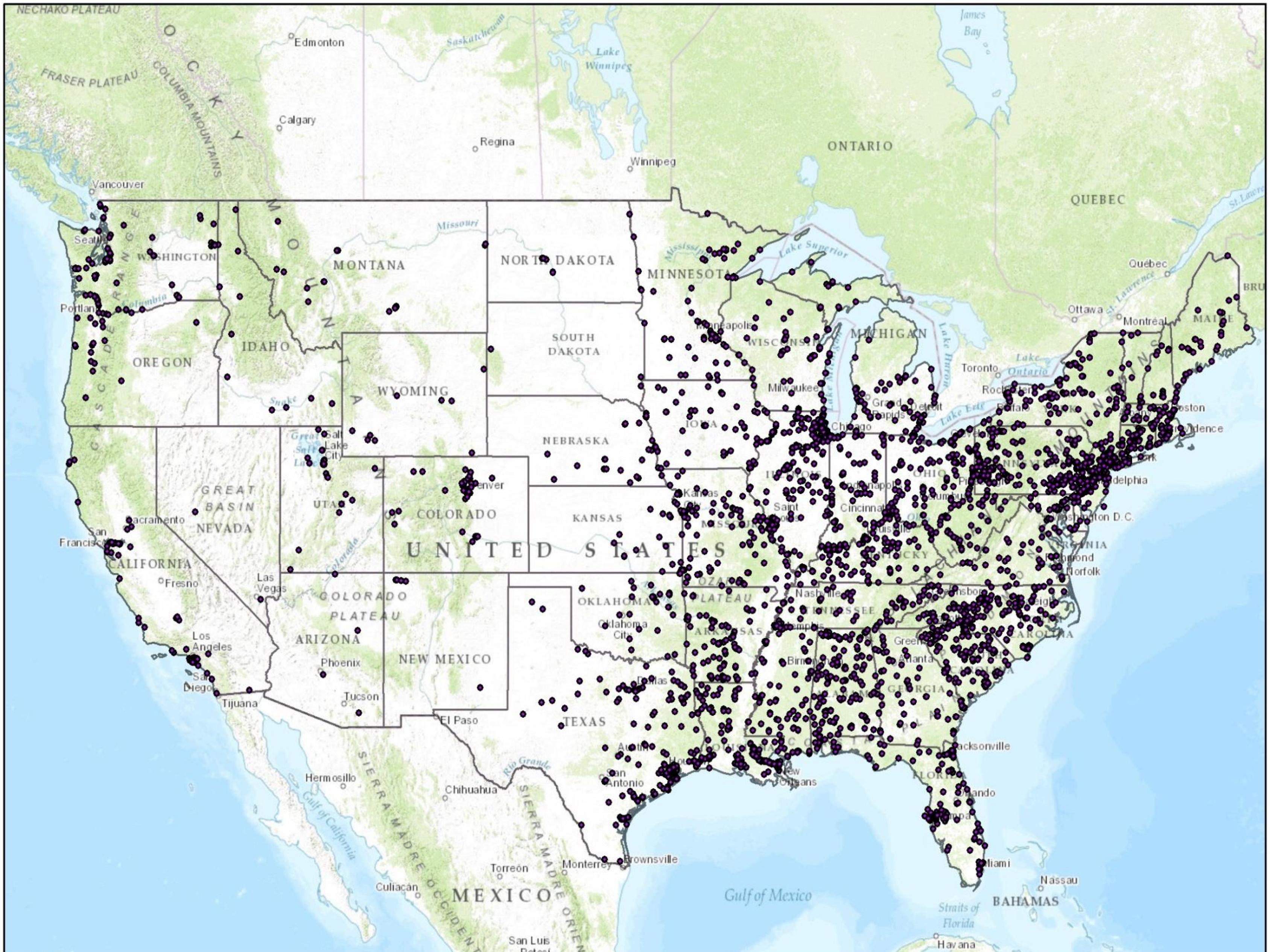


Figure 1. Approximate Locations of Facilites Potentially Regulated by EPA's Final 316(b) Rule

Facility Location

N

0 125 250 500 Miles

5.0 Status of the Species

In the biological evaluation, EPA identified 312 species that may be affected by the proposed Rule (Table 2-2 of biological evaluation). Table 2 represents a refinement of EPA's list of 312 to include only those species under the jurisdiction of the USFWS we believe may be affected by the proposed action (n=195). Table 3 includes those species distinct population segments, evolutionarily significant units, or subspecies under the jurisdiction of the NMFS we believe may be affected by the proposed action (n=71). We reach this conclusion based on the overlap between the species' habitats and facilities with CWISs, and/or the level of effect on the species from CWISs that may result in incidental take.

For more information regarding the individual species and critical habitats listed in Table 2, and the factors affecting their conservation status, please refer to proposed and final listing determinations, critical habitat designations, recovery plans, and five-year reviews available at: http://ecos.fws.gov/ecos/indexPublic.do. For more information regarding the individual species and critical habitats listed in Table 3 and the factors affecting their conservation status, please refer to Appendix B. The discussion that follows focuses on attributes of life history and distribution that influence the manner and likelihood that species may be exposed to the proposed action, as well as the species potential response and risk when exposure occurs.

Table 2. ESA-listed species and critical habitat that may be adversely affected by EPA's proposed 316(b) regulation under the jurisdiction of USFWS.

Common Name	Scientific Name	Status	Critical Habitat
Amphibians			
Ozark Hellbender	*Cryptobranchus alleganiensis*	Endangered	No*
Barton Springs Salamander	*Eurycea sosorum*	Endangered	Yes
California Red-Legged Frog	*Rana draytonii*	Threatened	Yes
Birds			
Hawaiian (=Koloa) Duck	*Anas wyvilliana*	Endangered	No*
Marbled Murrelet	*Brachyramphus marmoratus*	Threatened	No
Western Snowy Plover	*Charadrius alexandrinus nivosus*	Threatened	Yes
Piping Plover	*Charadrius melodus: Great Lakes*	Endangered	No
Piping Plover	*Charadrius melodus: Non-Great*	Threatened	No
Hawaiian Coot	*Fulica americana alai*	Endangered	No*
Hawaiian Common Moorhen	*Gallinula chloropus sandvicensis*	Endangered	No*
Whooping Crane	*Grus americana*	Endangered	Yes
Mississippi Sandhill Crane	*G. canadensis pulla*	Endangered	No
Hawaiian Stilt	*Himantopus mexicanus knudseni*	Endangered	No*
Wood Stork	*Mycteria americana*	Endangered	No*
Eskimo Curlew	*Numenius borealis*	Endangered	No*
Short-Tailed Albatross	*Phoebastria (=Diomedea) albatrus*	Endangered	No*
Steller's Eider	*Polysticta stelleri*	Threatened	No
Light-Footed Clapper Rail	*Rallus longirostris levipes*	Endangered	No*
California Clapper Rail	*R. longirostris obsoletus*	Endangered	No*
Yuma Clapper Rail	*R. l. yumanensis*	Endangered	No*

Common Name	Scientific Name	Status	Critical Habitat
Everglade Snail Kite	*Rostrhamus sociabilis plumbeus*	Endangered	No*
Least Tern	*Sterna antillarum*	Endangered	No*
California Least Tern	*S. antillarum browni*	Endangered	No*
Roseate Tern	*S. dougallii dougallii*	Threatened	No*
Bivalves			
Cumberland Elktoe	*Alasmidonta atropurpurea*	Endangered	No
Dwarf Wedgemussel	*A. heterodon*	Endangered	No*
Appalachian Elktoe	*A. raveneliana*	Endangered	No
Fat (Mussel) Three-Ridge	*Amblema neislerii*	Endangered	No
Ouachita Rock Pocketbook	*Arkansia wheeleri*	Endangered	No*
Spectaclecase (Mussel)	*Cumberlandia monodonta*	Endangered	No*
Fanshell	*Cyprogenia stegaria*	Endangered	No*
Dromedary Pearlymussel	*Dromus dromas*	Endangered	No*
Chipola Slabshell	*Elliptio chipolaensis*	Threatened	Yes
Altamaha Spinymussel	*E. spinosa*	Endangered	No
Tar River Spinymussel	*E. steinstansana*	Endangered	No*
Purple (Mussel) Bankclimber	*Elliptoideus sloatianus*	Threatened	No
Cumberlandian Combshell	*Epioblasma brevidens*	Endangered	Yes
Oyster Mussel	*E. capsaeformis*	Endangered	Yes
Curtis Pearlymussel	*E. florentina curtisii*	Endangered	No*
Yellow (Pearlymussel) Blossom	*E. f. florentina*	Endangered	No*
Tan Riffleshell	*E. f. walkeri (=E. walkeri)*	Endangered	No*
Upland Combshell	*E. metastriata*	Endangered	No
Purple Cat's Paw (=Purple Cat's Paw Pearlymussel)	*E. obliquata obliquata*	Endangered	No*
White (Pearlymussel) Catspaw	*E. o. perobliqua*	Endangered	No*
Southern Acornshell	*E. othcaloogensis*	Endangered	No
Southern Combshell	*E. penita*	Endangered	No*
Green (Pearlymussel) Blossom	*E. torulosa gubernaculum*	Endangered	No*
Northern Riffleshell	*E. t. rangiana*	Endangered	No*
Tubercled (Pearlymussel) Blossom	*E. t. torulosa*	Endangered	No*
Snuffbox Mussel	*E. triquetra*	Endangered	No*
Turgid (Pearlymussel) Blossom	*E. turgidula*	Endangered	No*
Tapered Pigtoe	*Fusconaia burkei*	Threatened	No
Shiny Pigtoe	*F. cor*	Endangered	No*
Finerayed Pigtoe	*F. cuneolus*	Endangered	No*
Narrow Pigtoe	*F. escambia*	Threatened	No
Round Ebonyshell	*F. rotulata*	Endangered	No
Cracking Pearlymussel	*Hemistena lata*	Endangered	No*
Pink (Pearlymussel) Mucket	*Lampsilis abrupta*	Endangered	No*
Finelined Pocketbook	*L. altilis*	Threatened	No
Higgins Eye (Pearlymussel)	*L. higginsii*	Endangered	No*
Orangenacre Mucket	*L. perovalis*	Threatened	Yes
Arkansas Fatmucket	*L. powellii*	Threatened	No*

Common Name	**Scientific Name**	**Status**	**Critical Habitat**
Shinyrayed Pocketbook	*L. subangulata*	Endangered	Yes
Speckled pocketbook	*L. streckeri*	Endangered	No*
Alabama Lampmussel	*L. virescens*	Endangered	No*
Carolina Heelsplitter	*Lasmigona decorata*	Threatened	No
Birdwing Pearlymussel	*Lemiox rimosus*	Endangered	No*
Scaleshell Mussel	*Leptodea leptodon*	Endangered	No*
Louisiana Pearlshell	*Margaritifera hembeli*	Threatened	No*
Alabama Pearlshell	*M. marrianae*	Endangered	No
Alabama Moccasinshell	*Medionidus acutissimus*	Threatened	No
Coosa Moccasinshell	*M. parvulus*	Endangered	No
Gulf Moccasinshell	*M. penicillatus*	Endangered	Yes
Ochlockonee Moccasinshell	*M. simpsonianus*	Endangered	Yes
Ring Pink (Mussel)	*Obovaria retusa*	Endangered	No*
Littlewing Pearlymussel	*Pegias fabula*	Endangered	No*
White (Pearlymussel) Wartyback	*Plethobasus cicatricosus*	Endangered	No*
Orangefoot (Pearlymussel) Pimpleback	*P. cooperianus*	Endangered	No*
Sheepnose Mussel	*P. cyphyus*	Endangered	No*
Clubshell	*Pleurobema clava*	Endangered	No*
James Spinymussel	*P. collina*	Endangered	No*
Black Clubshell	*P. curtum*	Endangered	No*
Southern Clubshell	*P. decisum*	Endangered	Yes
Dark Pigtoe	*P. furvum*	Endangered	No
Southern Pigtoe	*P. georgianum*	Endangered	No
Cumberland Pigtoe	*P. gibberum*	Endangered	No*
Georgia Pigtoe	*P. hanleyianum*	Endangered	No
Flat Pigtoe	*P. marshalli*	Endangered	No*
Ovate Clubshell	*P. perovatum*	Endangered	No
Rough Pigtoe	*P. plenum*	Endangered	No*
Oval Pigtoe	*P. pyriforme*	Endangered	Yes
Fuzzy Pigtoe	*P. strodeanum*	Threatened	No
Heavy Pigtoe	*P. taitianum*	Endangered	No*
Fat Pocketbook	*Potamilus capax*	Endangered	No*
Alabama (=Inflated) Heelsplitter	*P. inflatus*	Threatened	No*
Triangular Kidneyshell	*Ptychobranchus greenii*	Endangered	No
Southern Kidneyshell	*P. jonesi*	Endangered	No
Rough Rabbitsfoot	*Quadrula cylindrica strigillata*	Endangered	Yes
Winged Mapleleaf	*Q. fragosa*	Endangered	No*
Cumberland (Pearlymussel) Monkeyface	*Q. intermedia*	Endangered	No*
Appalachian (Pearlymussel) Monkeyface	*Q. sparsa*	Endangered	No*
Stirrupshell	*Q. stapes*	Endangered	No*
Pale (Pearlymussel) Lilliput	*Toxolasma cylindrellus*	Endangered	No*
Choctaw Bean	*Villosa choctawensis*	Endangered	No*
Rayed Bean	*V. fabalis*	Endangered	No*

Common Name	Scientific Name	Status	Critical Habitat
Purple Bean	*V. perpurpurea*	Endangered	Yes
Cumberland (Pearlymussel) Bean	*V. trabalis*	Endangered	No*
Fish			
Gulf Sturgeon	*Acipenser oxyrinchus desotoi*	Threatened	Yes
White Sturgeon	*A. transmontanus*	Endangered	No
Santa Ana Sucker	*Catostomus santaanae*	Threatened	No
June Sucker	*Chasmistes liorus*	Endangered	No
Laurel Dace	*Chrosomus saylori*	Endangered	No
Blue Shiner	*Cyprinella caerulea*	Threatened	No*
Spotfin Chub	*Erimonax monachus*	Threatened	No
Slender Chub	*Erimystax cahni*	Threatened	No
Slackwater Darter	*Etheostoma boschungi*	Threatened	No
Relict Darter	*E. chienense*	Endangered	No*
Etowah Darter	*E. etowahae*	Endangered	No*
Niangua Darter	*E. nianguae*	Threatened	No
Duskytail Darter	*E. percnurum*	Endangered	No*
Rush Darter	*E. phytophilum*	Endangered	No
Bayou Darter	*E. rubrum*	Threatened	No*
Cherokee Darter	*E. scotti*	Threatened	No*
Maryland Darter	*E. sellare*	Endangered	No
Cumberland Darter	*E. susanae*	Endangered	No
Boulder Darter	*E. wapiti*	Endangered	No*
Tidewater Goby	*Eucyclogobius newberryi*	Endangered	No
Unarmored Threespine Stickleback	*Gasterosteus aculeatus williamsoni*	Endangered	No*
Hutton Tui Chub	*Gila bicolor* ssp.	Threatened	No*
Mohave Tui Chub	*G. b. ssp. mohavensis*	Endangered	No*
Humpback Chub	*G. cypha*	Endangered	No
Bonytail Chub	*G. elegans*	Endangered	No
Gila Chub	*G. intermedia*	Endangered	No
Virgin River Chub	*G. seminuda (=robusta)*	Endangered	No
Rio Grande Silvery Minnow	*Hybognathus amarus*	Endangered	No
Delta Smelt	*Hypomesus transpacificus*	Threatened	Yes
White River Spinedace	*Lepidomeda* albivallis	Endangered	No
Little Colorado Spinedace	*Lepidomeda vittata*	Threatened	No
Spikedace	*Meda fulgida*	Endangered	No
Waccamaw Silverside	*Menidia extensa*	Threatened	No
Palezone Shiner	*Notropis albizonatus*	Endangered	No*
Cahaba Shiner	*N. cahabae*	Endangered	No*
Arkansas River Shiner	*N. girardi*	Threatened	No
Cape Fear Shiner	*N. mekistocholas*	Endangered	No
Pecos Bluntnose Shiner	*N. simus pecosensis*	Threatened	No
Topeka Shiner	*N. topeka (=tristis)*	Endangered	No
Chucky Madtom	*N. crypticus*	Endangered	No

Common Name	Scientific Name	Status	Critical Habitat
Yellowfin Madtom	*N. flavipinnis*	Threatened	No
Neosho Madtom	*N. placidus*	Threatened	No*
Pygmy Madtom	*N. stanauli*	Endangered	No*
Scioto Madtom	*N. trautmani*	Endangered	No*
Greenback Cutthroat Trout	*O. clarki stomias*	Threatened	No*
Lahontan Cutthroat Trout	*O. clarkii henshawi*	Threatened	No*
Paiute cutthroat Trout	*O. clarkii seleniris*	Threatened	No*
Oregon Chub	*Oregonichthys crameri*	Threatened	No
Amber Darter	*Percina antesella*	Endangered	No
Goldline Darter	*P. aurolineata*	Threatened	No*
Conasauga Logperch	*P. jenkinsi*	Endangered	No
Leopard Darter	*P. pantherina*	Threatened	No
Roanoke Logperch	*P. rex*	Endangered	No*
Snail Darter	*P. tanasi*	Threatened	No*
Blackside Dace	*Phoxinus cumberlandensis*	Threatened	No*
Woundfin	*Plagopterus argentissimus*	Endangered	No
Gila (Incl. Yaqui) Topminnow	*Poeciliopsis occidentalis*	Endangered	No*
Colorado Pikeminnow (=Squawfish)	*Ptychocheilus lucius*	Endangered	No
Foskett Speckled Dace	*R. osculus ssp.*	Threatened	No*
Atlantic Salmon	*Salmo salar*	Endangered	No
Bull Trout	*Salvelinus confluentus*	Threatened	No
Pallid Sturgeon	*Scaphirhynchus albus*	Endangered	No*
Alabama Sturgeon	*Scaphirhynchus suttkusi*	Endangered	No
Loach Minnow	*Tiaroga cobitis*	Endangered	No
Razorback Sucker	*Xyrauchen texanus*	Endangered	Yes
Mammals			
Northern Sea Otter	*Enhuydra lutris kenyoni*	Threatened	No
Southern Sea Otter	*E.l. nereis*	Threatened	No*
West Indian Manatee	*Trichechus manatus*	Endangered	Yes
Grizzly Bear	*Ursus arctos horribilis*	Threatened	No*
Reptiles			
American Crocodile	*Crocodylus acutus*	Threatened	No
Yellow-Blotched Map Turtle	*Graptemys flavimaculata*	Threatened	No*
Alabama Red-Belly Turtle	*Pseudemys alabamensis*	Endangered	No*
Snails			
Pecos Assiminea Snail	*Assiminea pecos*	Endangered	No
Anthony's Riversnail	*Athearnia anthonyi*	Endangered	No*
Slender Campeloma	*Campeloma decampi*	Endangered	No*
Lacy (Snail) Elimia	*Elimia crenatella*	Threatened	No*
Koster's Springsnail	*Juturnia kosteri*	Endangered	No
Round Rocksnail	*Leptoxis ampla*	Threatened	No*
Interrupted (=Georgia) Rocksnail	*Leptoxis foremani*	Endangered	No
Plicate Rocksnail	*Leptoxis plicata*	Endangered	No*

Common Name	Scientific Name	Status	Critical Habitat
Painted Rocksnail	*Leptoxis taeniata*	Threatened	No*
Flat Pebblesnail	*Lepyrium showalteri*	Endangered	No*
Cylindrical (Snail) Lioplax	*Lioplax cyclostomaformis*	Endangered	No*
Snake River Physa Snail	*Physa natricina*	Endangered	No*
Rough Hornsnail	*Pleurocera foremani*	Endangered	Yes
Bliss Rapids Snail	*Taylorconcha serpenticola*	Threatened	No*
Tulotoma Snail	*Tulotoma magnifica*	Threatened	No*

*Critical habitat has not been designated for these species.

Table 3. ESA-listed species and critical habitat that may be adversely affected by EPA's proposed 316(b) regulation under the jurisdiction of NMFS.

Common name (Distinct population segment, evolutionarily significant unit, or subspecies)	Scientific name	Status	Critical habitat
Cetaceans			
Blue whale	*Balaenoptera musculus*	Endangered	No
Bowhead whale	*Balaena mysticetes*	Endangered	No
Fin whale	*Balaenoptera physalus*	Endangered	No
Humpback whale	*Megaptera novaeangliae*	Endangered	No
Killer whale (Southern Resident*)	*Orcinus orca*	Endangered	Yes
North Atlantic right whale*	*Eubalaena glacialis*	Endangered	Yes
Sei whale	*Balaenoptera borealis*	Endangered	No
Sperm whale	*Physeter macrocephalus*	Endangered	No
Beluga whale (Cook Inlet)*	*Delphinapterus leucas*	Endangered	Yes
False killer whale (Main Hawaiian Island insular)	*Pseudorca crassidens*	Endangered	No
Pinnipeds			
Guadalupe fur seal	*Arctocephalus townsendi*	Threatened	No
Hawaiian monk seal*,**	*Monachus schauinslandi*	Endangered	Yes, Proposed
Steller sea lion (Western*)	*Eumetopias jubatus*	Endangered	Yes
Bearded seal (Beringia)	*Erignathus barbatus nauticus*	Threatened	No
Ringed seal (Arctic)	*Phoca hispida hispida*	Threatened	No
Sea turtles			
Green sea turtle (Florida & Mexico's Pacific coast colonies)	*Chelonia mydas*	Endangered	No
Green sea turtle (all other areas*)		Threatened	Yes
Hawksbill sea turtle*	*Eretmochelys imbricate*	Endangered	Yes
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	No
Leatherback sea turtle*	*Dermochelys coriacea*	Endangered	Yes
Loggerhead sea turtle (North Pacific Ocean)	*Caretta caretta*	Endangered	No
Loggerhead sea turtle (Northwest Atlantic Ocean**)		Threatened	Proposed
Olive ridley sea turtle (Mexico's Pacific coast breeding colonies)	*Lepidochelys olivacea*	Endangered	No
Olive ridley sea turtle (all other areas)		Threatened	No
Sturgeons			
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered	No

Common name (Distinct population segment, evolutionarily significant unit, or subspecies)	Scientific name	Status	Critical habitat
Green sturgeon (southern*)	*Acipenser medirostris*	Threatened	Yes
Gulf sturgeon*	*Acipenser oxyrhynchus desotoi*	Threatened	No
Atlantic sturgeon (Gulf of Maine)	*Acipenser oxyrhynchus*	Threatened	No
Atlantic sturgeon (New York Bight)		Endangered	No
Atlantic sturgeon (Chesapeake Bay)		Endangered	No
Atlantic sturgeon (Carolina)		Endangered	No
Atlantic sturgeon (South Atlantic)		Endangered	No
Salmonids			
Atlantic salmon (Gulf of Maine*)	*Salmo salar*	Endangered	Yes
Chinook salmon (CA Coastal*)	*Oncorhynchus tschawytscha*	Threatened	Yes
Chinook salmon (Central Valley Spring-run*)		Threatened	Yes
Chinook salmon (Lower Columbia River*)		Threatened	Yes
Chinook salmon (Upper Columbia River Spring-run*)		Endangered	Yes
Chinook salmon (Puget Sound*)		Threatened	Yes
Chinook salmon (Sacramento River Winter-run*)		Endangered	Yes
Chinook salmon (Snake River Fall-run*)		Threatened	Yes
Chinook salmon (Snake River Spring/Summer-run*)		Threatened	Yes
Chinook salmon (Upper Willamette River*)		Threatened	Yes
Chum salmon (Columbia River*)	*Oncorhynchus keta*	Threatened	Yes
Chum salmon (Hood Canal Summer-run*)		Threatened	Yes
Coho salmon (Central CA Coast*)	*Oncorhynchus kisutch*	Endangered	Yes
Coho salmon (Lower Columbia River**)		Threatened	Proposed
Coho salmon (Southern Oregon & Northern California Coast*)		Threatened	Yes
Coho salmon (Oregon Coast*)			Yes
Sockeye salmon (Ozette Lake*)	*Oncorhynchus nerka*	Threatened	Yes
Sockeye salmon (Snake River*)		Endangered	Yes
Steelhead (Central California Coast*)	*Oncorhynchus mykiss*	Threatened	Yes
Steelhead (California Central Valley*)		Threatened	Yes
Steelhead (Lower Columbia River*)		Threatened	Yes
Steelhead (Middle Columbia River*)		Threatened	Yes
Steelhead (Northern California*)		Threatened	Yes
Steelhead (Puget Sound)		Threatened	No
Steelhead (Snake River*)		Threatened	Yes
Steelhead (South-Central California Coast*)		Threatened	Yes
Steelhead (Southern California*)		Threatened	Yes
Steelhead (Upper Columbia River*)		Threatened	Yes
Steelhead (Upper Willamette River*)		Threatened	Yes
Other fishes			
Pacific eulachon*	*Thaleichthys pacificus*	Threatened	Yes
Bocaccio (Georgia Basin**)	*Sebastes paucispinis*	Endangered	Proposed
Yelloweye rockfish (Georgia Basin**)	*Sebastes pinniger*	Threatened	Proposed

Common name (Distinct population segment, evolutionarily significant unit, or subspecies)	Scientific name	Status	Critical habitat
Canary rockfish (Georgia Basin**)	*Sebastes ruberrimus*	Threatened	Proposed
Smalltooth sawfish*	*Pristis pectinata*	Endangered	Yes
Marine invertebrates			
Elkhorn coral*	*Acropora palmata*	Threatened[3]	Yes
Staghorn coral*	*Acropora cervicornis*	Threatened[1]	Yes
White abalone	*Haliotis sorenseni*	Endangered	
Black abalone*	*Haliotis cracherodii*	Endangered	Yes
Marine plants			
Johnson's seagrass*	*Halophilia johnsonii*	Threatened	Yes

6.0 Environmental Baseline

The Environmental Baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions, which are contemporaneous with the consultation in process (50 CFR 402.02). The key purpose of the Environmental Baseline is to describe the condition of the listed species/critical habitat that exist in the action area in the absence of the action subject to consultation. This Environmental Baseline focuses primarily on the status and trends of the aquatic ecosystems in the United States and the consequences of that status for listed resources.

Consistent with case law, we include in the Environmental Baseline the existence of CWIS at existing facilities, but not their operation. We acknowledge that facilities with CWIS exist, and that those facilities impinge and entrain aquatic organisms on a daily basis. However, the operation of those CWIS is within EPA's discretion. Therefore, for this baseline, we assume the CWIS are in place, but are not in operation. In *re Operation of Missouri River System Litigation*, 421 F.3d. 618 (8th Cir. 2005), the Eighth Circuit upheld the Service's use of a 'run of the river' baseline, "in which the dams and physical channel modifications are assumed to be in place, but all floodgates are assumed to be wide open, with no flood control, "…the hypothetical continued operation [*sic*] (of the dams) under the previous version of the Master Manual in future years, as the alternative to the proposed action of updating the Master Manual, does not in any sense constitute a "past impact" of federal action." The Ninth Circuit reached a similar conclusion in *National Wildlife Federation v. NMFS*: "Although we acknowledge that the existence of the dams must be included in the environmental baseline, the operation of dams is within the federal agencies' discretion under both the ESA and the Northwest Power Act, 16 U.S.C. §839." 524 F.3d 917 (9th Cir.2008): Using the same logic, the continued operation of CWIS does not constitute a past impact of Federal action and is not included in the environmental baseline.

All of the endangered and threatened species and designated critical habitat considered in this Opinion depend on the health of aquatic ecosystems for their survival. These species were listed

[3] Proposed endangered

as endangered or threatened, at least in part, because of the consequences of human activities on the aquatic ecosystems to include estuaries, rivers, lakes, streams, and associated wetlands, floodplains, and riparian ecosystems of the United States, its Territories and possessions. The status and trends of those aquatic ecosystems determines the status and trends of these species and the critical habitat that has been designated for them.

Habitat

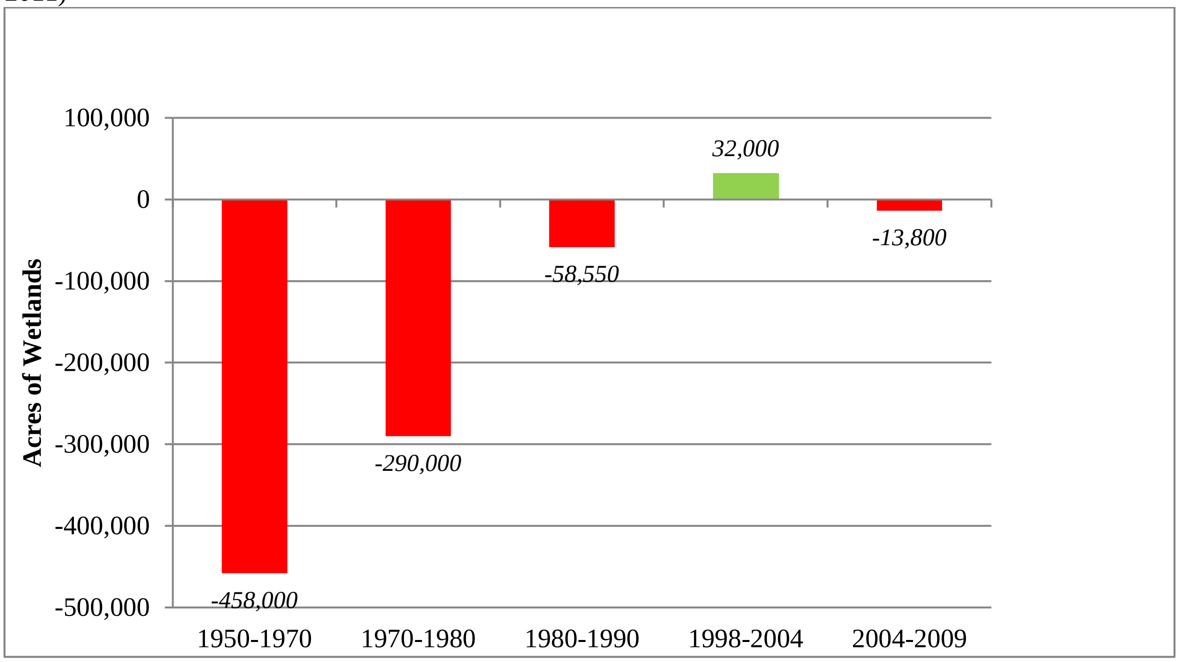
Freshwater habitats are among the most threatened ecosystems in the world (Leidy and Moyle 1998). Reviews of aquatic species' conservation status over the past three decades have documented the cumulative effect of anthropogenic and natural stressors on freshwater aquatic ecosystems, resulting in a significant decline in the biodiversity and condition of indigenous fish, mussel and crayfish communities (Taylor et al. 2007; Jelks et al. 2008). Anthropogenic stressors are present to some degree in all water bodies of the United States, and are the result of many different impacts. These stressors often lead to long-term environmental degradation associated with lowered biodiversity, reduced primary and secondary production, and a lowered capacity or resiliency of the ecosystem to recover to its original state in response to natural perturbations (Rapport and Whitford 1999).

Many of our nation's rivers and streams have been altered by dams, stream channelization, and dredging to stabilize water levels in rivers or lakes. When examining the impacts of large dams alone, it is estimated that 75,000 large dams have modified at least 600,000 miles of rivers across the country (IWSRCC 2011). For example, more than 400 dams exist in the Columbia River Basin alone (Columbia Basin Trust 2014). Habitat loss coupled with other stressors has led to impacts on fish communities as well. By the early 80's, approximately 81 percent of the native fish communities in the United States had been adversely affected by human activities (Judy et al. 1984).

Wetland habitats have been drained to make land available for agriculture; they have been filled to make land available for residential housing, commerce, and industry; they have been diked to control mosquitoes; and they have been flooded for water supply. Efforts to create and restore wetlands and other aquatic habitats by agencies of Federal, State, and local governments, non-governmental organizations, and private individuals have dramatically reduced the rate at which these ecosystems have been destroyed or degraded, but many aquatic habitats continue to be lost each year. Between 2006 and 2009, approximately 13,800 acres of wetlands were lost per year (Dahl 2011). While this is significantly less than losses experienced in the previous decades (Figure 2), an estimated 72 percent of U.S wetlands have already been lost when compared to historical estimates (Dahl 2011).

Estuaries are some of the most productive ecosystems in the world. Thousands of species of birds, mammals, fish, and other wildlife depend on estuarine habitats as places to live, feed, and reproduce. Many marine organisms, including most commercially-important species of fish, depend on estuaries at some point during their development. Estuaries are important nursery and rearing habitat for fishes such as salmon and sturgeon, sea turtles, and many other species. For example, in estuaries that support salmon, changes in habitat and food-web dynamics have altered their capacity to support juvenile salmon (Bottom *et al.* 2005, Fresh *et al.* 2005, NMFS 2006d, LCFRB 2010). Diking and filling activities have reduced the tidal prism and eliminated emergent and forested wetlands and floodplain habitats. These changes likely have reduced these estuary's' salmon-rearing capacity. Restoration of estuarine habitats, particularly diked emergent and forested wetlands, reduction of avian predation by terns, and flow manipulations to restore historical flow patterns may have begun to enhance the estuary's productive capacity for salmon, although historical changes in population structure and salmon life histories may prevent salmon from making full use of the productive capacity of estuarine habitats.

Figure 2. Average annual net wetland acreage loss and gain estimates for the conterminous U.S. (Taken from Dahl 2011)



Pollution

In addition to direct loss and alteration of aquatic habitat, many aquatic ecosystems have been impacted by various contaminants and pollutants. In 2008, the Heinz Center for Science, Economics and the Environment (Heinz Center) published a comprehensive report on the condition of our nation's ecosystems. In their report, the Heinz Center noted the following:

- From 1992 to 2001, benchmarks for the protection of aquatic life were exceeded in 50 percent of streams tested nationwide—83 percent of streams in urbanized areas—and 94 percent of streambed sediments.
- Contaminants were detected in approximately 80 percent of sampled freshwater fish and most of these detected contaminants exceeded wildlife benchmarks (1992–2001 data) (Gilliom et al 2006)
- Nearly all saltwater fish tested had at least five contaminants at detectable levels, and concentrations exceeded benchmarks for the protection of human health in one-third of fish tissue samples—most commonly DDT, PCBs, PAHs, and mercury (USEPA 2007.)

Toxic contaminants, as noted above have, been documented in the Lower Columbia River and its tributaries (LCREP 2007). More than 41,000 waters are listed as impaired by pollutants that include mercury, pathogens, sediment, other metals, nutrient, and oxygen depletion, and other causes (USEPA 2013a). Pennsylvania reported the greatest number of impaired waters (6,957), followed by Washington (2,420), Michigan (2,352), and Florida (2,292). These figures likely underestimate the true number of impaired waterbodies in the U.S. For example, EPA's National Aquatic Resource Surveys (NARS) is a probability based survey that provides a national assessment of the nation's waters and is used to track changes in water quality over time. Through this method, EPA estimates that 50 percent of the nation's streams (approximately 300,000 miles) and 45 percent of the nation's lakes (approximately seven million acres) are in fair to poor condition for nitrogen or phosphorus levels relative to reference condition waters (USEPA 2013b). However, data submitted by the States indicates that only about half of the NARS estimate (155,000 miles of rivers and streams and about four million acres of lakes) have been identified on EPA's 303(d) impaired waters list for nutrient related causes (USEPA 2013b).

Water quality problems, particularly the problem of non-point sources of pollution, have resulted from changes humans have imposed on the landscapes of the United States over the past 100 to 200 years. The mosaic or land uses associated with urban and suburban centers has been cited as the primary cause of declining environmental conditions in the United States (Flather et al. 1998) and other areas of the world (Houghton 1994). Most land areas covered by natural vegetation are highly porous and have very little sheet flow; precipitation falling on these landscapes infiltrates the soil, is transpired by the vegetative cover or evaporates. The increased transformation of the landscapes of the United States into a mosaic of urban and suburban land uses has increased the area of impervious surfaces such as roads, rooftops, parking lots, driveways, sidewalks, etc., in those landscapes. Precipitation that would normally infiltrate soils in forests, grasslands and wetlands falls on and flows over impervious surfaces. That runoff is then channeled into storm sewers and released directly into surface waters (rivers and streams), which changes the magnitude and variability of water velocity and volume in those receiving waters.

Increases in polluted runoff have been linked to a loss of aquatic species diversity and abundance, including many important commercial and recreational fish species. Nonpoint source pollution has also contributed to coral reef degradation, fish kills, seagrass bed declines and algal blooms (including toxic algae) (NOAA 2013). In addition, many shellfish bed and swimming beach closures can be attributed to polluted runoff. As discussed in EPA's latest National Coastal Condition Report (NCCR), nonpoint sources have been identified as one of the stressors contributing to coastal water pollution (USEPA 2012). Since 2001, EPA has periodically released these reports detailing condition of the nation's costal bays and estuaries and assessing trends in water quality in coastal areas. The latest NCCR report indicates that coastal water conditions have remained "fair" and the trend assessment demonstrates no significant change in the water quality of U.S. coastal waters since the publication of the NCCR II in 2004 (USEPA 2012).

In many estuaries, agricultural activities are major source of nutrients to the estuary and a contributor to the harmful algal blooms in summer, although according to McMahon and Woodside 1997 (EPA 2006a) nearly one-third of the total nitrogen inputs and one-fourth of the total phosphorus input to the estuary are from atmospheric sources. The National Estuary Program Condition Report found that nationally, 37% of national estuary program estuaries are in poor condition (http://water.epa.gov/type/oceb/nep/nepccr-factsheet.cfm).

Throughout the 20th century, mining, agriculture, paper and pulp mills, and municipalities contributed large quantities of pollutants to many estuaries. For example, the Roanoke River and the Albemarle-Pamlico Estuarine Complex which receives water from 43 counties in North Carolina and 38 counties and cities in Virginia. This estuarine system supports an array of ecological and economic functions that are of regional and national importance. Both the lands and waters of the estuarine system support rich natural resources that are intertwined with regional industries including forestry, agriculture, commercial and recreational fishing, tourism, mining, energy development, and others. The critical importance of sustaining the estuarine system was reflected in its Congressional designation as an estuary of national significance in 1987. Even so, today the Albemarle-Pamlico Estuarine Complex is rated in good to fair condition in the National Estuary Program Coastal Condition Report despite that over the past 40-year period data indicate some noticeable changes in the estuary, including increased dissolved oxygen levels, increased pH, decreased levels of suspended solids, and increased chlorophyll *a* levels (EPA 2006b).

Since 1993 EPA has compiled information on locally issued fish advisories and safe eating guidelines. This information is provided to the public to limit or avoid eating certain fish due to contamination of chemical pollutants. EPA's 2010 National Listing of Fish Advisories database indicates that 98 percent of the advisories are due (in order of importance) to: mercury, PCBs, chlordane, dioxins, and DDT (USEPA 2010). Fish advisories have been issued for 36 percent of the total river miles (approximately 1.3 million river miles) and 100 percent of the Great Lakes and connecting waterways (USEPA 2010). Fish advisories have been steadily increasing over the National Listing of Fish Advisories period of record (1993-2010), but EPA interprets these increases to reflect the increase in the number of waterbodies being monitored by States and advances in analytical methods rather than an increase in levels of problematic chemicals (USEPA 2010).

Water-quality concerns related to urban development include providing adequate sewage treatment and disposal, transport of contaminants to streams by storm runoff, and preservation of stream corridors. Water availability has been and will continue to be a major, long- term issue in many areas. It is now widely recognized that ground-water withdrawals can deplete streamflows (Morgan and Jones 1999), and one of the increasing demands for surface water is the need to maintain instream flows for fish and other aquatic biota.

Climate Change

All species discussed in this Opinion are or will be threatened by the direct and indirect effects of global climatic change. Climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine ecosystems in the near future (IPCC 2002). The Intergovernmental Panel on Climate Change (IPCC) estimated that average global land and sea surface temperature has increased by 0.85°C (± 0.2) since the late-1800s, with most of the change occurring since the mid-1900s (IPCC 2013). This temperature increase is greater than what would be expected given the range of natural climatic variability recorded over the past 1,000 years (Crowley and Berner 2001). The IPCC estimates that the last 30 years were likely the warmest 30-year period of the last 1,400 years, and that global mean surface temperature change will likely increase in the range of 0.3 to 0.7°C over the next 20 years.

Warming water temperatures attributed to climate change can have significant effects on survival, reproduction, and growth rates of aquatic organisms (Staudinger et al 2012). For example, warmer water temperatures have been identified as a factor in the decline and disappearance of mussel and barnacle beds in the Northwest (Harley 2011). Shifts in migration timing of pink salmon (*Oncorhynchus gorbuscha*) which may lead to high pre-spawning mortality have also been tied to warmer water temperatures (Taylor 2008). Increasing atmospheric temperatures have already contributed to changes in the quality of freshwater, coastal, and marine ecosystems and have contributed to the decline of populations of endangered and threatened species (Karl et al. 2009; Littell et al. 2009; Mantua et al. 1997). Ocean acidification, as a result of increased atmospheric carbon dioxide, can interfere with numerous biological processes in corals including: fertilization, larval development, settlement success, and secretion of skeletons (Albright et al. 2010).

Climate change is also expected to impact the timing and intensity of stream seasonal flows (Staudinger et al 2012). Warmer temperatures are expected to reduce snow accumulation and increase stream flows during the winter, cause spring snowmelt to occur earlier in the year, and reduced summer stream flows in rivers that depend on snow melt. As a result, seasonal stream flow timing will likely shift significantly in sensitive watersheds (Littell et al. 2009). Warmer temperatures may also have the effect of increasing water use in agriculture, both for existing fields and the establishment of new ones in once unprofitable areas (ISAB 2007). This means that streams, rivers, and lakes will experience additional withdrawal of water for irrigation and increasing contaminant loads from returning effluent. Changes in stream flow due to use changes and seasonal run-off patterns may alter predator-prey interactions and change species assemblages in aquatic habitats. For example, a study conducted in an Arizona stream documented the complete loss of some macroinvertebrate species as the duration of low stream flows increased (Sponseller et al 2010). As it is likely that intensity and frequency of droughts will increase across the southwest (Karl et al. 2009), similar changes in aquatic species composition in the region is likely to occur.

Warmer water also stimulates biological processes which can lead to environmental hypoxia. Oxygen depletion in aquatic ecosystems can result in anaerobic metabolism increasing, thus leading to an increase in metals and other pollutants being released into the water column (Staudinger et al 2012). In addition to these changes, climate change may affect agriculture and other land development as rainfall and temperature patterns shift. Aquatic nuisance species invasions are also likely to change over time, as oceans warm and ecosystems become less resilient to disturbances (USEPA 2008). If water temperatures warm in marine ecosystems, native species may shift poleward to cooler habitats, opening ecological niches that can be occupied by invasive species introduced via ships' ballast water or other sources (Ruiz et al. 1999, Philippart et al. 2011). Invasive species that are better adapted to warmer water temperatures would outcompete native species that are physiologically geared towards lower water temperatures; such a situation currently occurs along central and northern California (Lockwood and Somero 2011)

In summary, the direct effects of climate change include increases in atmospheric temperatures, decreases in sea ice, and changes in sea surface temperatures, patterns of precipitation, and sea level. Indirect effects of climate change include altered reproductive seasons/locations, shifts in migration patterns, reduced distribution and abundance of prey, and changes in the abundance of competitors and/or predators. Climate change is most likely to have its most pronounced effects on species whose populations are already in tenuous positions (Isaac 2008).

Clean Water Act

Several laws and regulations have been put in place to help improve the state of our aquatic resources, the principal one being the CWA. The original 1948 statute was totally re-written in 1972 to produce its current purpose: "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Federal Water Pollution Control Act, Public Law 92 –500). Congress made substantial amendment to the CWA in the Water Quality Act of 1987 (P. L. 100-4) in response to the significant and persistent water quality problems.

To achieve its objectives, the CWA generally prohibits all point source discharges into the nation's waters, unless otherwise authorized under the CWA. One of the main ways that point source discharges are regulated is through permits issued under the NPDES authorized under the CWA. For example, the NPDES program regulates discharges of pollutants like bacteria, oxygen-consuming materials, and toxic pollutants like heavy metals, pesticides, and other organic chemicals. EPA has also promulgated regulations setting effluent limitations guidelines and standards under sections 301, 304, and 306 of the CWA for more than 50 industries [40 CFR parts 405 through 471]. These effluent limitations guidelines and standards for categories of industrial dischargers are based on pollutants of concern discharged by industry; the degree of control that can be attained using pollution control technology; consideration of various economic tests appropriate to each level of control; and other factors identified in sections 304 and 306 of the CWA (such as non-water quality environmental impacts including energy impacts) (F76 FR 22174-22288). These effluent limitations have been credited for helping reduce the amount of pollutants like toxic metals entering the aquatic environment (Smail et al 2012). While provisions of the CWA have helped significantly improve the quality of aquatic ecosystems, nonpoint sources of water pollution, which are believed to be responsible for the majority of modern water quality problems in the United States, are not subject to CWA permits or regulatory requirements. Instead, nonpoint sources of pollution are regulated by programs overseen by the States.

Water quality is important to all of the listed resources identified above in Tables 2 and 3. In some cases, the deterioration of water quality has led to the endangerment of aquatic species; in all cases, activities that threaten water quality also threaten these listed resources. Endangered and threatened species have experienced population declines that leave them vulnerable to a multitude of threats. Because of reduced abundance, low or highly variable growth capacity, and the loss of essential habitat, these species are less resilient to additional disturbances. In larger populations, stressors that affect only a limited number of individuals could once be tolerated by the species without resulting in population level impacts, whereas in smaller populations, the same stressors are more likely to reduce the likelihood of survival. It is with this understanding of the environmental baseline that we consider the effects of the proposed action, including the likely effect that CWIS's will have on endangered and threatened species and their designated critical habitat.

7.0 Effects of the Action

The effects of the action refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated and interdependent with that action. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur. Therefore, the issuance of State NPDES permits and any ensuing adverse effects to ESA-listed species or critical habitat caused by operation of CWISs is considered to be an indirect effect of EPA's 316(b) Rule promulgation.

In determining whether an action is likely to jeopardize listed species, the Services consider the effects of the action are in conjunction with the environmental baseline. The Services understand the effects of this action to include the operation of any facility with a CWIS that is permitted, either by EPA or by State or Tribal permitting authorities, pursuant to this regulation. We recognize the Rule may result in a net reduction of aquatic organisms lost to impingement and entrainment when compared to what has occurred historically. However, our analysis of effects is based, in part, on the assumption that all covered facilities must comply with the Rule or cease CWIS operations. As such, analysis of the effects of this action includes an evaluation of the full extent of impacts to listed species that will occur when facilities operate pursuant to the Rule, rather than an evaluation of the expected net decline versus current operations.

Pursuant to section 7(a)(2) of the ESA, Federal agencies are required to insure their actions are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. Using the best available scientific and commercial information, we describe in this section: the potential physical, chemical, or biotic stressors associated with the proposed actions; the probability of individuals of listed species being exposed to these stressors; and the probable responses of those individuals (given exposure). If responses are likely to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, and lifetime reproductive success), we evaluate the risk posed to the viability of the individuals' population, and ultimately of the species. The ultimate purpose of this assessment is to determine whether the proposed action is expected to reduce the species' likelihood of survival and recovery in the wild.

Our "destruction or adverse modification" determinations must be based on an action's effects on the conservation value of habitat that has been designated as critical to threatened or endangered species. If an area encompassed in a critical habitat designation is likely to be exposed to the direct or indirect effects of the proposed action on the natural environment, we ask if primary constituent elements included in the designation (if there are any) or physical, chemical or biotic components that give the designated area conservation value are likely to respond to that exposure.

7.1 Programmatic Approach

As noted, the scope of the 316(b) Rule is nationwide covering an array of facilities that may affect a wide variety of listed species. The specific State CWA NPDES programs differ in regulatory approaches and the individual facilities vary in their size, scope, control technology, and operation. It is also uncertain which facilities may ultimately apply for CWA 316(b) permits. Under these circumstances, it is not feasible to conduct a meaningful site specific and species specific effects analysis, nor is such analysis required given the programmatic nature of the Rule and the fact that the Rule is not self-effecting (i.e. it is implemented only through future permits). Rather, the Services determined that a programmatic consultation is appropriate to address the regulatory process as it is outlined in the Rule and supporting documentation. The 316(b) Rule outlines the process and responsibilities for both facility owners and State Directors and those measures that will be implemented in the future. In our Programmatic approach, we examine whether and to what degree EPA has structured their 316(b) Rule to ensure that implementation of the final Rule is not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of critical habitat. In this evaluation, we assess whether EPA has structured the Rule and supporting documentation to enable EPA to fulfill the following criteria: (1) understand the scope of its action; (2) reliably estimate the physical, chemical, or biotic stressors that are likely to be produced as a direct or indirect result of their action; (3) minimize adverse effects of such activities on ESA-listed species and designated critical habitat; (4) identify, inform, encourage, and screen applicants for potential eligibility under or participation in the permitting activity; (5) continuously monitor and evaluate likely adverse effects on listed species and critical habitat; (6) monitor and enforce permit compliance; and (7) modify its action if new information (including inadequate protection for species or low levels of compliance) becomes available.

We assess EPA's compliance with the provisions of section 7(a)(2) of the ESA by evaluating the extent to which the Rule and supporting documentation establishes processes to require EPA, the owner or operator, and the Director, to collectively implement the provisions of section 316(b) of the CWA in a manner that ensures effects to ESA-listed species and critical habitat will be minimized and thereby avoid likely jeopardy and likely destruction or adverse modification of critical habitat, consistent with section 7(a)(2) of the ESA. Therefore, we focus primarily on the required aspects of the Rule and EPA's commitment to overseeing the implementation of the Rule when considering whether EPA has fulfilled its responsibilities under section 7(a)(2) of the ESA.

Key Assumptions for the Effects Analysis

In developing this analysis, we needed to make a number of key assumptions due to the lack of information and uncertainties surrounding the location, timing, frequency, and intensity of CWIS activities. If these assumptions prove incorrect or warrant changes during implementation of the Rule, it could affect the validity of this analysis and trigger re-initiation of ESA section 7 consultation if it results in effects that were not considered herein. When EPA is the NPDES permitting authority, EPA will consult on all NPDES permits it issues. Where EPA is not the permitting authority, the Rule requires Directors to provide the Services copies of all permit applications for review and comment, and to include in the record for the draft permit any species protection measures that the Services recommend. In addition, Directors must provide the Services with copies of all draft permits. We view this exchange of information and any resulting coordination as falling within the broad scope of "technical assistance" as described in the Services' Consultation Handbook. Accordingly, we use the phrase technical assistance to describe the exchange of information between Directors and the Services as required in the Rule.

The following assumptions were used in completing this analysis:

- The Services will receive all permit applications upon receipt by the Director for a 60 day review prior to publication of a draft permit as required per the Rule.
- The Services anticipate that where necessary, State and Tribal Directors will incorporate the control measures, monitoring, and reporting recommendations provided by the Services through technical assistance facilitated by the exchange of information between the Directors and the Services into NPDES permits that contain 316(b) requirements.
- The control measures, monitoring, and reporting developed by the Services through technical assistance with the Directors will minimize the adverse effects of CWIS to levels that will avoid jeopardy to species and/or destruction and adverse modification of critical habitat.
- In the case of State permits that have been administratively continued, if the Services or EPA identify a permitted action by a facility that meets the eligibility requirements of the rule which is likely to have more than a minor detrimental effect on Federally-listed species or critical habitat, then the Services or EPA will contact the State to seek to remedy the situation (for instance by requesting new information from the facility when necessary). EPA will provide support and assistance to the Services in working with the State or Tribe. EPA and States have no authority to require changes to an expired, administratively continued permit. Instead, Directors have authority to issue a new permit. Therefore, EPA or the Services could request that the State issue a new permit. *See* 66 Fed. Reg. 11202 (Feb. 22, 2001). The Services assume this process will resolve any concerns regarding adverse effects to ESA-listed species and designated critical habitat;
- EPA will work with States and Tribes to reduce or remove the detrimental effects of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and
- In States where EPA is the permitting authority for NPDES permits, EPA will consult with the Services on the issuance of those permits where required by ESA section 7.

1.1.1 Scope

The scope of the action includes all aspects of EPA's issuance and implementation of the 316(b) Rule, including issuance of NPDES permits containing 316(b) requirements for existing power generating facilities and existing manufacturing and industrial facilities that withdraw more than 2 million gallons of water per day from Waters of the United States and use at least 25 percent of the water they withdraw exclusively for cooling purposes. While the majority of permits issued under the new 316(b) Rule will be State issued permits, EPA has an ongoing role in the administration and enforcement of NPDES permits in the states that assumed the NPDES permitting authority. While the following regulations are not subject to this consultation, under CWA section 402(d) and its implementing regulations (40 C.F.R. § 123.44), EPA reviews proposed State NPDES permits and, when EPA determines the permit fails to be consistent with the requirements of the CWA, then EPA may assume the authority to issue permits to which it has raised objections. In addition, under CWA section 309, EPA has the authority to enforce conditions and limitations in State NPDES permits. The Rule establishes these conditions and limitations as they pertain to the operation of CWIS.

In order to reliably estimate the probable individual or aggregate effects to ESA-listed species or designated critical habitat, EPA would need to know or reliably estimate the probable number of facilities that will be subject to the final Rule. Therefore, we ask whether EPA has structured their Rule to reliably estimate the probable number and location of facilities with CWIS that will be authorized by the Rule and their impact on federally listed species and designated critical habitat. Previously, the majority of facilities have not been required to provide EPA or the appropriate permitting authority specific information regarding the operation of the CWIS and impacts to federally-listed species and critical habitat. EPA knows general information about the power generating and manufacturing facilities (15 percent of the potentially regulated community), but it does not know the number, location, volume, and timing of water withdrawals (if any) from the approximate 3,155 manufacturing facilities. To rectify this paucity of information, the Rule requires all facilities to submit, as part of their NPDES permit application, specific information including; the facility's location, description of cooling water operations, source water biological data, and identification of threatened and endangered species that may be susceptible to impingement or entrainment at their facility. Depending on a facility's selected method of compliance for the impingement mortality standard, 2 years of biological monitoring data may also be required to be part of their permit application. In addition, owners and operators must identify all federally-listed threatened and endangered species and/or designated critical habitat that are or may be present in the action area.

Through the requirements described above, owners and operators will be responsible for determining if listed species and designated critical habitat are likely to occur in an area affected by their cooling water intake operations and for notifying the relevant permitting authority if they determine that such effects are likely to occur. This requirement assumes that owners/operators will have sufficient knowledge to determine the presence or absence of ESA-listed species, and designated critical habitat near their facility, and have the technical knowledge necessary to determine if their activity might have direct or indirect effects on these species or designated critical habitat. Some owners/operators may have sufficient knowledge to make these judgments. However, the following points highlight why only a fraction of facilities seem likely to satisfy the requirement.

- Within their biological evaluation (pg 60), EPA identified 21,039 instances where threatened or endangered species and facilities currently overlap.
- There is a reasonable expectation that a listed species may be directly or indirectly affected by a facility's CWIS if that structure overlaps with the range of a listed species, and those effects may rise to the level of "take" as defined by the ESA.
- Facilities subject to the 316(b) Rule are already required to seek an exemption through an ESA section 10 incidental take permit (16 U.S.C. 1539 (a)) or an ESA section 7 Incidental Take Statement (16 U.S.C. 1536(b)(4)) for activities that result in the taking of federally-listed species. To our knowledge, few facilities have sought or obtained incidental take coverage for effects to listed species that may occur as a result of operation of their CWIS.

Further evidence that not all facilities are likely to self-identify as affecting federally-listed species or designated critical habitat is discussed within the biological evaluation. EPA selected eight facilities with a high number of identified overlaps with federally-listed species for review in the belief that these permits were likely to contain a discussion of considerations made for threatened and endangered species. Despite EPA's selection of these facilities because of overlap with the habitat of threatened and endangered species, review of the eight permits indicated:

- None of the eight discharge permits reviewed had special conditions or requirements specifically aimed at protection or minimization of impingement or entrainment to threatened or endangered species;
- Where ESA considerations were noted, little detail was provided describing the methods used to establish a finding of no adverse risk;
- Where improvements to reduce impingement and entrainment through technological or management options were required, these requirements were due to concern for the resident aquatic community and not for specific threatened or endangered species; and
- Most concerns regarding facility impacts to aquatic organisms were focused on facility discharges particularly thermal pollution (which is regulated under CWA section 316(a)) and not with the impingement and entrainment effects more commonly associated with CWIS.

The above information illustrates the problem associated with relying solely on owners and operators to identify if their operations impact threatened and endangered species. To help rectify this ongoing issue, additional language was included in the Rule that requires permitting authorities (State Directors or EPA Directors) to transmit all permit applications subject to the Rule to the appropriate Field Office of the USFWS and/or Regional Office of the NMFS for a 60-day review prior to public notice of the draft or proposed permit. This information will be transmitted to the Services' Field or Regional offices upon receipt of the application. Directors are also required to provide public comment and notice of draft permits per 40 CFR 124.10. Permitting authorities are required to submit a copy of the fact sheet or statement of basis (for EPA-issued permits), the permit application (if any) and the draft permit (if any) to the appropriate Field Office of the USFWS and/or Regional Office of the NMFS. While the requirement to provide draft permits and notice of public comment to the Services is not a new provision, the requirement for Directors to provide permit application materials to the Services prior to issuing a draft permit is a new requirement. The 60-day review provided to the Services will allow the Services to inform Directors if an owner or operator has accurately self-identified any potential risk to federally-listed species and/or critical habitat. In addition, the Services may recommend protective measures prior to the Director issuing public notice of the draft permit. The Director would then include those recommended protective measures in the public notice of the draft permit.

The new conditions EPA imposes through the 316(b) Rule creates a process where the Services will have an opportunity to review the determinations submitted by the owners or operators regarding the potential effects of the CWIS to ESA-listed species prior to a draft permit being issued. If an owner/operator or Director does not include recommendations of the Services, EPA's commitment to exercise their oversight authority as described in the April 8, 2014, correspondence from EPA (attached as Appendix A) and as described this Opinion allows EPA to correct any issues with the permit prior to issuance if EPA finds (giving deference to the views of the Services) that the permit will likely have more than minor detrimental effect or is likely to jeopardize the continued existence of listed species ore result in the destruction or adverse modification of designated critical habitat. This process established in the Rule and EPA's commitment to the oversight of the process will allow EPA to better estimate the number of facilities that will be subject to the final Rule so potential project impacts to federally listed species and designated critical habitat can be addressed.

1.1.2 Stressors

To determine if EPA has structured the Rule to reliably estimate the physical, chemical, or biological stressors that are likely to be produced as a direct or indirect result of their action, we review requirements in the Rule that allow EPA or the delegated State permitting authorities to identify stressors likely to be produced by permitted CWIS of existing facilities. Additionally, the Preamble to the Rule states EPA will use the full extent of its CWA authority to object to a State permit where EPA finds (giving deference to the views of the Services) that a State permit is likely to jeopardize the existence of ESA-listed species or adversely modify designated critical habitat.

We also evaluate the stressors identified in the biological evaluation. We provide a general overview and review in detail the following stressors: impingement and entrainment; thermal discharges; flow alterations; chemical discharge; and cumulative impacts (the aggregate effects of multiple facilities operating on one water source). We assess to what extent EPA has structured the Rule and supporting documentation to identify and estimate the stressors, and we identify reasons for uncertainty.

Regulatory Requirements—Identifying Stressors

For EPA-issued permits that may affect ESA-listed species or designated critical habitat, section 7(a)(2) consultation is required. Consultation information (50 CFR §402.14(c)) requirements include: description of the action; description of the specific area that may be affected by the action; description of ESA-listed species or designated critical habitat that may be affected by the action; description of the manner in which the action may affect ESA-listed species or designated critical habitat; relevant reports (e.g., the biological evaluation); and any other relevant available information on the action, the affected species, or critical habitat. Using this information from each permitted facility, EPA, with assistance from the Services, will be able to identify potential direct and indirect stressors. Therefore, for EPA-issued permits (approximately 8 percent of potentially regulated facilities), EPA is likely to know or reliably estimate the physical, chemical, or biotic stressors that are likely to be produced as a direct or indirect result of activities.

The Rule establishes information requirements that provide the basis for identifying and estimating potential stressors (122.21(r)(2)). The Director cannot waive these information requirements. However, several other information requirements are determined by the Director on a case-by-case basis. This Director determination for permit requirements on a case-by-case basis will be more unpredictable and inconsistent, making it difficult to accurately estimate potential stressors. Director determined Permit requirements and allowable modifications to BTA include:

- Three BTA Standards for Impingement Mortality involve Director-determined BTA or allows the Director to authorize less stringent standards;
  - 0.5 ft/sec through screen actual velocity, (the Director may authorize an exceedance of this standard for brief periods);
  - Modified traveling screens,; and
  - Systems of technologies as the BTA for impingement mortality.
- BTA standards for entrainment;
- Site-specific impingement and entrainment requirements until 42 months after the effective date of the Rule, for existing units at existing facilities (i.e., not BTA standards);
- Additional measures for shellfish;
- Site-specific BTA Standards for Impingement Mortality for CWIS used for electric generating unit(s), with an annual average capacity utilization rating of less than eight percent (averaged over a 24-month period);
- Control measures, monitoring and reporting requirements that are designed to reduce or remove more than minor detrimental effects to federally-listed species and designated critical habitat, or avoid jeopardizing federally-listed species or destroying or adversely modifying designated critical habitat (e.g., prey base). Such control measures, monitoring and reporting requirements may include measures that may have been identified by the Services during coordination;
- Prior to 42 months after the effective date of the Rule, the Director determines on a case-by-case basis when the facility becomes subject to site-specific entrainment requirements;
- Schedule of requirements (i.e., after issuance of a final permit that establishes the entrainment requirements, EPA requires the owner or operator of an existing facility to comply with the entrainment standard as soon as possible, based on a schedule of requirements established by the Director); and
- Alternative requirements or additional BTA standards for entrainment for new units at existing facilities.

The biological evaluation states that a detailed evaluation of each of the potential effects of facilities subject to the proposed action is not possible because,

> "…driven by vast uncertainty in the universe of regulated facilities, a lack of baseline source water biological characterization data, and a dearth of IM&E [impingement mortality and entrainment] monitoring data, the scope and magnitude of potential and actual effects is unknown for virtually all species and distinct population segments."

Nonetheless, the biological evaluation provides a qualitative assessment of the stressors potentially arising from the proposed action and their possible direct or indirect effects on ESA-listed species and designated critical habitat. These stressors include: impingement and entrainment, thermal discharges, chemical discharges, altered flow regimes, and cumulative impacts (Table 3 EPA 2013). Further consideration of each stressor is provided in the following sections of this Opinion. In Table 3, EPA divides the stressors into those principally associated with the CWIS (i.e., impingement, entrainment, and flow alteration) and those associated with the discharge of cooling water (flow alteration, thermal discharge, and chemical discharge).

While discharge of cooling water is regulated 301, 306, or 316(a) of the CWA, and those regulations are not subject to this consultation, cooling water discharge is an indirect effect of cooling water intake as regulated by the Rule and therefore considered in this Opinion. As described in the biological evaluation (pg 37), indirect effects of flow alteration, thermal discharge, and chemical discharge may include: physiochemical changes in aquatic habitat; secondary effects on upper trophic predators (e.g., by reduction in prey) or other species which compete for resources with ESA listed species (e.g., spawning habitat loss from flow reduction); and other changes in biological communities and/or ecosystem functions (USEPA 2013c). These may affect all life stages of ESA-listed species; however, EPA cannot further elaborate on these indirect effects because, as stated in the biological evaluation (USEPA 2013c):

> "The exact nature and magnitude of these indirect effects would be species-specific based on the relative size and amount of overlap of habitat with facility and CWIS locations, dependence of affected prey populations, life cycle considerations, and many other factors. Given the lack of direct data available to EPA, indirect effects are difficult if not impossible to measure quantitatively. Accordingly, given the lack of data available, EPA did not attempt to estimate the relative magnitude or probability of these indirect effects on a species-specific scale, but instead acknowledges that these indirect effects are likely to occur, and may play a role when the effects of each are summed, or when [ESA-listed] species live in areas with a high density of regulated facilities."

Table 3: CWIS Effects on Ecosystem Functions/Cumulative Impacts Potentially Affected, Both Directly and Indirectly, by 316(b) Regulations (Taken from USEPA 2013c)

Category	**Direct/Indirect**	**Local/Regional/ National**
A. Impingement and Entrainment (direct and indirect effects)		
Effects on Individuals		
Loss of individuals (direct effects)	Direct	Local/Regional/National
Phytoplankton	Direct	Local/Regional/National
Zooplankton (excluding fish larvae/eggs)	Direct	Local/Regional/National
Invertebrates	Direct	Local/Regional/National
Fish	Direct	Local/Regional/National
Non-fish vertebrates	Direct	Local/Regional/National
Species and Population-Level Effects		
Alteration of phenology of system (function of % water reduction in stream)	Direct	Local/Regional/National
Altered distribution of populations	Direct	Local
Altered niche space	Direct	Local/Regional
Altered stable age distributions of populations	Direct	Regional
Loss of keystone species	Direct	Local
Loss of T&E species	Direct	Regional
Novel selection pressure (e.g., negatively buoyant or stationary eggs)	Direct & Indirect	Local
Reduced/altered genetic diversity	Direct & Indirect	Regional/National
Reduced lifetime ecological function of individuals	Direct	Local/Regional
Community and Trophic Relationships		
Altered competitive interactions	Direct & Indirect	Local
Disrupted trophic relationships	Direct & Indirect	Local
Disrupted control of disease-harboring insects (e.g., mosquito larvae, etc.)	Indirect & Direct	Local/Regional
Increased quantity of detritivores	Indirect	Local
Loss of ecosystem engineers (due to trophic interactions)	Indirect & Direct	Local
Reduced potential for energy flows (e.g. trophic transfers)	Indirect	Local/Regional
Species diversity and richness	Direct & Indirect	Local/Regional/National
Trophic cascades	Indirect & Direct	Local/Regional
Ecosystem Function		

Table 3: CWIS Effects on Ecosystem Functions/Cumulative Impacts Potentially Affected, Both Directly and Indirectly, by 316(b) Regulations (Taken from USEPA 2013c)

Category	Direct/Indirect	Local/Regional/ National
Altered ecosystem succession	Indirect & Direct	Local/Regional
Decreased ability of ecosystem to control nuisance species (algae, macrophytes)	Indirect	Local
Disrupted cross-ecosystem nutrient exchange (e.g., up/downstream, aquatic/terrestrial)	Indirect	Regional
Disrupted nutrient cycling	Indirect & Direct	Local/Regional
Reduced compensatory ability to deal with environmental stress (resilience)	Direct & Indirect	Regional
Reduced ecosystem resistance	Indirect	Local/Regional
Reduced ecosystem stability (alternate states)	Indirect	Local/Regional
Sediment regulation	Indirect	Local/Regional
Substrate regulation	Indirect	Local
B. Thermal Effects		
Novel selection pressure (e.g., thermal optima, location of breeding, etc.)	Direct & Indirect	Regional/National
Altered phenology	Direct	Local/Regional
Links between temperature and metabolism		
Dissolved oxygen (physical)	Direct	Local
Dissolved oxygen (bacterial, respiratory rates)	Indirect	Local
Ecological energetic demands	Indirect	Local/Regional
Ecological nutrient demands	Indirect	Local/Regional
Altered algal productivity	Direct & Indirect	Local/Regional
Shifted nutrient cycling	Indirect & Direct	Local/Regional
C. Chemical Effects (anti-foulants, etc.)		
Altered survival/growth/production	Indirect & Direct	Local
Altered food web dynamics	Indirect	Local
D. Altered Flow Regimes (local and system-wide)		
Altered flow velocity	Direct & Indirect	Local/Regional
Altered turbulence regime	Direct & Indirect	Local/Regional
E. Cumulative Impacts (as a concentrated number of facilities)		
May push systems over the edge of nonlinearities in the system	Direct/Indirect	Local/Regional
Intensified CWIS effects (as above, Section B.)	Direct/Indirect	Local/Regional
Intensified thermal effects (as above, Section B.)	Direct/Indirect	Local/Regional

EPA's qualitative assessment included an analysis of the overlap between potentially regulated facilities (approximately 3,730) and the ranges or designated critical habitat of ESA-listed species (USEPA 2013). EPA estimates that a total of 3,490 facilities (94 percent) overlap with species' ranges, and 153 facilities (four percent) overlap with designated critical habitat (note: these estimates include ESA-listed species and designated critical habitat under the jurisdiction of both Services). Of the 805 positively identified power generating and manufacturing facilities, 768 (95 percent) overlap with one or more species, with 258 (37 percent) of such facilities withdrawing more than 125 mgd actual intake flow. Therefore, we interpret these data as follows:

- Most facilities overlap with at least one ESA-listed species; therefore, threatened or endangered species are likely to be exposed to the stressors potentially produced from most facilities;
- A large proportion of "overlap" facilities withdraw more than 125 mgd actual intake flow, indicating that the magnitude of each stressor has the potential to be large; and

- Few facilities (four percent) overlap with designated critical habitat, possibly because critical habitat has not been designated for most (66 percent) ESA-listed species.

The biological evaluation (page 8), states that some of these facilities are already in compliance with the impingement requirements of the Rule, as a result of State regulations; despite such regulations and the extent of overlap, EPA concludes that "data do not exist to determine the extent to which this geographical overlap impacts individuals or populations of [ESA-listed species]." In addition, EPA states that "under the final rule, all regulated facilities are required to submit baseline source water biological characterization data." We agree with EPA that the availability and quality of information will increase as facilities collect and submit such data, as well as additional impingement and entrainment study results (USEPA 2013c). It is important that this data will now be provided to the Services for their review, and the Services will be able to provide comment to the Director regarding potential impacts to federally-listed species. This will enable the Director and EPA to more reliably estimate the effect of the stressors on ESA-listed species that are likely to be produced as a direct or indirect result of activities.

In the biological evaluation, EPA identifies other sources of uncertainty regarding the effects the Rule is likely to have on individual species (USEPA 2013c). These sources of uncertainty include:

- Lack of data: EPA was unable to identify the complete universe of facilities regulated by the Rule, and EPA found few data to estimate the effects of the Rule on ESA-listed species.
- Location of the facility: the location of the facility (the location of the CWIS was often unknown) relative to ESA-listed species or designated critical habitat was determined by geographic proximity to the range or habitat designations. It did not consider other parameters (i.e., upstream or downstream, nearbank vs. farbank) that may affect species and CWIS interactions.
- Location of the CWIS within the source water: the location and depth of the CWIS within the cooling water source can affect the overall impact on ESA-listed species, designated critical habitat, and vulnerable life stages.
- CWIS water withdrawal volume of facility: CWIS water withdrawal volume varies widely due to the size or generating capacity of the facility. Differences in volume were not considered and a single very large facility could have a disproportionate effect on ESA-listed species or designated critical habitat, if located nearby.
- Scope of CWIS modifications: EPA states that the nature and degree of required CWIS modifications will vary among the non-compliant facilities.
- Accuracy of habitat delineations: There is a wide range of variation in accuracy for habitat locations of non-federal identified habitats, including well-defined (GIS-delineated), approximate (hydrologic unit codes), and descriptive.
- Impacts on functional groups: EPA states that implementation of the Rule will result in CWIS modifications that will reduce impingement mortality and set facility-specific requirements for entrainment, resulting in differential beneficial effects among functional groups. EPA expects that "fish or pelagic species vulnerable to impingement would benefit to a greater degree than freshwater mussels where entrainment of eggs and vulnerable life stages constitute the great proportion of species loss."

- Proportion of the ESA-listed species: EPA states that, with the exception of Federal designated critical habitats, there is no information to indicate the relative size or importance of the affected habitat to species or sub-populations, relative to the total species range or numbers.

In the BE, EPA states that the Rule expands and better defines the responsibilities of the compliant facilities seeking the NPDES permit, as well as the interaction of EPA, States, Tribes and Services in evaluating the potential impact to ESA-listed species and designated critical habitat. However, EPA acknowledges that initial determinations may be based on little available data. As facilities collect and submit source water baseline biological characterization data and additional impingement mortality and entrainment study results, EPA believes that data availability and quality will increase. It reasons that these data, collected over the period of years following NPDES permit renewal, will enable EPA and the Services to better determine the potential for any adverse impacts on ESA-listed species on a site specific basis.

As discussed in Section 7.1.1, the Rule requires the owner or operator to identify all threatened and endangered species that might be susceptible to impingement and entrainment at their CWIS and identify all federally-listed threatened and endangered species and/or designated critical habitat that are or may be present in the action area. In the April 8, 2014, correspondence, (Appendix A) EPA verified that whenever the phrase “action area” is used in the Preamble and Rule, it is to be interpreted in a manner consistent with the definition as found in the Services’ regulations implementing ESA section 7 at 50 CFR 402.02. In other words, “action area” includes all areas that may be directly or indirectly affected by the operation of a facility’s CWIS (i.e., impingement, entrainment, or other adverse effects caused by resultant environmental changes, including but not limited to, loss of prey, changes in water quality, and flow alteration). As such, owners/operators should identify all federally listed species and designated critical habitat that may be directly or indirectly affected by the result of a facility’s CWIS operation.

The Rule requires the Director to submit all permit applications to the Services. The Services can then verify if the list of ESA-listed species and designated critical habitat affected by CWIS operations is accurate. While the Rule does not require biological or environmental monitoring of CWIS impacts to ESA-listed species and critical habitat from all facilities; the Director may include such monitoring requirements that have been provided by the Services. If a State or Tribal Director fails to include the Services’ recommended monitoring requirements and the Services believe that the permit may result in more than minor detrimental effects to federally-listed species or designated critical habitat, the permit will be subject to EPA oversight provisions as outlined in the Preamble of the Rule, the April 8, 2014 correspondence from EPA (Appendix A), and in section 2.1 of this Opinion.

As stated above, the Rule requires that Directors provide permit applications to the Services for a 60-day review period, during which time, the Services may provide technical assistance and develop control measures, monitoring and reporting deemed necessary to minimize impacts on ESA-listed species and critical habitat. The Rule does not require the Director to include such control measures and monitoring/reporting requirements in the NPDES permit. However, if a Director fails to include such measures, monitoring and reporting and the Services believe the permit will have more than minor detrimental effects on federally-listed species or designated critical habitat and contacts EPA, then EPA has committed to the following:

i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;
ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and
iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
    - Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

Through this process and EPA's commitment to oversight of the process, the Rule improves the availability of data and better defines the responsibilities of relevant parties. In addition, the process committed to in the Rule also will ensure that any effects from stressors that have more than minor detrimental effects or that rise to the level of jeopardizing a listed species or adversely modifying critical habitat will be addressed through State incorporation of appropriate measures into State permits, EPA's work with the State or Tribe to reduce or remove the minor detrimental impacts, including in appropriate circumstances by objecting to and federalizing the permit consistent with EPA's CWA authority, or EPA's commitment to exercise the full extent of its CWA authority to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.

Impingement and Entrainment
In the biological evaluation (pages 3, 10, 21-36, and others), EPA describes impingement and entrainment as potential stressors likely to be produced as a result of its action. Impingement affects juvenile (e.g., young-of-year) and adult stages of ESA-listed species, while entrainment affects vulnerable early life stages (USEPA 2013c). As stated in the biological evaluation, impingement and entrainment from CWIS:

> "…may represent a substantial portion of annual reproduction. Consequently, [impingement and entrainment] may either lengthen species recovery time, or hasten the demise of these species much more so than for species that are abundant. For this reason, the population-level and social values of [ESA-listed species] losses are likely to be disproportionately higher than the absolute number of losses that occur. Unfortunately, available quantitative and qualitative data on the effects of CWIS on [ESA-listed] species are extremely limited. However, it is known that adverse effects of CWIS on [ESA-listed] species may occur in several ways:

- Individual organisms among [ESA-listed] species may suffer direct mortality as a consequence of impingement and entrainment. This direct loss of individuals may be particularly important because [ESA-listed] species have severely depressed population levels that are approaching local, national, or global extinction.
- Individuals may suffer injury, which may reduce survival probability, reproductive potential and fitness.
- [ESA-listed] species may suffer indirect harm if the CWIS substantially alters the food web in which these species interact. This might occur as a result of altered populations of predator or prey species, the removal of foundation species, or (for species with parasitic life history stages) the loss of host species."

The biological evaluation provided limited data regarding the effect of impingement and entrainment on ESA-listed species. However, we were able to accumulate some information from a small subset of facilities that have completed section 7 consultations or habitat conservation plans regarding the effect of impingement and entrainment to sea turtles. We analyzed data from 14 facilities representing 7 to 33 years of monitoring per facility. Annual entrapment at each facility ranged from 0 to 949 turtles. For all facilities during all years, a total of 15,595 turtles were entrapped, an average of 46 turtles per facility per year (standard deviation = 165). The annual number of deaths at each facility was between 0 to 28 turtles. Data presented by the facilities for all years indicated that a total of 385 entrapped turtles died. This data represents a minimized impact on sea turtles that can be expected from impingement and entrainment, as the facilities summarized here had worked with NMFS through the ESA section 7 or the section 10 process to reduce their impacts on sea turtles. For further information on potential impacts to sea turtles, see Appendix C.

While quantitative and qualitative data on the effects of CWIS on the suite of ESA-listed species that may be affected by implementation of the Rule is limited, effects to more common species have been documented through various monitoring studies conducted at individual facilities. These studies provide further insight as to the effect impingement and entrainment may have on federally-listed species. For example, Bay Shore Power Plant located on Lake Erie near the mouth of the Maumee River conducted an impingement and entrainment study in 2005 and 2006. At the time of the study, the plant took in an estimated 638 million gallons of water/day for cooling water purposes (Ager et al 2008). The study estimated over 2.2 billion larval fish (approximately 10 percent of the larval population in the river), 208 million fish eggs, and 13 million juvenile fish were entrained on an annual basis. Additionally, an estimated 46 million fish were impinged annually (Ager et al 2008). While four species comprised the majority of entrainment and impingement losses, over 50 different species of fish were impinged or entrained during the course of the study.

An ecological assessment prepared by the U.S. Army Corps of Engineers (USACE) for the Upper Mississippi River and Illinois Waterways in 2000 provides a summary of the aggregate effects of impingement and entrainment from multiple facilities along a watercourse. The assessment contained a review of impingement and entrainment rates of fish attributed to 40 power plants. Eleven of the 40 plants had studies on impingement and/or entrainment rates, with most studies being 15 to 20 years old (West 2000). From the data available, the USACE estimated six of the power plants accounted for over 64 million fish entrained and over 56 million fish impinged on an annual basis (West 2000). Similar to the Bay Shore study, over 50 different species of fish were impacted, but a smaller set of species accounted for over 50 percent of impingement and entrainment losses (West 2000). In both instances, species considered relatively common comprised the majority of individuals impinged or entrained.

These studies illustrate the large number of species and individuals that may be impinged and entrained at a single facility, or through the combination of multiple facilities along a watercourse. So it is likely that any CWIS operating in the vicinity of listed aquatic organisms will cause impingement or entrainment of species protected under the ESA (see Appendix C for species under NMFS jurisdiction).

With regard to salmonids, we know that without screens and bypass systems, impingement (and resulting mortality) is more likely. Automatically cleaned screens with low approach velocity (less than 0.4 ft/s), small screen face openings (3/32" circular or square, or 1.75 mm continuous slots or rectangular openings) and bypass systems designed for fish swimming ability and behavioral traits, typically avoid most juvenile salmonid fish impingement or entrainment, and should be used anywhere juvenile salmonids could be present. With inadequate screen submergence, the water velocity directly between the water surface and the top of the screen can exceed the juvenile salmon swimming ability, potentially capturing fish above the screens until they fatigue or become prey.

EPA acknowledges the potential for impingement and entrainment to lengthen ESA-listed species recovery time, or hasten their demise. Effects to individuals include: death, injury, and indirect effects (e.g., resulting from trophic cascades). In the biological evaluation, EPA explains that it is unable to quantify the extent of the stressors, as a result of limited data. The Services agree with EPA that implementation of the standards set forth in this Rule reduces the impingement/entrainment of listed organisms. The Services also acknowledges that the ultimate extent of such impingement/entrainment is likely to be reduced by implementation of this Rule when compared to the extent that pre-dates the effective date of the Rule (i.e., prior to regulation by EPA). Upon taking effect, all facilities covered by the Rule will be required to comply with the Rule and therefore the appropriate effects analysis for this Opinion is to ask whether the levels of impingement/entrainment that will exist after the Rule takes effect and is implemented through NPDES permits are consistent with the obligations of section 7(a)(2) of the ESA.

The Rule requires owners and operators to provide any previously conducted entrainment performance studies as an information requirement of all existing facilities so the Director can establish site-specific entrainment standards. Additionally, facilities that withdraw more than 125 million gallons of cooling water/day must submit as part of their permit application, an entrainment characterization study that includes a minimum of 2 years of entrainment data collection. While the Rule does not require monitoring for impingement or entrainment for ESA-listed species at any facilities, the Director may establish additional monitoring for impingement, and the Director may also establish monitoring requirements for entrainment on a site-specific basis. Director determinations of monitoring may include recommendations provided by the Services as a result of their review of permit applications. The Rule also states that where the Director requires additional measures to protect federally-listed threatened or endangered species pursuant to 125.94(g) of the Rule, the Director shall require monitoring associated with those measures. Allowing the Services to provide the Director impingement and entrainment monitoring recommendations tailored to address site-specific and species-specific issues will help address the following concerns associated with current monitoring efforts as identified in the biological evaluation:

- Because of the low population densities of ESA-listed species and the small volume of water sampled for impingement and entrainment studies, it is likely that many impinged or entrained individuals are never recorded;
- Species identification is difficult at early life history stages (e.g., egg, larvae), which comprise a large proportion of organisms impinged or entrained; and
- At facilities using fish return technology, individuals returned to the waterbody may not be recorded and the condition of the returned individuals is unknown.

In summary, EPA, in their biological evaluation, acknowledges that impingement and entrainment have the potential to either lengthen species recovery time, increase the number of deaths/injuries to ESA-listed species, or increase their extinction risk. EPA also acknowledges that most facilities overlap with at least one ESA-listed species or designated critical habitat. Lastly, EPA stipulates that it cannot quantify the effects of impingement and entrainment at this time due to limited data. The Rule does not establish monitoring requirements for the impingement or entrainment of ESA-listed species and designated critical habitat. Rather, the Rule establishes a process that allows the Director to work with the Services to determine if additional measures are necessary to reduce impacts to federally-listed species and designated critical habitat and if so, to determine the associated monitoring requirements. If the Director chooses to not include the measures and associated monitoring requirements in the permit and the Services have concerns that a permit will have more than minor detrimental effects on federally-listed species or critical habitat and contact EPA with their concerns, EPA has committed to the following:

i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;
ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA’s CWA authority; and
iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
    - Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

To date, EPA has not been able to reliably estimate the impact of impingement and entrainment associated with CWIS operations on federally-listed species or critical habitat. However, the process of information exchange required in the Rule and EPA’s commitment to the oversight of that process as described above will allow EPA to more reliably estimate stressors associated with impingement and entrainment that are likely to be produced as a direct or indirect result of CWIS operations subject to the Rule. In addition, the process committed to in the Rule also will ensure that any effects from stressors that have more than minor detrimental effects or that rise to the level of jeopardizing a listed species or adversely modifying critical habitat will be addressed through State incorporation of appropriate measures into State permits, EPA's work with the State or Tribe to reduce or remove the minor detrimental impacts, including in appropriate circumstances by objecting to and federalizing the permit consistent with EPA's CWA authority, or EPA's commitment to exercise the full extent of its CWA authority to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.

Thermal discharges

Thermal discharges are regulated under sections 301, 306, or 316(a) of the CWA to protect a balanced indigenous population of shellfish, fish and wildlife in and on the water. While those sections of the CWA are not subject to this consultation, thermal discharges from facilities operating a CWIS regulated under this Rule are an interrelated action and thermal discharges are known stressors on aquatic environments.

As described in the biological evaluation, studies have shown that thermal discharges may substantially alter the structure of the aquatic community by modifying photosynthetic (Bulthuis 1987; Chuang et al. 2009; Martinez-Arroyo et al. 2000; Poornima et al. 2005) metabolic, and growth rates (Leffler 1972), and reducing levels of dissolved oxygen. Thermal pollution may also alter the location and timing of fish behavior including spawning (Bartholow et al. 2004), aggregation, and migration (USEPA 2002), and may result in thermal shock-induced mortality for some species (Ash et al 1974; Deacutis 1978; Smythe and Sawyko 2000). Thus, thermal pollution is likely to alter the ecological services provided by ecosystems surrounding facilities returning heated cooling water into nearby waterbodies.

Thermal discharge limitations vary by State, but typically discharges have to remain below 90°F. A study conducted in 2008 found that over 350 power plants across 14 different states reported discharges exceeding this threshold (Averyt et al. 2011). Large fish kills attributed to an exceedance of thermal discharges at power plants have been documented (NCDWQ 2010, Schwarzen, C. 2000 in Averyt et al 2011). Many common species of fish cannot tolerate water temperatures that exceed 90°F, and for many species of trout, water temperatures that exceed 80°F can be fatal (Seaby and Henderson 2007, Skaggs et al 2012). "Heat death" in fish occurs when temperatures of fish rise to a level where coordination in the central nervous system begins to break down (Seaby and Henderson 2007).

Dissolved oxygen likely plays a key role in temperature tolerance (Niklitchek 2001). Water temperature and dissolved oxygen levels are related, with warmer water generally holding less dissolved oxygen. In summer, the coupling of low dissolved oxygen at depth and water temperatures greater than 20°C above the thermocline limits non-stressful habitat due to a temperature-oxygen habitat squeeze (Coutant 1987). Sturgeon, for example, are more sensitive to low level dissolved oxygen conditions than some other fishes and become stressed in hypoxic conditions (generally under 5 mg/L), which may limit growth, metabolism, activity, and swimming (Cech et al. 1984, Secor and Gunderson 1998, Secor and Niklitschek 2001, Secor and Niklitschek 2002, Cech and Crocker 2002, Campbell and Goodman 2004).

In summary, EPA acknowledges in the biological evaluation that temperature is "…a master environmental variable for aquatic ecosystems, affecting virtually all biota and biologically mediated processes, chemical reactions, as well as structuring the physical environment of the water column." As described above, thermal discharges are regulated under sections 301, 306, or 316(a) of the CWA and thus, the Rule does not establish control measures or monitoring requirements for habitats of ESA-listed species or designated critical habitat impacted by thermal discharges. However, as thermal discharges are an indirect effect of CWIS operations, and the Rule allows Directors to base their determination of site specific entrainment requirements on the benefits of reducing thermal discharge impacts, Directors may require additional measures, monitoring and reporting under 316(b) to conserve federally-listed species or designated critical habitat. Measures established by the Director may reflect recommendations made by the Services during either the 60-day review or the public comment period. If the owner or operator or the Director choose not to incorporate Services' recommended measures, and the Services contact EPA with concerns that the permit may cause more than minor detrimental effects to federally-listed species or critical habitat, then EPA will exercise its oversight authority, consistent with the Preamble to the Rule as clarified in the April 8, 2014 correspondence (Appendix A). To date, EPA has not been able to reliably estimate the impact of thermal discharge associated with CWIS operations on federally-listed species or designated critical habitat. However, more information will now be generated as the Rule promotes the exchange of information or technical assistance between the Services and the Directors. EPA now commits to the oversight of that process, which will allow EPA to more reliably estimate the physical, chemical, or biotic stressors that are likely to be produced as a direct or indirect result of thermal discharge activities.

Flow alteration

As described in the biological evaluation, the operation of CWIS, including water withdrawals and discharge returns, significantly alters patterns of flow within receiving waters, both in the immediate area of the CWIS intake and discharge pipe and in mainstream waterbodies. In ecosystems with strongly delineated boundaries (i.e., rivers, lakes, enclosed bays, etc.), CWIS may withdraw and subsequently return a substantial proportion of water available to the ecosystem. For example, of 521 facilities located on freshwater streams or rivers, 164 (31 percent) have an average intake greater than 5 percent of the mean annual flow of the source waters (USEPA 2013c). Based on the ratio of water demand to water supply, power plants are the major drivers of water stress in 44 basins across the United States (Skaggs et al. 2012). As EPA describes in the biological evaluation, such withdrawals are likely to have significant impact on the aquatic habitat, in general, and on ESA-listed species and designated critical habitat, especially in inland riverine environments.

All withdrawals are likely to alter flow characteristics of the waterbody including turbulence and water velocity (USEPA 2013c). As described in the biological evaluation, altered flow velocities and turbulence may lead to several changes in the physical environment, including: sediment deposition (Hoyal et al. 1995), sediment transport (Bennett and Best 1995), and turbidity (Sumer et al. 1996), each of which play a role in the physical structuring of ecosystems. Biologically, flow velocity is a dominant controlling factor in aquatic ecosystems. Flow has been shown to alter feeding rates, settlement and recruitment rates (Abelson and Denny 1997), bioturbation activity (Biles et al. 2003), growth rates (Eckman and Duggins 1993), and population dynamics (Sanford et al. 1994).

In addition to flow rates, turbulence plays an important role in the ecology of small organisms, including fish eggs and larvae, phytoplankton, and zooplankton. In many cases, the turbulence of a waterbody directly affects the behavior of aquatic organisms, including fish, with respect to swimming speed (Lupandin 2005), location preference with a waterbody (Liao 2007), predator-prey interactions (Caparroy et al. 1998; MacKenzie and Kiorboe 2000), recruitment rates (MacKenzie 2000; Mullineaux and Garland 1993), and the metabolic costs of locomotion (Enders et al. 2003). The sum of these effects may result in changes to the food web or the location of used habitat, and thereby substantially alter the aquatic environment (USEPA 2013).

In the biological evaluation, EPA also acknowledges that flow alteration as a result of CWIS operation is likely to change over time as a result of climate change. Climate change is predicted to have variable effects on future river discharge in different regions of the United States, with some rivers expected to have large increases in flood flows, while other basins will experience water stress. For example, Palmer et al. (2008) predict that mean annual river discharge is expected to increase by about 20 percent in the Potomac and Hudson River basins, but to decrease by about 20 percent in Oregon's Klamath River and California's Sacramento River.

To summarize, in the biological evaluation, EPA states that CWIS may alter habitat that is essential to the long-term survival of ESA-listed species as a result of altered flow regimes or turbidity. Flow alterations may be caused by all degrees of withdrawals, not just those that withdraw a significant proportion of the mean annual flow of source waters. To date, EPA has not been able reliably estimate the effects of flow alteration on ESA-listed species and critical habitat. While the Rule does not establish control measures or monitoring and reporting requirements to reduce the effects of flow alteration on ESA-listed species and designated critical habitat, it does establish a process that allows the Director to work with the Services to determine the benefits of reducing impacts of flow alteration and in determining appropriate controls under section 316(b), including those that conserve ESA-listed species. If additional measures are necessary, the Services will be able to provide appropriate monitoring and reporting recommendations. The Director may then include these measures, monitoring, and reporting in the permit. If a State or Tribal Director chooses to not include the measures and associated monitoring requirements in the permit and the Services have concerns that a permit will have more than minor detrimental effects on federally-listed species or critical habitat and contact EPA with their concerns, EPA has committed to the following:

i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;
ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and

iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
   - Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

The technical assistance process facilitated by the exchange of information as required in the Rule and EPA's commitment to the oversight of that process as described above will allow EPA to more reliably estimate stressors associated with flow alterations that are likely to be produced as a direct or indirect result of CWIS operations subject to the Rule.

Chemical discharges

As described in the biological evaluation, contaminated effluent is a byproduct of once-through cooling water systems. Chemical discharges are addressed in NPDES permits by either water quality-based effluent limitations or technology-based effluent limitations of the CWA. We consider chemical discharges in this consultation, because in the biological evaluation, EPA identifies chemical discharges as a stressor produced by operation of CWIS that fall under the purview of this Rule.

In the biological evaluation, EPA explains that toxic pollutants, such as metals, polycyclic aromatic hydrocarbons, pesticides, biofouling chemicals, or chlorine may be present in the discharge of CWISs. They conclude that such chemical discharges could lead to local extirpation of sensitive species, or to greatly altered biological communities due to chronic impacts on viability, growth, reproduction, and resistance to other stressors (USEPA 2013). To date, EPA has not been able to reliably estimate the effects of chemical discharges on ESA-listed species and designated critical habitat, as environmental monitoring and data collection has not been required from all facilities. The Rule does not establish specific control measures or monitoring and reporting requirements to reduce the effects of chemical discharge on ESA-listed species and designated critical habitat; however, it does establish a process that allows the Director to work with the Services to determine the benefits of reducing impacts of chemical discharge and in determining appropriate controls under section 316(b), including those that conserve ESA-listed species. If additional measures are necessary, the Services will be able to provide appropriate monitoring and reporting recommendations. The Director may then include these measures, monitoring, and reporting in the permit. If the Director chooses to not include the measures and associated monitoring requirements in the permit and the Services have concerns that a permit will have more than minor detrimental effects on federally-listed species or critical habitat and contact EPA with their concerns, EPA has committed to EPA has committed to the following:

i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;

ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and

iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
   - Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

The technical assistance process facilitated by the exchange of information between the Director and the Services as required in the Rule, and EPA's commitment to the oversight of that process as described above will allow EPA to more reliably estimate stressors associated with chemical discharge that are likely to be produced as a direct or indirect result of CWIS operations subject to the Rule.

Aggregate Impacts

As described in the biological evaluation, cumulative impacts are the magnified environmental stressors created by regulated CWIS when two or more facilities are located nearby (USEPA 2013c). To avoid confusion with the regulatory definition of cumulative effects, we use the term "aggregate impacts." Aggregate impacts are likely to occur if multiple facilities are located in close proximity, such that they impinge or entrain aquatic organisms within the same source waterbody, watershed system, or along a migratory pathway of a specific species (e.g., striped bass in the Hudson River) (USEPA 2004). Aggregate impacts include the magnified effects of indirect effects associated with the operation of CWISs of two or more facilities.

EPA estimates that approximately 20 percent of potentially regulated facilities are located on waterbodies with multiple CWIS (USEPA 2004). Review of geographic locations of 316(b) facilities (approximated by CWIS latitude and longitude) indicates that facilities in inland settings are clustered around rivers to a greater extent than marine and estuarine facilities (USEPA 2013c). In the biological evaluation, EPA explains that aggregate impacts of clustered facilities may be significant, due to concentrated impingement and entrainment mortality, combined intake flows, and the potential for other impacts such as thermal or chemical discharges and flow alterations. EPA also notes that power generation demand and cooling intake water volume is typically at its annual maximum during mid-late summer, which is also a period of seasonal low flows and highest in-stream temperatures. Although low flows traditionally occur in late summer to early fall, drought conditions and manipulations of water levels may lead to low flow during other periods as well. Low flow is problematic when it overlaps with seasonal concentrations of eggs, developing young of the years, and migrating juveniles or adults (USEPA 2013c). EPA estimates that aggregate impacts may be greater in inland waters due to the following factors:

- the majority of national annual intake flow is associated with freshwater CWIS;
- freshwater plants use a greater relative volume of available fish habitat than marine or estuarine counterparts; and

- seasonal variation in power demand and river flow may increase entrainment potential during low-flow periods of the year (NETL 2009).

To summarize, in the biological evaluation, EPA acknowledges that the stressors described above are magnified when two or more facilities are located in close proximity; approximately 20 percent of facilities are located in waterbodies with multiple CWIS; and most facilities overlap with at least one ESA-listed species. Because the above stressors have the potential to lengthen species recovery time, hasten the demise of these species, or alter habitat that is critical to long-term survival, magnification of such stressors has a greater potential to jeopardize the continued existence of listed species and adversely modify critical habitat.

To date, EPA has not been able know or reliably estimate the aggregate impacts of CWIS operations on ESA-listed species and critical habitat. While the Rule does not establish control measures or monitoring and reporting requirements to reduce aggregate impacts from CWIS on ESA-listed species and designated critical habitat; it does establish a process that allows the Director to work with the Services to determine if additional measures are necessary to reduce aggregate impacts and if so, to determine the associated monitoring reporting requirements. The Director may then include these measures, monitoring, and reporting in the permit. If the Director chooses to not include the measures and associated monitoring and reporting requirements in the permit and the Services have concerns that a permit will have more than minor detrimental effects on federally-listed species or critical habitat and contact EPA with their concerns, EPA has committed to the following:

i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;
ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and
iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
    - Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

Summary

Stressors associated with the operation of CWIS as described above have the potential to significantly affect federally-listed species and designated critical habitat. EPA has structured the Rule to more reliably estimate these physical, chemical, or biotic stressors as they relate to federally-listed species and designated critical habitat. For permits issued by EPA on a facility by facility basis, EPA is likely to know or reliably estimate the physical, chemical, or biotic stressors that are likely to be produced as a direct or indirect result of activities as they are required to consult with the Services through the section 7(a)(2) process if the action may affect listed species or critical habitat. For State-issued permits, the technical assistance process facilitated by the exchange of information between the Director and the Services as required in the Rule, and EPA's commitment to the oversight of that process as described in this Opinion and in the April 8, 2014, correspondence from EPA, will allow EPA to more reliably estimate stressors that are likely to be produced as a direct or indirect result of activities regulated under the Rule. Specifically, the Services will now be able to provide review and comment as to whether stressors to ESA-listed species have been correctly identified in permit applications. The following are those steps in the Rule and supporting documentation that outline this process:

- ESA-listed species and/or critical habitat that occurs in the action area for a facility and impacted by CWIS will be identified by the owner or operator and provided to the Services for verification;
- The Directors are required to send all permit application information to the Services and provide the Services with 60 days to review the information. If the Services provide control measures, monitoring or reporting requirements to reduce impacts associated with CWIS to the Director, the Director may include those in the permit;
- If the Director does not include the control measures, monitoring or reporting requirements recommended by the Services and the Services have concerns that a permit will have more than minor detrimental effects on federally-listed species or critical habitat and contact EPA with their concerns:
    - i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;
    - ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and
    - iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
        - o Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

1.1.3 Minimization of likely adverse effects

In regulations for new facilities (316(b) Phase I), EPA deemed closed-cycle recirculating systems to be the best technology available to minimize adverse environmental impacts resulting from the operation of CWIS. In the Rule, EPA requires the owner or operator of a new unit at an existing facility to reduce the design intake flow "to a level commensurate with that which can be attained by the use of a closed-cycle recirculating system" or to "demonstrate achievement of reductions commensurate with closed-cycle recirculating system." We agree that closed-cycle systems are the best technology available and are likely to reduce impingement of ESA-listed species and reduce impacts to designated critical habitat; however, it is not clear that closed-cycle systems will minimize, as defined in the Rule, such impacts. In the Rule, minimize means "to reduce to the smallest amount, extent, or degree reasonably possible." Without additional devices (e.g., screens or excluder bars), closed-cycle recirculation systems may still impinge listed species, which is take (or a more than minor detrimental, effect requiring a permit or exemption from the Services).

Impingement Standard

The BTA Standards for Impingement Mortality involving demonstrated ≤ 0.5 ft/sec through-screen velocity (design or actual) exceed velocities recommended by the Services (≤ 0.2, 0.33, or 0.4 ft/sec, depending on conditions) to protect salmonids and other sensitive fishes (FFTT 2011). For example, studies have indicated the federally-threatened delta smelt (*Hypomesus transpacificus*) are slow swimmers that are unable to sustain swimming velocities above 0.33 ft/s for more than a few minutes (Swanson et al 2000, Swanson et al 1998). Through screen velocities of 0.5 ft/sec would likely not provide adequate protection. Therefore, if facilities implement the BTA Standard for Impingement Mortality as found in the Rule, impingement of ESA-listed species is still likely to occur. This example demonstrates why the requirement for Directors to provide the Services an opportunity to review permit applications prior to issuing a draft and final permit per the Rule is a critical aspect of EPA's action.

The Rule defines a velocity cap as "an open intake designed to change the direction of water withdraw from vertical to horizontal, thereby creating horizontal velocity patterns that result in avoidance of the intake by fish and other aquatic organisms. For purposes of this [Rule], the velocity cap must use bar screens or otherwise exclude marine mammals, sea turtles, and other large aquatic organisms." Offshore is defined as a minimum of 800 feet from the shoreline and outside of the littoral zone. If an offshore velocity cap operates as intended (i.e., avoids intake of fish and other aquatic organisms), then this BTA Standard for Impingement Mortality minimizes impingement of ESA-listed species and designated critical habitat. While the Rule allows the Director to establish alternative procedures for visual or remote inspections that verify the effectiveness of the velocity cap, the Services will be provided an opportunity to recommend to the Director what inspection procedures should entail and notify EPA of any concerns as they relate to federally-listed species

The Rule defines modified traveling screens as "traveling water screens that incorporate measures protective of fish and shellfish, including but not limited to: screens with collection buckets or equivalent mechanisms designed to minimize turbulence to aquatic life; addition of a guard rail or barrier to prevent loss of fish from the collection system; replacement of screen panel materials with smooth woven mesh, drilled mesh, molded mesh, or similar materials that protect fish from descaling and other abrasive injury; continuous or near-continuous rotation of screens and operation of fish collection equipment to ensure any impinged organisms are recovered as soon as practical; a low pressure wash or gentle vacuum to remove fish prior to any high pressure spray to remove debris from the screens; and a fish handling and return system with sufficient water flow to return the fish directly to the source water in a manner that does not promote predation or re-impingement of the fish, or require a large vertical drop." This BTA Standard for Impingement Mortality does not include several of the specifications recommended by NMFS and adopted by the USFWS to protect salmonids and other fishes (FFTT 2011), including: defined maximum screen face openings; spacing of trash racks; maintenance schedule; debris management requirements; escape routes; sweeping velocities; and height/bottom requirements for screens. The Rule states that the Director may approve of fish being returned to water sources other than the original source water, which could result in the displacement of ESA-listed species or their prey. Additionally, returning fish or other species to water sources other than their source water may result in ESA-listed species being impacted due to the inadvertent transfer of disease or aquatic invasive species. Based on correspondence received from EPA on April 8, 2014, EPA verified that Directors will address any concerns from the Services regarding the return of aquatic species to waters other than their source waters. If the Services' concerns are not addressed and the permit would cause more than minor detrimental effects, the permit will be subject to the EPA oversight provisions as committed to by EPA as a part of their action. While, the modified traveling screen BTA Standard for Impingement Mortality as described in the Rule may not be protective enough of federally-listed species and designated critical habitat (e.g., prey base), the Services will be provided an opportunity to recommend to the Director additional site-specific and species-specific control measures during their review of the permit applications as afforded in the Rule.

The Rule allows an owner or operator to meet the BTA Standard for Impingement Mortality by operating a system of technologies, management practices, and operation measures that the Director determines is the best technology available, using information from the impingement technology performance optimization study. The range of possible systems, practices, and measures is wide and unspecified, and their efficacy is unknown. Therefore, we cannot conclude that this standard on its own is likely to minimize the impingement of ESA-listed species or critical habitat. However, as previously described, the Services will be provided an opportunity to recommend additional site-specific and species-specific control measures during their review of permit applications.

The Rule also allows a12-month impingement mortality performance standard, which requires monthly monitoring. The Rule requires that impingement mortality be less than 24 percent:

$$\frac{\text{\# fish killed***}}{\text{\# fish impinged}} < \quad \text{24 percent}$$

***After collected or retained in ≤ 0.56 inch sieve and held for 18 to 96 hours, or other time as specified by the Director*

The Rule indicates that the number of fish killed includes latent mortality, for all non-fragile species together that are collected or retained in a sieve with maximum opening dimension of 0.56 inches and kept for a holding period of 18 to 96 hours; it allows the Director to provide an alternate holding period. This Standard on its own does not appear to minimize the impingement of ESA-listed species or critical habitat. Instead it places a limit (24 percent) on the proportion of impinged "fish" that may be killed. This raises several concerns. EPA estimates 1.9 billion age-one equivalents are impinged and entrained each year (USEPA 2013d). In the Preamble of the Rule, EPA indicates this number could be in the hundreds of billions of aquatic organisms when plankton, fish eggs, and larvae are included. The authorization of so many mortalities - some of which may be listed-species - may jeopardize the continued existence of ESA-listed species, which often exhibit extremely low abundance. Additionally, the Standard does not address the non-lethal fitness costs associated with impingement, such as injury or loss of reproductive success. These concerns further demonstrate why the review process afforded the Services in the Rule and EPA's commitment to exercise their oversight authority if necessary are critical elements of this action, as the impingement mortality performance standard on its own is still likely to result in a large amount of lethal and non-lethal take. However, EPA makes clear that the Rule does not authorize take, as defined by the ESA. Furthermore, the Rule requires that each permit include as a permit condition a statement that: "nothing in the permit authorizes take for the purposes of a facility's compliance with the ESA."

The Rule includes provisions for *de minimis* rates of impingement. The Rule states that in limited circumstances, rates of impingement may be so low at a facility that additional impingement controls may not be justified. However, EPA verified in their April 8, 2014, correspondence with the Services, that in circumstances where a Director determines a facility's rate of impingement is so exceptionally low as to not warrant additional impingement controls, the operation of CWIS may still have more than minor detrimental effects on federally-listed species if listed species are subject to impingement. A proposed permit that would cause more than minor detrimental effects to federally-listed species would be subject to EPA's oversight authority as committed to by EPA as a part of this action.

Based on the analysis above, implementation of the BTA Standards for Impingement Mortality on their own is unlikely to minimize adverse effects on ESA-listed species and designated critical habitat. Though some BTA Standards have the potential to minimize adverse effects (e.g. closed cycle and velocity cap), biological monitoring is needed to verify their effectiveness. Through ESA section 7 consultation on EPA issued permits and the technical assistance process with State or Tribal Directors facilitated by the exchange of information as established in the Rule, the Services will be able to provide to EPA or the Director additional site-specific and species-specific control measures, monitoring, and reporting recommendations to further enhance the protectiveness of these standards as they relate to federally-listed species. Examples of species-specific control measures the Services may recommend can be found in Appendix D. By including the Services recommendations for control measures, monitoring and reporting in the final permit, the State or Tribal Director will further reduce the impacts of CWIS operations on federally listed species and designated critical habitat. The Services expect, for purposes of this Opinion, that issues related to ESA- listed species will be adequately addressed in light of: the two opportunities for the Services to engage in the permitting process (in reviewing the permit application and the proposed permit), the obligation of State Directors to consider and address any information brought to its attention by the Services and make its permitting decisions based on the administrative record before it, the opportunity for public participation in the permitting process, and, finally, EPA's commitment to exercise its oversight authority to resolve any issues that arise.

Entrainment Standard

EPA gives discretion to the Director in determination of the entrainment standard. The Rule states that entrainment requirements "must reflect the Director's determination of the maximum reduction in entrainment warranted after consideration of factors relevant for determining the best technology available for minimizing adverse environmental impact at each facility." These determinations must be based on:

- Numbers and types of organisms entrained, including, specifically, the numbers and species (or lowest taxonomic classification possible) of federally-listed threatened or endangered species and designated critical habitat (e.g., prey base);
- Impact of changes in particulate emissions or other pollutants associated with entrainment technologies;
- Land availability inasmuch as it relates to the feasibility of entrainment technology
- and remaining useful plant life; and
- Quantified and qualitative social benefits and costs of available entrainment technologies of a sufficient quality and rigor for the director to make a decision.

The entrainment standards may also be based on:

- Entrainment impacts on the waterbody
- Thermal discharge impacts
- Credit for unit retirements occurring within the past 10 years
- Impacts on water consumption
- Availability of process water, gray water, waste water, reclaimed water, or other waters of appropriate quantity and quality for reuse as cooling water

If all technologies considered have social costs not justified by the social benefits, or have unacceptable adverse impacts that cannot be mitigated, the Director may determine that no additional control requirements are necessary beyond what the facility is already doing. The Director may reject an otherwise available technology as BTA standards for entrainment if the social costs are not justified by the social benefits. It is important to note that when making these determinations, the ESA and its legislative history indicate the preservation of endangered species should be given the highest priority (TVA v. Hill 437 U.S. 153 1978). Additionally, the Director may reject an otherwise available technology as a basis for entrainment requirements if the Director determines there are unacceptable adverse impacts, including: impingement, entrainment, or other adverse effects to ESA-listed species or designated critical habitat.

The Director-determined entrainment requirements are not required to but "may also reflect any control measures, monitoring and reporting requirements that are designed to minimize incidental take, reduce or remove more than minor detrimental effects to federally-listed species and designated critical habitat, or avoid jeopardizing federally-listed species or destroying or adversely modifying designated critical habitat. Such control measures, monitoring and reporting requirements may include measures or requirements identified by an appropriate Field Office of the USFWS and/or Regional Office of the NMFS Service during the 60 day review period pursuant to 125.98(h) of the Rule or the public notice and comment period pursuant to 40 C.F.R. 124.10. If required by the Director, the owner or operator must implement any additional control measures

EPA's entrainment standard does not specifically reduce the impacts of entrainment on federally-listed species or designated critical habitat. Director determined entrainment requirements are likely to vary from State to State and from permit to permit. For EPA issued permits, EPA will consult pursuant to section 7 of the ESA with the Services. For State and Tribal-issued permits, per the Rule, the Services will be provided an opportunity to recommend site-specific and species-specific entrainment requirements to the Director to minimize incidental take and reduce or remove more than minor detrimental effects of entrainment on federally-listed species and designated critical habitat. By including the Services' recommendations for control measures, monitoring and reporting in the final permit, the Director will further reduce the impacts of CWIS operations on federally-listed species and designated critical habitat. It is through this process, which the Services assume for this consultation will result in inclusion of control measures in State and Tribal-issued permits, and EPA's commitment as part of their action to working with States and Tribes to remove more than minor detrimental effects of permits when contacted by the Services that EPA has minimized the adverse effects of entrainment that are likely to result from EPA's action.

Incidental Take

In the Rule, EPA states, "This regulation does not authorize take, as defined by the Endangered Species Act, 16 USC 1532(19). The Fish and Wildlife Service and National Marine Fisheries Service have determined that any impingement or entrainment of federally-listed species constitute take. Such take may be authorized pursuant to the conditions of a permit issued under 16 U.S.C. 1539(a) or where consistent with an Incidental Take Statement contained in a Biological Opinion pursuant to 16 U.S.C. 1536(o)." In addition, EPA requires the Director to include the following language as a permit condition: "Nothing in this permit authorizes take for the purposes of a facility's compliance with the Endangered Species Act." These are statements of fact: incidental take may only be exempted or permitted by the Services.

Neither the Rule, nor permits issued per the Rule, authorizes the incidental take of ESA-listed species. However, if during their review of permits as afforded in the Rule, the Services determine that a facility's CWIS operations may result in incidental take, the Services may provide the Director additional control measures designed to minimize incidental take. If the Director chooses not to include these measures in the permit and the Services contact EPA with their concerns, the permit would be subject to EPA's oversight authority as committed to by EPA as a part of this action. This process, as outlined in the Rule and supporting documentation allow EPA to address incidental take that is reasonably certain to be caused by implementation of the Rule.

Summary

EPA has stated adverse environmental impacts include adverse effects to listed species (USEPA 2013f), and Section 316(b) of the CWA requires that the location, design, construction, and capacity of CWIS reflect the BTA for minimizing adverse environmental impacts. As such, when determining if a facility has met the requirements of the Rule, the Director should consider if a facility has minimized adverse effects to federally-listed species to the smallest amount, extent, or degree reasonably practicable. To aid Directors in their decision, EPA has established a requirement in the Rule for Directors to provide the Services with all NPDES permit applications subject to the Rule for a 60-day review period. The review period will allow the Services to review the impacts a facility may have on federally-listed species and designated critical habitat and provide the Director any control measures, monitoring and reporting requirements the Services believe are necessary to reduce those impacts. If a Director fails to include these recommendations in the permit and the Services contact EPA with their concerns, the permit would be subject to EPA's oversight authority as committed to by EPA as a part of this action. This process, as outlined in the Rule and supporting documentation will allow EPA to minimize adverse effects that are reasonably certain to be caused by implementation of the Rule.

1.1.4 Identifies, informs, encourages, and screen applicants for potential eligibility under the Rule

In this section, we review requirements in the Rule that allow EPA to identify, inform, encourage, and screen applicants for potential eligibility under the Rule. The Rule is clear in that it applies to owners and operators of existing facilities with CWIS that withdraw > 2 mgd and use at least 25 percent of the water for cooling purposes. EPA was able to positively identify all electric facilities (n=575) that will be subject to the Rule; however they were unable to identify all manufacturing facilities. EPA will inform the regulated community by publishing the Rule in the Federal Register (the final rule will be codified in the Code of Federal Regulations) where it previously published the original regulations, the suspension of the original regulations, and the proposed regulations. It is likely that owners or operators who had previously been issued permits are aware that the Rule is in the process of being amended by EPA.

The current uncertainty surrounding the true number and location of manufacturing facilities is problematic. Adding to the uncertainty are those facilities that currently operate under administratively continued permits. If an applicant has submitted a complete permit application for a new permit and the Director is unable to issue a new permit in time, the previous permit is administratively continued without an opportunity for comment or review. Such extensions allow the facility to continue operating under the provisions of the old permit until the new permit is issued. As of EPA's latest count (March 2013), approximately 24 percent (n=1,617) of all major facilities and 17 percent (n=6,569) of all minor facilities were operating under administratively continued NPDES permits (USEPA 2013e). These numbers represent the "universe of NPDES facilities" and not just those facilities which may be subject to the Rule.

EPA addresses the uncertainty associated with administratively continued permits and their potential effects on federally-listed species with the following measures:

- As stated in the Preamble of the Rule, "given the history of litigation around this section [316(b)] of the Clean Water Act, states have, in some instances, administratively extended permits while awaiting final federal action…" EPA is now taking final action through the promulgation of the Rule. Some NPDES permits have been continued for a decade or more. For example, the 1991 NPDES permit issued by EPA to the Pilgrim Nuclear Power Station has been administratively continued since it expired in 1996 (i.e., 18 years).
- The Preamble of the Rule goes on to state that, "the Director should consider if any [administratively continued] permits would need additional updated information to support the permit issuance decision. The Director may, under 40 CFR 122.21(g)(13), request additional information including any application requirements in 122.21(r)." As the Rule requires owners and operators to identify all federally-listed threatened and endangered species and/or designated critical habitat that are or may be present in the action area (the area directly or indirectly affected by the operation of a facility's CWIS) as part of their permit application, this is new information that has not been required in the past and provides reason for a Director to request this new information from facilities operating under administratively continued permits.

Directors are required to provide the Services with a copy of every NPDES permit application pertaining to the Rule, allowing the Services to evaluate if a facility's CWIS operations adversely affect federally-listed species. Directors also have authority to request new information and to reopen administratively continued permits based on new information (e.g. impacts to federally-listed species not previously considered in previous permit applications). Given these provisions and EPA's commitment to exercise their oversight authorities when necessary, the Rule and supporting documentation are structured to allow EPA to identify, inform, encourage, and screens applicants of their eligibility under the Rule.

1.1.5 Monitoring and evaluation of adverse effects

EPA has established monitoring requirements for four of seven of the BTA Standards for Impingement Mortality. These are mainly non-biological monitoring requirements and include: daily flow intake for closed-cycle recirculating systems; daily intake flow for offshore velocity caps; and daily through-screen actual velocity (maximum = 0.5 ft/sec). Only the impingement mortality performance standard requires biological monitoring, which must be conducted at least monthly. The monthly monitoring requirement is not likely to be sufficient to identify the impingement of ESA-listed species because such organisms are often found in low abundance and/or intermittently, such that their impingement may not be detected by a once/per month monitoring effort. Such monitoring on its own is not sufficient to identify incidental take of impinged ESA-listed species.

EPA requires the Director to determine monitoring and reporting requirements for entrainment on a site-specific basis. For both impingement and entrainment, the Director may establish additional monitoring and reporting requirements and those requirements may include recommendations provided by the Services. As described in the Rule, where the Director requires additional measures to protect federally-listed threatened or endangered species or designated critical habitat pursuant to 125.94(g), the Director shall require monitoring associated with those measures. Directors are also required to submit facilities' annual reports submitted pursuant to 125.97(g) of the Rule, for compilation and transmittal to the Services.

As described above, the Rule does not establish specific monitoring or reporting requirements to evaluate likely adverse effects on ESA-listed species or designated critical habitat. However, through technical assistance facilitated by the information exchange and review process required per the Rule, the Services will be able to provide monitoring and reporting requirements for federally-listed species and designated critical habitat on a site-specific and species-specific basis. These recommendations will be provided to the Director for his consideration of inclusion in the permit. If a Director chooses not to include the Services' monitoring and reporting recommendations in the permit, and the Services have concerns that a permit will have more than minor detrimental effects on federally-listed species or critical habitat and contact EPA with their concerns:

i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;

ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and

iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
   - Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

1.1.6 Compliance

We expect compliance with regulatory requirements because the Rule is enforceable by law, EPA and states may levy fines for non-compliance, and citizens may bring citizen suits. EPA expects Directors will comply with this rule and that permittees will comply with their permits because of the penalties for noncompliance. Additionally, the Services expect compliance because take incidental to operation of CWISs permitted through the implementation process described in this Opinion and incorporating the control measures, monitoring, and reporting recommended by the Services will be exempted from section 9 and section 4(d) take prohibitions.

To estimate the degree of compliance with the Rule and the extent to which enforcement-related activities may be taken, we reviewed EPA's most recent Annual Noncompliance Report, 2012. The report summarizes enforcement and compliance data on the "middle tier of NPDES facilities" which comprise 41,688 smaller facilities with individual NPDES permits. Of the 41,688 facilities, EPA had sufficient data to review the compliance status for 83 percent of the facilities (USEPA 2014). Over 8,300 facilities (~24 percent) were identified as having a Category I violation (i.e., a more serious violation). Accordingly, the report indicated over 8,600 informal and formal enforcement actions were taken to correct these violations, resulting in over $16 million dollars in penalties and fines assessed (USEPA 2014). The total number of enforcement actions is higher than the total number of violations as informal enforcement may have required subsequent formal enforcement actions.

The rate of non-compliance with NPDES permits resulting in Category I violations as described above is concerning. When combined with violations of a less serious nature (those below the Category I level), this rate may be even higher. However, the number of enforcement actions taken indicates Directors and EPA do address non-compliance issues and seek means to remedy them.

Per the Rule, owners and operators are required to identify all federally-listed threatened and endangered species and/or designated critical habitat that are or may be present in the action area of their CWIS. As verified by EPA, the phrase "action area" as used in the Preamble and Rule, is to be interpreted in a manner consistent with the definition as found in the Services' regulations implementing ESA Section 7 at 50 CFR 402.02. In other words, "action area" includes all areas that may be directly or indirectly affected by the operation of a facility's

CWIS. Additionally, as described in the biological evaluation and in this Opinion, direct and indirect effects may include impingement, entrainment, or other adverse effects caused by resultant environmental changes, including but not limited to, loss of prey, changes in water quality, and flow alteration. The identification of ESA-listed species and the potential direct and indirect effects will now be provided by the Director to the Services for the Services' review and comment prior to publication of a draft and final permit. The exchange of information between the Director and the Services will help identify any concerns with CWIS operations as they relate to federally-listed species and designated critical habitat. While, this process does not require Directors or owners and operators to implement recommendations made by the Service to reduce impacts to federally-listed species; EPA, as a part of this action, has committed to exercising their oversight authority when requested to do so by the Services if a permit will cause more than minor detrimental effects to federally listed species or designated critical habitat. The Services expect compliance with their recommended control measures, monitoring and reporting because incidental take exemption will be afforded to EPA when the Rule, including its implementation process, is carried out as described in this Opinion. In addition, any take incidental to the operation of a CWIS permitted under the Rule through the implementation process described in this Opinion will be exempt from Section 9 and Section 4(d) prohibitions if the owner/operator implements enforceable control measures, monitoring, and reporting as agreed upon by the owner/operator and the Services, and as reflected in the permit. It is through this process, and EPA's commitment as part of their action to the oversight of the process, that allows EPA to encourage, monitor/evaluate impacts to ESA-listed species, and enforce compliance with the Rule.

1.1.7 Adaptive management

In this section, we evaluate if EPA structured the Rule to allow them to change it or activities authorized under it, if deemed necessary, to minimize unanticipated impacts on listed species and critical habitat. The Rule does not require the owner or operator to monitor for unanticipated (or anticipated) impacts to ESA-listed species or designated critical habitat; however, the Preamble describes the authority the Director has to modify a permit if such unanticipated impacts occur. As described in the Preamble, "the NPDES regulations also allow a Director to modify a permit during the term of the permit, consistent with the Federal regulations at 40 CFR sections 122.62, 122.63, 122.64, and 124.5. Among other things, under 40 CFR 122.62, reasons for permit modification include new information, not available at the time of permit issuance, including information on newly listed threatened or endangered species or federally-designated critical habitat (or unanticipated impacts thereto) received that would have justified the application of different permit conditions at the time of issuance."

The biological evaluation states that the true impact of CWIS may be higher than estimated if ESA concerns are not revisited regularly during facility relicensing or permitting activities. For example, a review of the potential geographic overlap between ESA-listed species and licensed commercial nuclear power facilities in the United States was conducted in 1997 (Sackschewsky 1997). At that time, approximately 484 ESA-listed species were identified as potentially occurring near one or more of the 75 facility sites that were examined. Despite the fact that no quantitative take data of ESA-listed species were obtained or analyzed, this review required updating in only a few years because:

- nearly 200 species were added to the ESA list between 1997 and 2003;

- critical habitat were newly designated for many species; and
- significantly more information became available online, allowing for more accurate and efficient evaluations of ESA-listed species' potential presence near power plants (Sackschewsky 2004).

Sackschewsky reevaluated approximately half of the original facilities identified in 1997 (38 of 75) six years later and found overlap with 452 ESA-listed species, nearly as many found in all facilities examined in 1997 (Sackschewsky 2004). Although information about each species was gathered to support an assessment of the probability of occurrence at each of the reactor sites, no attempt to assess take was completed. Reviewing these issues, the Nuclear Regulatory Commission concluded that regular review of ESA compliance at each licensed commercial nuclear power generating facility was warranted, particularly due to the periodic updating of species and designated critical habitat areas on the ESA lists. In the biological evaluation, EPA states, "Similarly, regular reviews of ESA compliance at 316(b) regulated facilities is warranted in the future."

As part of the Rule, all facilities will be required to better characterize the waters in the area of influence of their CWIS, including the identification of ESA-listed species. Additionally, Directors can require facilities to collect additional information if data is missing, newly-listed species or newly-designated critical habitat are located in the vicinity of the facility, or other environmental conditions (e.g., water quality, flow) have changed since earlier studies. This information can include source water baseline biological characterization data, such as: species present (including threatened and endangered), species susceptibility to impingement and entrainment, spawning periods, and seasonal patterns of the local presence of species. The Services will now have an opportunity to review all information contained within the permit application and will be able to provide the Director with monitoring and reporting recommendations that are appropriate to assess unanticipated (or anticipated) impacts to ESA-listed species or designated critical habitat. If the Director includes the monitoring recommendations provided by the Services in a permit, Directors are required to submit to EPA the results of such monitoring on an annual basis. These reports will then be transmitted to the Services. If impacts associated with CWIS operations are affecting federally-listed species and designated critical habitat in unanticipated ways after a permit has been issued, the Services and EPA can request the Director reopen the permit. By including a process where appropriate monitoring and reporting for federally-listed species can be developed and implemented on a species-specific and site-specific basis, and EPA committing to exercising their oversight authority if requested by the Services when a permit will have more than minor detrimental effects to federally listed species, the Rule allows EPA to use their authorities to request modifications to issued permits in order to minimize unanticipated impacts on listed species and critical habitat.

8.0 Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered by this Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Declines in the abundance or range of many federally-threatened, endangered, and other special status species are attributable to various human activities on Federal, State, and private lands, such as human population expansion and associated infrastructure development; construction and operation of dams along major waterways; water retention, diversion, or dewatering of springs, wetlands, or streams; recreation, including off-road vehicle activity; expansion of agricultural or grazing activities, including alteration or clearing of native habitats for domestic animals or crops; and introductions of non-native plant, wildlife, or fish or other aquatic species, which can alter native habitats or out-compete or prey upon native species. Given the action area has been identified as waters over which EPA has jurisdiction , from which existing facilities withdraw water for cooling purposes, many of these activities are expected to continue within the range of various federally protected wildlife, fish, and plant species, and could contribute to cumulative effects to the species within the action area. Species with small population sizes, endemic locations, or slow reproductive rates will generally be more susceptible to cumulative effects.

9.0 Integration and Synthesis of Effects

EPA proposes to promulgate regulations under 316(b) of the CWA to establish requirements for all existing power generating facilities and existing manufacturing and industrial facilities that withdraw more than two million gallons per day (mgd) of water from Waters of the U.S. and use at least 25 percent of the water they withdraw exclusively for cooling purposes. The action will occur throughout the Waters of the U.S., i.e., the action area. The proposed action is likely to adversely affect the species and critical habitats listed in Tables 2 and 3. Here, we integrate information presented in this Opinion to summarize stressors and the likely consequences of exposing listed resources to these stressors.

A significant portion of the nation's waters have been impacted by anthropogenic stressors described within this Opinion. Based on available information, impingement and entrainment has resulted in the death or injury of billions of aquatic organisms, flow regimes have been altered, water quality has been degraded by physical and chemical pollutants, and ecosystems have been altered by a combination of these and other stressors. The operation of CWIS at power generating and manufacturing facilities contributes to all of these stressors.

Power generating facilities are estimated to use between 60 billion and 200 billion gallons of water per day (Kenny et al. 2005, Averyt et al. 2011). These withdrawals account for 41 percent of all fresh water use in the United States. In some instances, intake from one facility can represent more than five percent of the average annual flow of its source water. While much of this water is eventually returned to the source, it is returned at temperatures that are as much as 50°F warmer than intake temperatures (Madden 2013). Thermal pollution can have a wide range of effects on aquatic communities including altering spawning and migration patterns to altering chemical properties of water by reducing dissolved oxygen (Madden 2013). Elevated water temperatures in streams, lakes, and rivers as a result of climate changes are projected to further exacerbate thermal pollution effects. In addition to thermal pollution, discharges from 316(b) regulated facilities can include toxic pollutants, such as metals, polycyclic aromatic hydrocarbons (PAHs), pesticides, biofouling chemicals, or chlorine (USEPA 2013c)

EPA estimates that hundreds of billions of plankton, fish eggs, and larvae are lost every year as a result of impingement or entrainment for cooling water withdrawals (USEPA 2013f). Other studies conducted at individual facilities appear to support this estimate (Seaby and Henderson, 2007, Rossman 1986). When examining the number of ESA-listed species lost as a result of impingement and entrainment, EPA extrapolates that more than 65,000 eggs, larvae and adults of ESA-listed fish and sea turtles are lost on an annual basis (USEPA 2013c). As stated in the biological evaluation, aquatic species are disproportionately imperiled relative to terrestrial species; 39 percent of freshwater and diadromous fish species (Jelks et al. 2008), 67 percent of freshwater mussels (Williams et al. 1993) and 48 percent of crayfish (Taylor et al. 2007) are classified as special concern, threatened, or endangered. Given these numbers, the amount of direct loss of ESA-listed species due to impingement and entrainment is probably much higher than estimated by EPA, as ESA-listed species are found at low population densities, and the volume of water sampled by facility-level impingement and entrainment studies is low.

Our Programmatic Effects Analysis assesses whether, and to what degree, EPA structured the Rule to establish processes that require EPA , the owner or operator, and the Directors to collectively implement the provisions of section 316(b) of the CWA in a manner that addresses adverse effects to listed species, and ensures the operation of facilities subject to the Rule are not likely to jeopardize the continued existence of endangered or threatened species or destroy or adversely modify designated critical habitat. We addressed this issue by answering seven questions:

First, we concluded that EPA has structured the Rule to better estimate the number of facilities that may adversely affect ESA-listed species and designated critical habitat. While EPA is currently unable to identify all facilities that will be subject to the Rule and thus quantify impacts to listed species associated with CWIS operations, per the Rule, facilities will have to identify threatened and endangered species and/or designated critical habitat that are or may be within the action area. The Services will now have an opportunity to review these determinations prior to a draft permit being issued, provide technical assistance to the Directors regarding the species lists, and the Services may notify the Director or EPA of any inaccuracies or discrepancies that may exist. Thereby, facilities whose operations impact listed species or critical habitat will be correctly identified.

Second, we concluded the Rule allows EPA to more reliably estimate the physical, chemical, or biotic stressors that are likely to be produced as a direct or indirect result of their action. As previously discussed, impingement and entrainment rates of fish at larger facilities can be in the billions and smaller facilities may impinge and entrain millions. Other stressors, including flow alteration and chemical discharge, can also have significant impacts on the aquatic environment.

The information exchange between the Director and the Services established in the Rule provides a process of technical assistance whereby impacts associated with these stressors will be more accurately identified by the Services, as owners, operators, and Directors may not have the expertise necessary to do so. For purposes of this consultation, the Services assume that

State and Tribal Directors will include Services' recommended measures for protection of species in final permits. Additionally, EPA's commitment to the oversight of that process as described in the Preamble to the Rule as clarified in the April 8, 2014 correspondence from EPA (attached as Appendix A), will allow EPA to more reliably estimate stressors that are likely to be produced as a direct or indirect result of activities regulated under the Rule. Specifically:

- Owners' or operators' identification and determinations of ESA-listed species and critical habitats impacted by their CWIS in their permit application will be provided to the Services for verification;
- The Directors are required to send all permit application information to the Services and provide the Services with 60 days to review the information. If the Services provide control measures, monitoring or reporting recommendations to reduce impacts associated with CWIS to the Director, the Director may include those in the permit;
- If a Director chooses not to include the Services' monitoring and reporting recommendations in the permit, and the Services have concerns that a permit will have more than minor detrimental effects on federally-listed species or critical habitat and contact EPA with their concerns:

    i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;
    ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and
    iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
        - Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

Third, we concluded EPA structured the Rule to minimize the adverse effects of impingement, entrainment, and other stressors produced by CWIS on ESA-listed species and designated critical habitat. As described in our analysis, the Impingement Standards and Director determined Entrainment Standard provided in the Rule are not designed to specifically minimize impacts to ESA-listed species. However, the Services will be able to provide site-specific and species-specific control measures, monitoring and reporting recommendations through the review process. As EPA was unable to provide specific information on each facility's CWIS operations and associated impacts to federally listed species for purposes of this consultation, the Services' development of control measures is more appropriate during the review of each facility's permit application. EPA's oversight commitment provides assurance that permits that may result in more than minor detrimental effects to listed species or designated critical habitat will be corrected before issuing.

Fourth, we concluded that EPA has structured the Rule to identify, inform, and encourage all eligible applicants of their eligibility under the Rule. EPA was unable to identify all eligible facilities for purposes of this consultation, and eligible facilities may continue to operate under administratively continued permits. However, the Rule requires owners and operators provide updated information on impacts to ESA-listed species as part of their permit applications. This information was not previously required and is information a Director would need to support his/her permit issuance decision for facilities with administratively continued permits. A Director's ability to reopen administratively continued permits for new information along with EPA's commitment to exercise their oversight authorities when necessary, allow EPA to identify, inform, encourage, and screens applicants of their eligibility under the Rule.

Fifth, we concluded that EPA has structured the Rule to continuously monitor and evaluate adverse effects associated with CWIS on ESA-listed species and designated critical habitat. While the Rule does not establish specific monitoring or reporting requirements to evaluate adverse effects on ESA-listed species or designated critical habitat, it does allow those monitoring and reporting requirements to be developed on a site-specific and species-specific basis via technical assistance facilitated by the exchange of information between the Director and the Services. One of the Services' assumptions for this consultation is that the Services anticipate where necessary, State and Tribal Directors will incorporate the control measures, monitoring, and reporting recommendations provided by the Services through technical assistance facilitated by the exchange of information between the Directors and the Services into NPDES permits that contain 316(b) requirements. If a Director chooses not to include the Services' monitoring and reporting recommendations in the permit, and the Services have concerns that a permit will have more than minor detrimental effects on federally-listed species or critical habitat and contact EPA with their concerns, EPA has committed to the following oversight process described in the Preamble to the Rule and as clarified in the April 8, 2014 correspondence with the Services (attached as Appendix A):

i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;
ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and
iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
    - Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

Sixth, we concluded EPA has structured the Rule to encourage, monitor/evaluate, and enforce compliance regarding ESA issues. We have little data indicating EPA has previously used its oversight authority to review and object to State issued permits specifically to reduce the impacts of NPDES permits on ESA-listed species. However, available data does indicate that EPA and Directors do take enforcement actions to correct non-compliant NPDES permits. Additionally, EPA expects a high rate of compliance with the Rule and any measures that the Services may provide through technical assistance. The exchange of information between the Director and the Services required in the Rule will help identify any concerns with CWIS operations as they relate to federally-listed species and designated critical habitat. The Directors may address those concerns through NPDES permit conditions that implement the Services control measures, monitoring, and reporting recommendations. While, the Rule does not stipulate that Directors must include recommendations made by the Services to reduce impacts to federally-listed species in the permit, one of the Services' assumptions for this consultation is that the Services anticipate where necessary, State and Tribal Directors will incorporate the control measures, monitoring, and reporting recommendations provided by the Services through technical assistance facilitated by the exchange of information between the Directors and the Services into NPDES permits that contain 316(b) requirements. In addition, in the Preamble to the Rule and as clarified in the April 8, 2014 correspondence (attached as Appendix A), EPA, as a part of this action, has committed to exercising their oversight authority when requested to do so by the Services in cases where a permit will cause more than minor detrimental effects to federally-listed species or designated critical habitat.

Seventh, we concluded the Rule is structured to inform EPA of unanticipated impacts to ESA-listed species and, if necessary, allow EPA to minimize such unanticipated impacts on listed species and critical habitat. State Directors have the ability to modify a permit during the term of the permit if new information, including information on newly listed threatened or endangered species or federally-designated critical habitat (or unanticipated impacts thereto) is received that would have justified the application of different permit conditions at the time of issuance. EPA also has the authority to object to issuance of permits that will result more than a minor detrimental effect on ESA-listed species or critical habitat or result in jeopardy to species and/or destruction and adverse modification of critical habitat. In both cases, the Rule establishes a process where:

- The Services will have the opportunity to provide Directors with appropriate monitoring recommendations designed to detect impacts of CWIS operations on federally-listed species and critical habitat. Information provided as a result of this monitoring will allow Directors to reopen and modify permits if necessary;
- EPA will work with States and Tribes to remove the detrimental effects of permits if requested by the Services to do so.

10.0 Conclusion

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that EPA's action, as proposed, is not likely to jeopardize the continued existence of ESA-listed species listed in Tables 2 and 3 of this Opinion and is not likely to destroy or adversely modify designated critical habitat identified in Tables 2 and 3.

As described in the Rule and this Opinion, the operation of CWIS can have significant adverse effects on the aquatic environment and federally-listed species. EPA's Rule establishes a process (Figure 3) whereby the Services will be provided an opportunity to review permit applications of each facility seeking compliance with 316(b) of the CWA, either during a section 7 consultation with EPA or during review of every permit application submitted to a State or Tribe, and analyze impacts to federally-listed species and designated critical habitat that may result from operation of the facility's CWIS. During this review, the Services will have an opportunity to recommend control measures, monitoring and reporting recommendations on a site specific and species specific basis that will minimize adverse effects of CWIS operations. If the Services contact EPA with concerns that a State or Tribal permit will have more than minor detrimental effects on federally-listed species or critical habitat that cannot be resolved with the State or Tribal permitting authority:

i. EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of federally-listed species and critical habitat;
ii. EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and
iii. EPA will exercise the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat.
    - Based on correspondence received from EPA on April 8, 2014, EPA will give deference to the views of the Services with regard to effects on federally-listed fish and wildlife resources.

Therefore, it is our opinion that this Rule has built in a sufficient process to insure that it is not likely to result in an appreciable reduction in the likelihood of both the survival and recovery of any listed species by reducing the reproduction, numbers or distribution of that species. It is also our opinion that the process insures that this Rule is not likely to result in destruction or adverse modification of critical habitat. The process achieves this through a comprehensive suite of requirements, including, but not limited to:

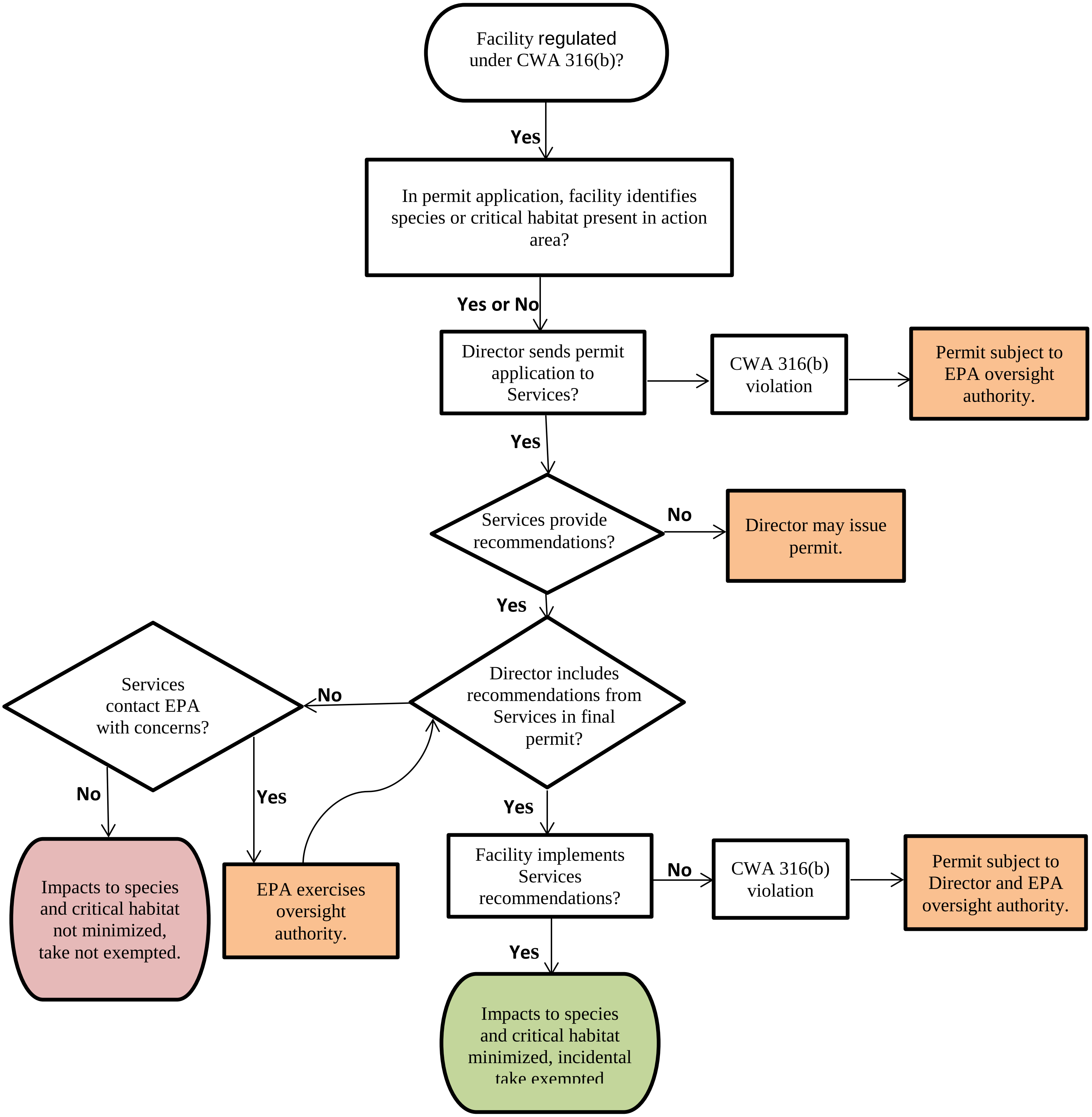
- Ensuring every permit application is provided to and reviewed by the Services ,thereby allowing the Services to provide meaningful input to State Directors early in the permit application process so that measures to address ESA-listed species may be incorporated into State permits;
- The Services or EPA identifying administratively continued permits which are likely to have more than minor detrimental effects on federally-listed species or critical habitat, contacting the State to seek to remedy the situation (for instance by requesting new information from the facility when necessary) and EPA or the Services requesting that the State issue a new permit when appropriate to resolve the concerns of the Services; and

- Ultimately ensuring that no permit is issued that is likely to jeopardize the continued existence of an ESA-listed species or result in the destruction or adverse modification of designated critical habitat by either (a) incorporation into State permits conditions necessary to avoid jeopardy to ESA-listed species or adverse modification to critical habitat; or (b) if the such conditions are not incorporated, preventing issuance of the State permit by exercising the full extent of its CWA authority, to object to a permit proposed by a State where EPA finds (giving deference to the views of the Services) that a State or Tribal permit is likely to jeopardize the continued existence of such species or result in the destruction or adverse modification of such critical habitat jeopardizing permit.

We base our conclusion, in part, on the following assumptions:

- The Services will receive all permit applications upon receipt by the Director for a 60 day review prior to publication of a draft permit as required per the Rule;
- The Services anticipate that where necessary, State and Tribal Directors will incorporate the control measures, monitoring, and reporting recommendations provided by the Services through technical assistance facilitated by the exchange of information between the Directors and the Services into site-specific NPDES permits that contain 316(b) requirements;
- The control measures, monitoring, and reporting developed by the Services through technical assistance with the Directors will minimize the adverse effects of CWIS to levels that will avoid jeopardy to species and/or destruction and adverse modification of critical habitat;
- In the case of State permits that have been administratively continued, if the Services or EPA identify a permitted action by a facility that meets the eligibility requirements of the rule which is likely to have more than a minor detrimental effect on Federally-listed species or critical habitat, then the Services or EPA will contact the State to seek to remedy the situation (for instance by requesting new information from the facility when necessary). EPA will provide support and assistance to the Services in working with the State or Tribe. EPA and States have no authority to require changes to an expired, administratively continued permit. Instead, Directors have authority to issue a new permit. Therefore, EPA or the Services could request that the State issue a new permit. *See* 66 Fed. Reg. 11202 (Feb. 22, 2001). The Services assume this process will resolve any concerns regarding adverse effects to ESA-listed species and designated critical habitat;
- As discussed in the preamble of the Rule and the April 8, 2014 correspondence (Attachment A), EPA will work with States and Tribes to reduce or remove the detrimental effects of the permit, including, in appropriate circumstances, by objecting to and federalizing the permit where consistent with EPA's CWA authority; and
- In States where EPA is the permitting authority for NPDES permits, then EPA will consult with the Services on the issuance of those permits where required by ESA section 7.

Figure 3. General process of Information Exchange and Technical Assistance Between Directors and the Services. Ovals represent start and end points; rectangles represent activities required in the Rule; diamonds represent discretionary activities described in the Rule. Process may be adjusted when warranted for consideration of individual permits.



11.0 Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the "take" of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the USFWS as an act which actually kills or injures wildlife, which may include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the USFWS as actions that create the likelihood of injury to listed species by annoying them to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of sections 7(b)(4) and 7(o)(2), taking that is incidental and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Section 7(b)(4) and 7(o)(2) of the ESA generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the ESA prohibits the removal and reduction to possession of Federally listed endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulation or in the course of any violation of a State criminal trespass law.

Amount or Extent of Take Anticipated

While the BE provided an analysis of impacts related to stressors to ESA-listed species, the paucity of information submitted by EPA regarding facilities with CWIS does not allow the Services to identify facility locations, the specific actions of those facilities that may result in take of listed species, the number of individuals that might be taken by those actions, or the proportion of populations of endangered or threatened species these might represent. However, through implementation of the Rule, this information will be provided to the Services. At the appropriate Field Office of the USFWS or Regional Office of NMFS, the Services' will have the opportunity to review all NPDES permit applications for each facility seeking compliance under 316(b) of the CWA, either during section 7 consultation with EPA or during the technical assistance process for State and Tribal-issued permits identified in the Rule. This affords the Services the opportunity to appropriately evaluate project effects on a site-specific and species-specific basis. This review will allow the Services to provide technical assistance to the State or Tribal Director and the owner/operator to adjust an action that may result in the take of endangered or threatened species. As described in our conclusion, we assume that through technical assistance with the State or Tribal Directors, appropriate control measures to minimize incidental take and detrimental effects associated with the operation of CWIS will be developed by the Services, and that these measures will ensure that each permit will minimize adverse effects and thereby avoid jeopardy to ESA-listed species identified in Tables 2 and 3 and avoid destruction or adverse modification of critical habitat. We also assume Directors will incorporate the Services' recommendations into NPDES permits that contain 316(b) requirements. If it is determined, through section 7 consultation with EPA or through technical assistance on individual permits with State or Tribal Directors that take of ESA-listed species is still expected to occur after implementation of recommended control measures, the amount or extent of incidental take will be quantified, at that time by the appropriate Field Office of the USFWS and/or Regional Office of the NMFS.

Incidental take exemption will be afforded to EPA when the Rule, including its implementation process, is carried out as described in this Opinion. In addition, any take incidental to the operation of a CWIS permitted under the Rule through the implementation process described in this Opinion will be exempt from Section 9 and Section 4(d) prohibitions if the owner/operator implements enforceable control measures, monitoring, and reporting as agreed upon by the owner/operator and the Services, and as reflected in the permit.

In summary, because of the large scale and broad scope of the proposed action, even the best scientific and commercial data available are not sufficient to enable the Services to accurately estimate the specific amount of potential incidental take associated with the action at this time. Incidental take of listed species will be quantified during ESA section 7 consultation process for permits issued by EPA or the technical assistance process for State and Tribal-issued permits associated with our review of the 316(b) application for a specific facility. This Incidental Take Statement does not apply in the absence of any take prohibited under Section 9 or Section 4(d) of the ESA.

12.0 Reasonable and Prudent Measures

The following reasonable and prudent measure is necessary and appropriate to minimize impacts of incidental take to species identified in Tables 2 and 3.

1. EPA will use its authorities under the CWA to minimize impacts to listed species pursuant to the 316(b) Rule and CWA.

13.0 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, EPA must comply with the following terms and conditions, which implement the reasonable and prudent measure described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. EPA will ensure the Directors notify both Services and EPA of control measures, monitoring, or reporting recommendations provided by the Services that have been adopted as permit conditions. A copy of the draft permit provided to the Services per 40 CFR 124.10(c)(1) prior to finalization of the permit will satisfy this requirement.

2. EPA will report and provide to the Services:
    a. an annual report summarizing the facility monitoring data submitted by State Directors to EPA pursuant to 125.98(k), including data on impacts to ESA-listed

species or critical habitat. If the Director (based on recommendations from the Services during their review of permit applications or draft permits) requires additional reporting per year, then that reporting from the state Director will be provided in addition to the annual summary report. The annual report must summarize any monitoring reports submitted by facilities to state Directors. EPA will provide the compiled raw data to the Services when the State provides such data to EPA. EPA will also seek to provide additional raw data from the Director's summarized reports if requested to do so; and

b. the annual report must include a table that identifies all ESA-listed species taken by CWIS along with the total number of organisms taken (deaths and injuries) per year at each facility as reported to EPA by the state Director pursuant to 125.98(k).

3. In order to review the effectiveness of the technical assistance process between the Directors and the Services as outlined in the Rule, EPA will report the following to the Services on an annual basis for the first four years following implementation of the Rule. As described in the Rule, data requirements for permit applications may warrant several years of data collection. Therefore, the number of permits issued may increase after the initial four year period. If necessary the Services may subsequently request EPA to report on a semi-annual basis:
   a. A list of all state permits issued pursuant to 316(b); and
   b. Of those permits issued pursuant to 316(b), identification of any that were elevated by the Services to an EPA's Regional Office and how those elevations were resolved.

4. Within 60 days of finalization of the Rule, EPA will provide each State Director an instructional memorandum developed in coordination with the Services detailing the technical assistance process that is to occur between the Services and the Directors. The memorandum will also further explain how Directors are to interpret the various aspects of the Rule, consistent with the April 8, 2014, correspondence from EPA (attached as Appendix A).

5. Within 60 days of finalization of the Rule, EPA will provide the Services a list of those facilities which are currently operating under administratively continued permits and may be subject to the Rule.

6. EPA will request Directors reopen any currently administratively continued permit if the Services determine the facility's CWIS operations may have more than minor detrimental effects to federally-listed species or critical habitat.

7. If incidental take as quantified for an individual facility through the technical assistance process is exceeded, EPA will request the State or Tribal Director reopen the permit to analyze if additional control measures, monitoring, and reporting are necessary to further minimize adverse effects on ESA-listed species.

8. EPA will inform Directors that pursuant to the Services Consultation Handbook

(1998) if an owner/operator locates dead or injured federally-listed species, immediate notification must be made to the appropriate Field Office of the USFWS and/or Regional Office of the NMFS. Pertinent information including the date, time, location, and possible cause of injury or mortality (e.g. impingement or entrainment) of each species shall be recorded and provided to the Services. Instructions for proper care, handling, transport, and disposition of such specimens will be issued by the Services. Care must be taken in handling sick or injured animals to ensure effective treatment and in handling dead specimens to preserve biological material in the best possible state.

14.0 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. We recommend that EPA implement the following actions:

1. In consultation with the Service, develop a conservation program for threatened and endangered species and, in collaboration with States and Tribes, develop conservation plans that specifically addresses threats to listed species and how implementation of CWA programs can ameliorate those threats;
2. .EPA should sponsor additional research and development with industry/facilities/States to support new technological devices or structures to further reduce impingement and entrainment of aquatic organisms.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

15.0 Reintiation Notice

This concludes formal consultation on the action. As described in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded-for this programmatic consultation, exceedance of take at individual facilities will be addressed as described in term and condition number 7; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. If the assumptions about the process outlined in this Opinion regarding how adverse effects to ESA-listed species and critical habitat will be addressed are not being followed, then this lack of adherence to the process constitutes new information per reinitiation trigger Number 2. This could be the basis for reinitiating consultation. Examples of how adverse effects will be addressed that are described in this Opinion include the Services' review of permit applications and draft permits, the transmittal by the Services of recommendations to the Director, and EPA's commitment to oversight of State permits to ensure that control measures, monitoring, and reporting recommendations necessary for the protection of ESA-listed species will be included in permits. Through the periodic reviews and reporting required of EPA in terms and conditions numbers 2 and 3, the Services and EPA will be able to identify whether there are deficiencies with the process as analyzed in this Opinion and determine if reinitiation of this consultation is necessary.

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Appendix A

April 8, 2014

Email Correspondence with EPA

Crane, Drew <drew_crane@fws.gov>

Description of Action Re: EPA's Final Rulemaking for Cooling water Intake Strcutures for Existing Facilities under Clean Water Act Section 316(b)

Wood, Robert <Wood.Robert@epa.gov> Tue, Apr 8, 2014 at 9:06 AM
To: "Frazer, Gary" <gary_frazer@fws.gov>
Cc: "Neugeboren, Steven" <Neugeboren.Steven@epa.gov>, Paul Souza <Paul_Souza@fws.gov>, Patrice Ashfield <patrice_ashfield@fws.gov>, Drew Crane <drew_crane@fws.gov>, "donna.wieting@noaa.gov" <donna.wieting@noaa.gov>, "cathy.tortorici@noaa.gov" <cathy.tortorici@noaa.gov>, Edward Boling <ted.boling@sol.doi.gov>, Pamela Lawrence - NOAA Federal <pamela.lawrence@noaa.gov>, "Southerland, Elizabeth" <Southerland.Elizabeth@epa.gov>, "Born, Tom" <Born.Tom@epa.gov>, "Hewitt, Julie" <Hewitt.Julie@epa.gov>, "Shriner, Paul" <Shriner.Paul@epa.gov>

Gary,

EPA has reviewed the attached FWS and NMFS description EPA's action in the final rulemaking for cooling water intake structures for existing facilities under Clean Water Act Section 316(b). I confirm that your description and understanding of the key elements of our action as reflected in this document are correct. Thanks,

Rob

____

Robert K. Wood, Director

Engineering and Analysis Division

U.S. EPA Office of Water

202-566-1822

Final FWS NMFS Summary of Action 316b 04072014.docx
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Important Provisions of the Action for Purposes of ESA Consultation: The Services regard the following as significant provisions of the pending final regulation with regard to potential effects to Federally-listed threatened and endangered species and designated critical habitat and request confirmation from EPA that we are understanding and interpreting these provisions appropriately.

Impingement, Entrainment, and Entrapment

The regulation requires that the location, design, construction, and capacity of CWIS reflect the best technology available for minimizing adverse environmental impacts, primarily by reducing the amount of fish and shellfish that are impinged (including entrapped) or entrained at a CWIS. The regulation also provides that the Director may establish in the permit additional control measures, monitoring requirements and reporting requirements that are designed to minimize incidental take, reduce or remove more than minor detrimental effects to Federally-listed species and designated critical habitat, or avoid jeopardizing federally-listed species or destroying or modifying designated critical habitat. For purposes of this consultation, the Service is interpreting the regulation's application to "fish and shellfish" and the Director's authority to establish additional measures to protect listed species and habitat as broadly encompassing all taxa of listed species, including their critical habitat. The Services also interpret the rule requirements – impingement (including entrapment) and entrainment reduction actions (e.g., BTA standards), including additional measures established by the Director to protect listed species and habitat – as applying to all taxa of listed species, including their designated critical habitats.

The Services interpret the BTA standards, including additional measures established by the Director to protect listed species and habitat, as applying to, and protecting the aquatic environment from, the direct and indirect effects of a CWIS, including effects to a listed species' prey base.

As part of the definition of "modified traveling screen" at §125.92, the regulations state that the Director may approve of fish being returned to water sources other than the original source water, taking into account any recommendations from the Services with respect to endangered or threatened species. The Services interpret this limitation to mean that when making permitting decisions concerning the return of impinged aquatic species to waters other than the source water, the Director will address any concerns from the Services. If the Services' concerns are not addressed and the permit would cause more than minor detrimental effects, the permit will be subject to the EPA oversight provisions of section IX.A of the 2001 MOA.

Action Area

Within the preamble and section 125.95(f), EPA uses the term "action area" to indicate the extent of potential effects to listed species and designated critical habitat. For the purposes of this consultation, the Services interpret the term "action area" whenever it is used in the preamble and rule in a manner consistent with the definition of this term in the Services' regulations implementing ESA Section 7 at 50 CFR 402.02.

Notification

Section 125.98(h) requires the Director to transmit all permit applications received from existing facilities to the appropriate Field Office of the U.S. Fish and Wildlife Service and/or Regional Office of the National Marine Fisheries Service upon receipt for a 60 day review prior to public notice of the draft or proposed permit. Directors may not propose/publish the draft permit until the 60 day review period has ended. Directors are also required to provide public notice and a public comment period (40 CFR 124.10) and to submit a copy of the fact sheet or statement of basis (for EPA-issued permits), the permit application (if any), and the draft permit (if any) to the Service. This includes notice of specific CWIS requirements and notice of the draft permit. When the Director submits this information to the Service, the Director should include any specific information the Director has about ESA-listed species and designated critical habitat that are or may be present in the action area, including any proposed control measures and monitoring and reporting requirements for such species and habitat.

Section 125.95(f) requires owners/operators to identify all endangered/threatened species and designated critical habitat in the action area.

Information

Section 125.95(f) requires that the owner or operator of an existing facility or new unit at an existing facility must, based on readily available information at the time of the permit application instead of the information required at 122.2(r)(4)(vi), identify all Federally-listed threatened and endangered species and/or designated critical habitat that are or may be present in the action area. The Services interpret "readily available information" to mean information that is publicly available information. "Readily available information" includes information obtained from the Services. "Readily available information" is not limited to information that is in the facility's possession; however, facilities are not required to create new information (e.g. new studies or surveys) in order to identify Federally-listed threatened and endangered species and/or designated critical habitat.

Take

Section 125.98(b)(1) specifies that the Director must include the following language as a permit condition "Nothing in this permit authorizes take for the purposes of a facility's compliance with the Endangered Species Act."

MOA

The Services interpret the statements in the preamble to mean that, consistent with subsection IX.A of the 2001 MOA, in situations where the Services contact EPA with concerns that a State or Tribal permit will have more than minor detrimental effect on Federally-listed species or critical habitat that cannot be resolved with the State or Tribal permitting authority:

i) EPA will coordinate with the State or Tribe to ensure that the permit will comply with all applicable CWA requirements and will discuss appropriate measures protective of Federally-listed species and critical habitat; and

ii) EPA will work with the State or Tribe to reduce or remove the detrimental impacts of the permit, including, in appropriate circumstances, by objecting to and Federalizing the permit where consistent with EPA's CWA authority.

The Services also interpret the preamble, consistent with subsection IX.A of the 2001 MOA, to mean that if EPA determines (after taking into account all available information, including any analysis conducted by the Services) that a State or Tribal permit is likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat, EPA will use the full extent of its CWA authority to object to the permit, including Federalizing the permit where consistent with EPA's CWA authority.

The Services interpret "giving, as appropriate, substantial weight to the views of the Services" and "taking into account . . . any analysis conducted by the Services" to include giving deference to the views of the Services with regard to effects on Federally-listed fish and wildlife resources.

In those situations where a Director determines, pursuant to §125.94(c)(11), that a facility's rate of impingement is so exceptionally low as to not warrant additional impingement controls, the Services may still consider the detrimental effects of the facility operation to be more than minor if Federally-listed threatened or endangered species are subject to impingement.

Discretionary Actions

Section 125.94(g) provides that State Directors may include as conditions of a CWIS permit control measures to avoid or minimize adverse effects to listed species or designated critical habitat, including such measures that are recommended by the Services.

Monitoring and Reporting

Section 125.94(g) provides that the Director may establish in the permit additional control measures, monitoring requirements, and reporting requirements that are designed to minimize incidental take, reduce or remove more than minor detrimental effects to Federally-listed species and designated critical habitat, or avoid jeopardizing Federally-listed species or destroying or adversely modifying designated critical habitat. We interpret this to mean that State or Tribal permitting authorities will include any monitoring and reporting recommendations provided by the Services. Failure to include these recommendations will subject the permit to the EPA oversight provisions of section IX.A of the 2001 MOA in circumstances where the Services are concerned about more than minor detrimental effects. This includes, but is not limited to, monitoring and reporting requirements related to impingement (including entrapment), entrainment, flow alteration, and indirect effects (e.g., effects to prey base).

Appendix B

Status Information for Species

Under Jurisdiction of NMFS

APPENDIX B

Status of Species Under National Marine Fisheries Service's Jurisdiction

Status of Species Under National Marine Fisheries Service Jurisdiction

Section 7(a)(2) of the Endangered Species Act (ESA) (16 U.S.C. 1531 et seq.) requires that each federal agency ensure any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. The following species are under the jurisdiction of NOAA's National Marine Fisheries Service (NMFS) and may be affected by the EPA's issuance of regulations pursuant to section 316(b) of the Clean Water Act (Table 1).

Table 1. National Marine Fisheries Service species listed under the Endangered Species Act that may be affected by the issuance of regulations pursuant to section 3016(b) of the Clean Water Act. Designated critical habitat is denoted by an asterisk (*); proposed critical habitat is denoted by a double asterisk (**).

Common name (Distinct population segment, evolutionarily significant unit, or subspecies)	Scientific name	Status
Cetaceans		
Blue whale	*Balaenoptera musculus*	Endangered
Bowhead whale	*Balaena mysticetes*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
Killer whale (Southern Resident*)	*Orcinus orca*	Endangered
North Atlantic right whale*	*Eubalaena glacialis*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Beluga whale (Cook Inlet)*	*Delphinapterus leucas*	Endangered
False killer whale (Hawaiian insular)	*Pseudorca crassidens*	Endangered
Pinnipeds		
Guadalupe fur seal	*Arctocephalus townsendi*	Threatened
Hawaiian monk seal*,**	*Monachus schauinslandi*	Endangered
Steller sea lion (Western*)	*Eumetopias jubatus*	Endangered
Bearded seal (Beringia)	*Erignathus barbatus nauticus*	Threatened
Ringed seal (Arctic)	*Phoca hispida hispida*	Threatened
Sea turtles		
Green sea turtle (Florida & Mexico's Pacific coast colonies)	*Chelonia mydas*	Endangered
Green sea turtle (all other areas*)		Threatened
Hawksbill sea turtle*	*Eretmochelys imbricate*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle*	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle (North Pacific Ocean)	*Caretta caretta*	Endangered
Loggerhead sea turtle (Northwest Atlantic Ocean**)		Threatened
Olive ridley sea turtle (Mexico's Pacific coast breeding colonies)	*Lepidochelys olivacea*	Endangered
Olive ridley sea turtle (all other areas)		Threatened
Sturgeons		
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Green sturgeon (southern*)	*Acipenser medirostris*	Threatened
Gulf sturgeon*	*Acipenser oxyrhynchus desotoi*	Threatened
Atlantic sturgeon (Gulf of Maine)	*Acipenser oxyrhynchus*	Threatened
Atlantic sturgeon (New York Bight)		Endangered
Atlantic sturgeon (Chesapeake Bay)		Endangered

Common name (Distinct population segment, evolutionarily significant unit, or subspecies)	Scientific name	Status
Atlantic sturgeon (Carolina)		Endangered
Atlantic sturgeon (South Atlantic)		Endangered
Salmonids		
Atlantic salmon (Gulf of Maine*)	*Salmo salar*	Endangered
Chinook salmon (CA Coastal*)	*Oncorhynchus tschawytscha*	Threatened
Chinook salmon (Central Valley Spring-run*)		Threatened
Chinook salmon (Lower Columbia River*)		Threatened
Chinook salmon (Upper Columbia River Spring-run*)		Endangered
Chinook salmon (Puget Sound*)		Threatened
Chinook salmon (Sacramento River Winter-run*)		Endangered
Chinook salmon (Snake River Fall-run*)		Threatened
Chinook salmon (Snake River Spring/Summer-run*)		Threatened
Chinook salmon (Upper Willamette River*)		Threatened
Chum salmon (Columbia River*)	*Oncorhynchus keta*	Threatened
Chum salmon (Hood Canal Summer-run*)		Threatened
Coho salmon (Central CA Coast*)	*Oncorhynchus kisutch*	Endangered
Coho salmon (Lower Columbia River**)		Threatened
Coho salmon (Southern Oregon & Northern California Coast*)		Threatened
Coho salmon (Oregon Coast*)		
Sockeye salmon (Ozette Lake*)	*Oncorhynchus nerka*	Threatened
Sockeye salmon (Snake River*)		Endangered
Steelhead (Central California Coast*)	*Oncorhynchus mykiss*	Threatened
Steelhead (California Central Valley*)		Threatened
Steelhead (Lower Columbia River*)		Threatened
Steelhead (Middle Columbia River*)		Threatened
Steelhead (Northern California*)		Threatened
Steelhead (Puget Sound)		Threatened
Steelhead (Snake River*)		Threatened
Steelhead (South-Central California Coast*)		Threatened
Steelhead (Southern California*)		Threatened
Steelhead (Upper Columbia River*)		Threatened
Steelhead (Upper Willamette River*)		Threatened
Other fishes		
Pacific eulachon*	*Thaleichthys pacificus*	Threatened
Bocaccio (Georgia Basin**)	*Sebastes paucispinis*	Endangered
Yelloweye rockfish (Georgia Basin**)	*Sebastes pinniger*	Threatened
Canary rockfish (Georgia Basin**)	*Sebastes ruberrimus*	Threatened
Smalltooth sawfish*	*Pristis pectinata*	Endangered
Marine invertebrates		
Elkhorn coral*	*Acropora palmata*	Threatened[1]
Staghorn coral*	*Acropora cervicornis*	Threatened[1]
White abalone	*Haliotis sorenseni*	Endangered
Black abalone*	*Haliotis cracherodii*	Endangered
Marine plants		
Johnson's seagrass*	*Halophilia johnsonii*	Threatened

[1] Proposed endangered

1 Cetaceans

There are about 90 species of cetaceans; all are found in marine environments except for four species of freshwater dolphins. The order contains two suborders; mysticeti (baleen whales) and odontoceti (toothed whales, which includes dolphins and porpoises). Ten ESA-listed cetacean species may be affected by the proposed action and are described below.

1.1 Cook Inlet Beluga Whale

The beluga whale (*Delphinapterus leucas*) is a small, toothed, white whale. The DPS resides year-round within Cook Inlet, in the Gulf of Alaska. It was listed as endangered under the ESA, effective December 22, 2008 (73 FR 62919). We used information available in the final rule, the 2008 Status Reviews (Hobbs and Shelden 2008, Hobbs et al. 2008), and recent stock assessment reports (Allen and Angliss 2011) to summarize the status of the DPS, as follows.

1.1.1 Life History

The Cook Inlet DPS is reproductively, genetically, and physically discrete from the four other known beluga populations in Alaska (i.e., those north of the Alaska Peninsula). Its unique habitat experiences large tidal exchanges, with salinities varying from freshwater to marine at either end of the estuary. Belugas occur in mid-Inlet waters in the winter. During spring, summer, and fall, they concentrate in the upper Inlet (a contraction of its range), which offers the most abundant prey, most favorable feeding topography, best calving areas, and best protection from predation. Cook Inlet belugas focus on specific prey species when they are seasonally abundant. During the spring, they focus on eulachon; in the summer, as the eulachon runs diminish, their focus shifts to salmonids. These fatty, energy-rich prey are critical to pregnant and lactating belugas. Calves are born in the summer and remain with their mothers for about 24 months. The calving interval ranges from 2 – 4 years. Females reach sexual maturity at 4 to 10 years, and males mature at 8 to 15 years. Life expectancy exceeds 60 years.

1.1.2 Population Dynamics

The most recent abundance estimate for the Cook Inlet DPS is 345 (CV = 0.13) belugas, based on an average of population estimates from 2008 to 2010 (Allen and Angliss 2011). There were an estimated 1,300 whales in 1979. Subsistence removals led to a 47 percent decline from 1994 to 1998 (from 653 to 347 whales). From 1999 to 2008, the population has declined an average of 1.5 percent per year, despite restriction on subsistence harvest since 1999 (0 – 2 whales harvested annually; 5 total).

1.1.3 Status

The Cook Inlet beluga whale DPS is endangered as a result of over-exploitation. A brief commercial whaling operation in the 1920s harvested 151 Cook Inlet belugas in 5 years. Cook Inlet belugas were harvested by Alaska Natives and for sport prior to the enactment of the Marine Mammal Protection Act (MMPA) in 1972. Annual subsistence take by Alaska Natives during 1995 - 1998 averaged 77 whales, with 20 percent of the population harvested in 1996. Subsistence removals through the 1990s are sufficient to account for past declines in abundance, but are now restricted. The current decline is attributed to other factors. Since the early 1990s, over 200 belugas have stranded along the mudflats in upper Cook Inlet, often resulting in death; the cause is uncertain but may be linked with the extreme tidal fluctuations, predator avoidance, or pursuit of prey. Additional threats include: coastal development, oil and gas development, seismic exploration, point and non- point source discharge of contaminants, contaminated waste disposal, water quality standards, activities that involve the release of chemical contaminant and/or noise, vessel operations, and research (73 FR 62919). Its resilience to future perturbation is low because of the following factors: the population is small (N = 345) and has not grown as expected with the cessation of harvest; as a result of the range contraction, the population is more vulnerable to catastrophic events; and if the current DPS is extirpated, it is unlikely other belugas would repopulate Cook Inlet (Hobbs et al. 2008).

1.1.4 Critical Habitat

On April 11, 2011, NMFS designated critical habitat for the Cook Inlet beluga whale that includes two areas. Area 1 encompasses the upper Inlet, a 1,909 km2 area bounded by the Municipality of Anchorage, the Matanuska-Susitna Borough, and the Kenai Peninsula borough. This area hosts a high concentration of belugas from spring through fall. It provides shallow tidal flats and river mouths or estuarine areas, important to foraging and calving. Mudflats and shallow areas adjacent may allow for molting and escape from predators. Area 2 consists of 5,891 km2 south of Area 1 including: Tuxedni, Chinitna, and Kamishak Bays on the west coast, a portion of Kachemak Bay on the east coast, and south of Kalgin Island. During the fall and winter, Belugas typically occur in smaller densities or deeper waters of this feeding and transit area. Areas 1 and 2 contain the following physical or biological features essential to the conservation of this DPS (76 FR 20180):

(1) Intertidal and subtidal waters of Cook Inlet with depths less than 30 feet (9.1 m) and within 5 miles (8 km) of high and medium flow anadromous fish streams.

(2) Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.

(3) Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales.

(4) Unrestricted passage within or between the critical habitat areas.

(5) Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales.

1.2 Southern Resident Killer Whale

Killer whales (or orcas) are distributed worldwide, but populations are isolated by region and ecotype (i.e., different morphology, ecology, and behavior). Southern Resident killer whales occur in the inland waterways of Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait during the spring, summer and fall. During the winter, they move to coastal waters primarily off Oregon, Washington, California, and British Columbia. The DPS was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). We used information available in the final rule, the 2011 Status Review (NMFS 2011p) and the 2011 Stock Assessment Report (http://www.nmfs.noaa.gov/pr/pdfs/sars/po2011whki-pensr.pdf) to summarize the status of this species, as follows.

1.2.1 Life History

Southern Resident killer whales are geographically, matrilineally, and behaviorally distinct from other killer whale populations (70 FR 69903). The DPS includes three large, stable pods (J, K, and L), which occasionally interact (Parsons et al. 2009). Most mating occurs outside natal pods, during temporary associations of pods, or as a result of the temporary dispersal of males (Pilot et al. 2010). Males become sexually mature at 10 – 17 years of age. Females reach maturity at 12 – 16 years of age and produce an average of 5.4 surviving calves during a reproductive life span of approximately 25 years. Mothers and offspring maintain highly stable, life-long social bonds, and this natal relationship is the basis for a matrilineal social structure. They prey upon salmonids, especially Chinook salmon (Hanson et al. 2010).

1.2.2 Population Dynamics
The most recent abundance estimate for the Southern Resident DPS is 87 whales in 2012. This represents an average increase of 0.4 percent annually since 1982 when there were 78 whales. Population abundance has fluctuated during this time with a maximum of approximately 100 whales in 1995 (http://www.nmfs.noaa.gov/pr/pdfs/sars/po2011whki-pensr.pdf). As compared to stable or growing populations, the DPS reflects a smaller percentage of juveniles and lower fecundity (NMFS 2011p) and has demonstrated weak growth in recent decades.

1.2.3 Status
The Southern Resident killer whale DPS was listed as endangered in 2005 in response to the population decline from 1996 – 2001, small population size, and reproductive limitations (i.e., few reproductive males and delayed calving). Current threats to its survival and recovery include: contaminants, vessel traffic, and reduction in prey availability. Chinook salmon populations have declined due to degradation of habitat, hydrology issues, harvest, and hatchery introgression; such reductions may require an increase in foraging effort. In addition, these prey contain environmental pollutants (e.g., flame retardants; PCBs; and DDT). These contaminants become concentrated at higher trophic levels and may lead to immune suppression or reproductive impairment (70 FR 69903). The inland waters of Washington and British Columbia support a large whale watch industry, commercial shipping, and recreational boating; these activities generate underwater noise, which may mask whales' communication or interrupt foraging. The factors that originally endangered the species persist throughout its habitat: contaminants, vessel traffic, and reduced prey. The DPS's resilience to future perturbation is reduced as a result of its small population size (N = 86); however, it has demonstrated the ability to recover from smaller population sizes in the past and has shown an increasing trend over the last several years. NOAA Fisheries is currently conducting a status review prompted by a petition to delist the DPS based on new information, which indicates that there may be more paternal gene flow among populations than originally detected (Pilot et al. 2010).

1.2.4 Critical Habitat
On November 29, 2006, NMFS designated critical habitat for the Southern Resident killer whale (71 FR 69054). The critical habitat consists of approximately 6,630 km^2 in three areas: the Summer Core Area in Haro Strait and waters around the San Juan Islands; Puget Sound; and the Strait of Juan de Fuca. It provides the following physical and biological features: water quality to support growth and development; prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and inter-area passage conditions to allow for migration, resting, and foraging.

1.3 Main Hawaiian Islands Insular False Killer Whale
NMFS currently recognizes three stocks of false killer whale in Hawaiian waters: the Main Hawaiian Islands insular, Hawaii pelagic, and the Northwestern Hawaiian Islands (Carretta et al.

2011, Bradford et al. 2012) (77 FR 70915). NMFS considers all false killer whales found within 40 km (22 nm) of the Main Hawaiian Islands as belonging to the insular stock and all false killer whales beyond 140 km (76 nm) as belonging to the Pelagic Stock (77 FR 70915). The animals belonging to the Northwest Hawaiian Islands stock are insular to the Northwest Hawaiian Islands (Bradford et al. 2012), however, this stock was identified by animals encountered off Kaua‘i. It has been previously recognized that the ranges for the two stocks (pelagic and insular) overlap by 100 km, but there is also overlap among all three stocks in these presently identified ranges (Carretta et al. 2011, Bradford et al. 2012).

The Main Hawaiian Islands insular false killer whale DPS is considered resident to the Main Hawaiian Islands and is genetically and behaviorally distinct compared to other stocks (77 FR 70915). Genetic data suggest little immigration into the Main Hawaiian Islands insular false killer whale population (Baird et al. 2012). However, because data on ecological relationships among false killer whale groups in the region are uncertain,additional data are being collected to identify whether other false killer whale groups in the Hawaiian Islands should also be considered part of the Main Hawaiian Islands insular false killer whale DPS (77 FR 70915).

1.3.1 Life History

Main Hawaiian Islands insular false killer whales are large members of the dolphin family. False killer whales have dark coloration except for some lighter patches near the throat and middle chest. Their body shape is more slender than other large delphinids.

1.3.2 Population Dynamics

The minimum population estimate for the Main Hawaiian Islands insular stock of false killer whales is the number of distinct individuals identified during the 2008-2011 photo-identification studies, which is 129 false killer whales (Baird, Hawaii insular false killer whale catalog; (Carretta et al. 2012). No data are available on current or maximum net productivity rate for this stock.

1.3.3 Status

NMFS listed the Main Hawaiian Island insular population of false killer whales as an endangered distinct population segment (DPS) on November 28, 2012 (77 FR 70915). Reeves et al. (2009) summarized information on false killer whale sightings near Hawaii between 1989 and 2007, based on various survey methods, and suggested that the Main Hawaiian Islands insular stock of false killer whales may have declined during the last two decades. More recently, Baird (Baird 2009) reviewed trends in sighting rates of false killer whales from aerial surveys conducted using consistent methodology around the Main Hawaiian Islands between 1994 and 2003 (Mobley Jr 2001, Mobley Jr. 2003, 2004, 2005). Sighting rates during these surveys exhibited a statistically significant decline that could not be attributed to any weather or methodological changes. Reanalysis of previously published abundance estimates for the insular stock has led to them generally being discounted (77 FR 70915).

The recent Status Review of Main Hawaiian Islands insular false killer whales (Oleson et al. 2010) presented a quantitative analysis of extinction risk using a Population Viability Analysis (PVA). The modeling exercise was conducted to evaluate the probability of actual or near extinction, defined as fewer than 20 animals, given measured, estimated, or inferred information on population size and trends, and varying impacts of catastrophes, environmental stochasticity and Allee effects. A variety of alternative scenarios were evaluated, with all plausible models indicating the probability of decline to fewer than 20 animals within 75 years as greater than 20 percent. Though causation was not evaluated, all models indicated current declines at an average rate of -9 percent since 1989 (95 percent probability intervals -5 to -12.5 percent) (Oleson et al. 2010).

1.3.4 Critical Habitat

No critical habitat has been designated for the Main Hawaiian Islands insular false killer whale.

1.4 Blue Whale

The blue whale is the largest animal on earth. Three subspecies comprise the species, which occurs in coastal and pelagic waters in all oceans. Though often found in coastal waters, blue whales generally occur in offshore waters, from subpolar to subtropical latitudes. The species was originally listed as endangered on December 2, 1970 (35 FR 18319). We used information available in the recovery plan (NMFS 1998b) and recent stock assessments (Waring et al. 2010, Carretta et al. 2013), and the status report (COSEWIC 2002) to summarize the status of the species, as follows.

1.4.1 Life History

The gestation period of blue whales is approximately 10 – 12 months, and calves are nursed for 6 – 7 months. The average calving interval is 2 – 3 years. Blue whales reach sexual maturity at 5 – 15 years of age. Parturition and mating occurs in lower latitudes during the winter season, and weaning probably occurs in or en route to summer feeding areas in higher, more productive latitudes. Blue whales forage almost exclusively on krill (i.e., relatively large euphausiid crustaceans) and can eat approximately 3,600 kg daily. Feeding aggregations are often found at the continental shelf edge, where upwelling produces concentrations of krill at depths of 90 – 120 m.

1.4.2 Population Dynamics

There are an estimated 5,000 – 12,000 blue whales worldwide. Three stocks occur in U.S. waters: the eastern North Pacific, the western North Atlantic, and Hawaii. For the eastern North Pacific stock, the best estimate of abundance is 2,497 whales, with an estimated annual growth rate of approximately three percent annually. The western North Atlantic stock has a minimum population size of 440 individuals, and abundance appears to be increasing, though there are insufficient data to provide reliable population trends. Blue whale sightings are rare in Hawaii, and no data are available from which to estimate abundance or trends.

1.4.3 Status

The blue whale is endangered as a result of past commercial whaling. In the North Atlantic, at least 11,000 blue whales were taken from the late 19th to mid-20th centuries. In the North Pacific, at least 9,500 whales were killed between 1910 and 1965. Commercial whaling no longer occurs, but blue whales are threatened by ship strikes, entanglement in fishing gear, pollution, and noise. Because populations appear to be increasing in size, the species appears to be somewhat resilient to current threats; however, it has not recovered to pre-exploitation levels.

1.4.4 Critical Habitat

No critical habitat has been designated for the blue whale.

1.5 Fin Whale

The fin whale is a large, widely distributed baleen whale, comprised of two (or possibly three) subspecies. Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes. The species was originally listed as endangered on December 2, 1970 (35 FR 18319). We used information available in the recovery plan (NMFS 2010b), the five-year review (NMFS 2011o), and recent stock assessment reports (Allen and Angliss 2012, Waring et al. 2012, Carretta et al. 2013)to summarize the status of the species, as follows.

1.5.1 Life History

The gestation period of fin whales is less than one year, and calves are nursed for 6 – 7 months. The average calving interval is 2 – 3 years. Fin whales reach sexual maturity at 6 – 10 years of age. Parturition and mating occurs in lower latitudes during the winter season. Intense foraging occurs at high latitudes during the summer. Fin whales eat pelagic crustaceans (mainly euphausiids or krill) and schooling fish such as capelin, herring, and sand lance. The availability of sand lance, in particular, is thought to have had a strong influence on the distribution and movements of fin whales along the east coast of the United States.

1.5.2 Population Dynamics

There are over 100,000 fin whales worldwide. Though only two subspecies are recognized (Northern Hemisphere and Southern Hemisphere), North Atlantic, North Pacific, and Southern Hemisphere fin whales appear to be reproductively isolated. Of the 3 – 7 stocks in the North Atlantic (N ~ 50,000), one occurs in U.S. waters, where the best estimate of abundance is 3,985 whales. There are three stocks in U.S. Pacific waters: Alaska (Nmin =5,700), Hawaii (Nmin = 101), and California/Oregon/Washington (Nmin = 3,269). Abundance appears to be increasing in Alaska (4.8 percent annually) and possibly California. Trends are not available for other stocks due to insufficient data. Abundance data for the Southern Hemisphere stock are limited; however, there were an estimated 85,200 whales in 1970.

1.5.3 Status

The fin whale is endangered as a result of past commercial whaling. In the North Atlantic, at least 55,000 fin whales were killed between 1910 and 1989. In the North Pacific, at least 74,000 whales were killed between 1910 and 1975. Approximately 704,000 whales were killed in the Southern Hemisphere from 1904 to 1975. Fin whales are still killed under the International Whaling Commission's "aboriginal subsistence whaling" in Greenland, under Japan's scientific whaling program, and via Iceland's formal objection to the Commission's ban on commercial whaling. Additional threats include: ship strikes, reduced prey availability due to overfishing or climate change, and noise. Though the original cause of endangerment remains, whaling has been significantly reduced. Its large population size may provide some resilience to current threats, but trends are largely unknown.

1.5.4 Critical Habitat

No critical habitat has been designated for the fin whale.

1.6 Sei Whale

The sei whale is a widely distributed baleen whale. Sei whales prefer subtropical to subpolar waters on the continental shelf edge and slope worldwide. They are usually observed in deeper waters of oceanic areas far from the coastline. The species was originally listed as endangered on December 2, 1970 (35 FR 18319). We used information available in the recovery plan (NMFS

2011q), the five-year review (NMFS 2012e), and recent stock assessment reports (Waring et al. 2012, Carretta et al. 2013)to summarize the status of the species, as follows.

1.6.1 Life History

The gestation period of sei whales is 10 – 12 months, and calves are nursed for 6 – 9 months. The average calving interval is 2 – 3 years. Sei whales reach sexual maturity at 6 – 12 years of age. They winter at relatively low latitudes and summer at relatively higher latitudes. Throughout their range, sei whales occur predominantly in deep water; they are most common over the continental slope. Sei whales in the North Atlantic reportedly feed primarily on calanoid copepods, with a secondary preference for euphausiids. In the Pacific, they also feed on fish (e.g., anchovies, saury, whiting, lamprey, and herring).

1.6.2 Population Dynamics

There are ~80,000 sei whales worldwide, in the North Atlantic, North Pacific, and Southern Hemispere. Three stocks occur in U.S. waters: Nova Scotia (N = 357), Hawaii (Nmin = 37), and Eastern North Pacific (Nmin = 83). Population trends are not available due to insufficient data. It is unknown whether the population size is stable or fluctuating.

1.6.3 Status

The sei whale is endangered as a result of past commercial whaling. There are no estimates of pre-exploitation abundance for the North Atlantic. Models indicate that total abundance declined from 42,000 to 8,600 individuals between 1963 and 1974, in the North Pacific. In the Southern Hemisphere, pre-exploitation abundance is estimated at 65,000 whales, with recent abundance estimated at 9,700 whales. Now, only a few individuals are taken each year by Japan; however, Iceland has expressed an interest in targeting sei whales. Current threats include ship strikes, fisheries interactions (including entanglement), climate change (habitat loss and reduced prey availability), and noise. Its large population size may provide some resilience to current threats, but trends are largely unknown.

1.6.4 Critical Habitat

No critical habitat has been designated for the sei whale.

1.7 Humpback Whale

The humpback whale is a widely distributed baleen whale, distinguishable by its long flippers. The species inhabits all major oceans from the equator to sub-polar latitudes and generally prefers coastal waters. The humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). On August 29, 2013, NMFS initiated a status review of the North Pacific population to determine whether to identify the population as DPS and to delist it. We used information available in the recovery plan (NMFS 1991) and recent stock assessment reports (Allen and Angliss 2013, Carretta et al. 2013, Waring et al. 2013)to summarize the status of the species, as follows.

1.7.1 Life History

The gestation period of humpback whales is 11 months, and calves are nursed for 12 months. The average calving interval is 2 – 3 years and sexual maturity is reached at 5 – 11 years of age. Humpback whales inhabit waters over or along the continental shelf and oceanic islands. They winter at low latitudes, where they calf and nurse, and summer at high latitudes, where they feed.

Humpbacks exhibit a wide range of foraging behaviors and feed on a range of prey types, including: small schooling fishes, euphausiids, and other large zooplankton.

1.7.2 Population Dynamics

There are over 60,000 humpback whales worldwide, occurring primarily in the North Atlantic, North Pacific, and Southern Hemisphere. Current estimates indicate approximately 20,000 humpback whales in the North Pacific, with an annual growth rate of 4.9 percent (Calambokidis 2010). Stocks in U.S. waters include: American Samoa, California/Oregon/Washington, and Central North Pacific. As of 1993, there was an estimated 11,570 humpback whales in the North Atlantic, growing at a rate of three percent annually (Stevick et al. 2003). The Southern Hemisphere supports more than 36,000 humpback whales and is growing at a minimum annual rate of 4.6 percent (Reilly et al. 2008).

1.7.3 Status

The humpback whale is endangered as a result of past commercial whaling. Prior to commercial whaling, hundreds of thousands of humpback whales existed. Global abundance declined to the low thousands by 1968, the last year of substantial catches (Reilly et al. 2008). Humpback whales may be killed under “aboriginal subsistence whaling” and “scientific permit whaling” provisions of the International Whaling Commission. Additional threats include ship strikes and fisheries interactions (including entanglement), and noise. The species’ large population size and increasing trends indicate that it is resilient to current threats, and one population (North Pacific) is currently being considered for delisting.

1.7.4 Critical Habitat

No critical habitat has been designated for the humpback whale.

1.8 North Atlantic Right Whale

The North Atlantic right whale is a narrowly distributed baleen whale, distinguished by its stocky body and lack of a dorsal fin. North Atlantic right whales inhabit coastal waters of the Atlantic Ocean, particularly between 20° and 60° latitude. For much of the year, their distribution is strongly correlated to the distribution of their prey. The species was originally listed as endangered on December 2, 1970 (35 FR 18319). We used information available in the 5-year review (NMFS 2012a) and the recent stock assessment report (Waring et al. 2013)to summarize the status of the species, as follows.

1.8.1 Life History

The gestation period of North Atlantic right whales is 12 – 13 months, and calves are nursed for 8 – 17 months. The average calving interval is 3 – 5 years. Right whales reach sexual maturity at 9 years of age. They migrate to low latitudes during the winter to give birth in shallow, coastal waters. In the summer, they feed on large concentrations of copepods in the high latitudes.

1.8.2 Population Dynamics

Right whales occur in the eastern and western North Atlantic; however, less than 20 individuals exist in the eastern North Atlantic, and the population may be functionally extinct. There are at least 396 individuals in the western North Atlantic population. Despite two periods of increased mortality, the species has demonstrated overall growth rates of two percent over 17 years (1990 – 2007). This variability may indicate loss of resilience and susceptibility to population collapse (Dai et al. 2012, Scheffer et al. 2012).

1.8.3 Status

The North Atlantic right whale is endangered as a result of past commercial whaling. Pre-exploitation abundance has been estimated at more than 1,000 individuals, distributed throughout temperate, subarctic, coastal and continental shelf waters of the North Atlantic Ocean. Commercial whaling reduced the population size to ~50 individuals and truncated the range of the species; however, whaling is now prohibited. The two major threats to the survival of the species are ship strike and fisheries interactions (including entanglement). While population trends are positive, the species' resilience to future perturbations is low due to its small population size and continued threats of ship strike and entanglement.

1.8.4 Critical Habitat

On June 3, 1994, NMFS designated critical habitat for the North Atlantic right whale (59 FR 28805). Northern designated areas (Great South Channel, Massachusetts Bay, Cape Cod Bay, and Stellwagen Bank) include complex oceanographic features that drive prey density and distribution. Southern areas (waters from the coast out 15 nautical miles between the latitudes of 31°15' N and 30°15' N and from the coast out five nautical miles between 30°15' N and 28°00' N) were designated to protected calving and breeding grounds.

1.9 North Pacific Right Whale

The North Pacific right whale is a baleen whale, distinguished by its stocky body and lack of a dorsal fin. It inhabits the Pacific Ocean, particularly between 20° and 60° latitude. The species was originally listed with the North Atlantic right whale (i.e., "Northern" right whale) as endangered on December 2, 1970 (35 FR 18319). It was listed separately as endangered on March 6, 2008 (73 FR 12024). We used information available in the 5-year review (NMFS 2012c) and the recent stock assessment report (Allen and Angliss 2013) to summarize the status of the species, as follows.

1.9.1 Life History

The gestation period of North Pacific right whales is approximately 1 year, and calves are nursed for approximately 1 year. Right whales reach sexual maturity at 9 – 10 years of age. Little is known about migrating patterns, but whales have been observed in lower latitudes in the winter (Japan, California, and Mexico). In the summer, they feed on large concentrations of copepods in the Alaskan waters.

1.9.2 Population Dynamics

The North Pacific right whale remains one of the most endangered whale species in the world, likely numbering fewer than 1,000 individuals. There are no reliable estimates of current abundance or trends for right whales in the North Pacific, and we do not know whether the population size is stable or fluctuating.

1.9.3 Status

The North Pacific right whale is endangered as a result of past commercial whaling. Pre-exploitation abundance has been estimated at more than 11,000 individuals. Current threats to the survival include poaching, ship strike, fisheries interactions (including entanglement). The species' resilience to future perturbations is low due to its small population size and continued threats of poaching, ship strike, and entanglement.

1.9.4 Critical Habitat

In 2008, NMFS designated critical habitat for the North Pacific right whale, which includes an area in the Southeast Bering Sea and an area south of Kodiak Island in the Gulf of Alaska (73 FR 19000). These areas are influenced by large eddies, submarine canyons, or frontal zones which enhance nutrient exchange and act to concentrate prey. These areas are adjacent to major ocean currents and are characterized by relatively low circulation and water movement. Both critical habitat areas support feeding by North Pacific right whales because they contain the designated primary constituent elements, which include: nutrients, physical oceanographic processes, certain species of zooplankton, and a long photoperiod due to the high latitude (73 FR 19000). Consistent North Pacific right whale sights are a proxy for locating these elements.

2 Pinnipeds

Pinnipedia is the group of semi-aquatic mammals that includes the families: Phocidae (earless or true seals); Otaridae (eared seals); and Odobenidae (walrus). Over thirty species of pinniped occur worldwide in a variety of aquatic habitats, though they most commonly occur in coastal, marine areas. Two ESA-listed pinniped species under NMFS's jurisdiction (walrus are under the jurisdiction of the USFWS) may be affected by the proposed action and are described below.

2.1 Steller Sea Lion (Western DPS)

The Steller sea lion ranges from Japan, through the Okhotsk and Bering Seas, to central California. It consists of two morphologically, ecologically, and behaviorally distinct DPSs: the Eastern DPS, which includes sea lions in Southeast Alaska, British Columbia, Washington, Oregon and California; and the Western DPS, which includes sea lions in all other regions of Alaska, as well as Russia and Japan. On May 5, 1997, NMFS issued a final determination to list the western DPS as endangered under the ESA (62 FR 24345). We used information available in the final listing (62 FR 24345) and the 2012 stock assessment report (Allen and Angliss 2012) to summarize the status of the western DPS, as follows.

2.1.1 Life History

Within the western DPS, pupping and breeding occurs at numerous major rookeries from late May to early July. Male Steller sea lions become sexually mature at 3 – 7 years of age. They are polygynous, competing for territories and females by age 10 or 11. Female Steller sea lion become sexually mature at 3 – 6 years of age and reproduce into their early 20s. Most females breed annually, giving birth to a single pup, but nutritional stress may result in reproductive failure. About 90% of pups within a given rookery are born within a 25-day period, as such they are highly vulnerable to fluctuations in prey availability. Most pups are weaned in 1 – 2 years.

Females and their pups disperse from rookeries by August – October. Juveniles and adults disperse widely, especially males. Their large aquatic ranges are used for foraging, resting, and traveling. Steller sea lions forage on a wide variety of demersal, semi-demersal, and pelagic prey, including fish and cephalopods. Some prey species form large seasonal aggregations, including endangered salmon and eulachon species. Others are available year round.

2.1.2 Population Dynamics

As of 2011, the best estimate of abundance of the western Steller sea lion DPS in Alaska was 52,209 (Nmin = 45, 916). This represents a large decline since counts in the 1950s (N = 140,000) and 1970s (N = 110,000). The potential biological removal is estimated at 275 animals.

2.1.3 Status

Steller sea lion western DPS site counts decreased 40 percent from 1991 to 2000, an average annual decline of 5.4 percent; however, counts increased 11 percent from 2000 to 2004 and three percent between 2004 and 2008, an average annual increase of 1.5 percent. The species was listed as threatened in 1990 because of significant declines in population sizes (55 FR 49204). At the time, the major threat to the species was thought to be reduction in prey availability. To protect and recovery the species, NMFS established the following measures: prohibition of shooting at or near sea lions; prohibition of vessel approach to within 3 nautical miles of specific rookeries, within 0.5 miles on land, and within sight of other listed rookeries; and restriction of incidental fisheries take to 675 sea lions annually in Alaskan waters. In 1997, the western DPS was reclassified as endangered because it had continued to decline since its initial listing in 1990 (62 FR 24345). Despite the added protection (and an annual incidental fisheries take of approximately 26 individuals), the DPS is likely still in decline (though the decline has slowed or stopped in some portions of the range). The reasons for the continued decline are unknown but may be associated with nutritional stress as a result of environmental change and competition with commercial fisheries. The DPS appears to have little resilience to future perturbations.

2.1.4 Critical Habitat

In 1997, NMFS designated critical habitat for the Steller sea lion (58 FR 45269). The critical habitat includes specific rookeries, haulouts, and associated areas, as well as three foraging areas that are considered to be essential for the health, continued survival, and recovery of the species.

In Alaska, areas include major Steller sea lion rookeries, haulouts and associated terrestrial, air, and aquatic zones. Critical habitat includes a terrestrial zone extending 3,000 feet (0.9 km) landward from each major rookery and haulout; it also includes air zones extending 3,000 feet (0.9 kin) above these terrestrial zones and aquatic zones. Aquatic zones extend 3,000 feet (0.9 km) seaward from the major rookeries and haulouts east of 144°W. In California and Oregon, major Steller sea lion rookeries and associated air and aquatic zones are designated as critical habitat. Critical habitat includes an air zone extending 3,000 feet (0.9 km) above rookery areas historically occupied by sea lions. Critical habitat also includes an aquatic zone extending 3,000 feet (0.9 kin) seaward.

In addition, NMFS designated special aquatic foraging areas as critical habitat for the Steller sea lion. These areas include the Shelikof Strait (in the Gulf of Alaska), Bogoslof Island, and Seguam Pass (the latter two are in the Aleutians). These sites are located near Steller sea lion abundance centers and include important foraging areas, large concentrations of prey, and host large commercial fisheries that often interact with the species.

2.2 Hawaiian Monk Seal

The Hawaiian monk seal is a large phocid that inhabits the Northwestern Hawaiian Islands (NWHI) and main Hawaiian Islands (MHI). It was listed as endangered under the ESA in 1976 (41 FR 51611). We used information available in the 2007 5-year review (NMFS 2007d), the 2012 stock assessment report (Carretta et al. 2013), and unpublished NMFS data to summarize the status of this species, as follows.

2.2.1 Life History

Monk seals are generally born between February and August. They nurse for 5 – 6 weeks, during which time the mother does not forage. Upon weaning, the mothers return to sea, and the pups are left unattended on the beaches. Females spend approximately 8 – 10weeks foraging at sea before returning to beaches to molt. They mature at 5 – 10 years of age. Males likely mature at the same age but may not gain access to females until they are older. Males compete in a dominance hierarchy to gain access to females (i.e., guarding them on shore). Mating occurs at sea, however, providing opportunity for female mate choice. Though some females mate every year after first parturition, most do not. Overall reproductive rates are low, especially in the NWHI. For example, the pooled birth rate at Laysan and Lisianski was 0.54 pups per adult female per year (Johanos et al. 1994). The low birth rates may reflect low prey availability. Monk seals are considered foraging generalists that feed primarily on benthic and demersal prey. They forage in subphotic zones either because these areas host favorable prey items or because these areas are less accessible by competitors (Parrish 2009). Juvenile seals may not have the experience, endurance, or diving capacity to make such deep dives, leaving them more susceptible to starvation.

2.2.2 Population Dynamics

As of 2012, ~1,212 Hawaiian monk seals remained in the wild. As of 2011, a total of 152 seals were documented in the MHI, where the subpopulation is growing at a rate of seven percent annually (Baker et al. 2011). The majority of seals (N = 893) still reside in the NWHI. Hawaiian monk seals are found predominantly throughout the NWHI with six of the population's reproductive sites being located at Kure Atoll, Midway Atoll, Pearl and Hermes Reef, Lisianski Island, Laysan Island, and the French Frigate Shoals (NMFS 2014 citing Antonelis et al. 2006; Reeves et al. 2002).

Hawaiian monk seals occur on lands (islands, atolls, emergent reefs) throughout the Hawaiian Archipelago, from Kure Atoll to Hawaiʻi Island, a distance of over 2,500 km (approximately 1,553 miles). Seals forage (search for food) in and transit the waters surrounding and between all land areas. Additionally, intermittent sightings of Hawaiian monk seals have occurred at remote Johnston Atoll approximately 800 km (about 500 miles) south of the Hawaiian Archipelago. Although seals are perhaps not continuously present at this site, they do occur there naturally so Johnston Atoll is considered part of the species range. Historically, most Hawaiian monk seals have been located in the remote NWHI, with subpopulations at Kure Atoll, Midway Atoll, Pearl and Hermes Reef, Lisianski Island, Laysan Island, French Frigate Shoals, Necker Island and Nihoa Island. Seals are also seen at Gardner Pinnacles and Maro Reef in the NWHI; however, these sites have limited areas where seals can haul out. A historically small, but currently growing portion of the seals occur in the MHI, including the islands of Niʻihau, Kauaʻi, Oʻahu, Molokaiʻi, Lānaʻi, Kahoʻolawe, Maui, and Hawaiʻi. Seals also land on smaller islands (for example, Kaula Rock, Lehua Rock) and offshore islets that occur throughout the MHI (NMFS 2014).

2.2.3 Status

The Hawaiian monk seal is a endangered species that continues to decline in abundance at a rate of four percent annually, presumably as a result in changes to their foraging base. The species has declined in abundance by over 68% since 1958. Birth rates in the NWHI declined dramatically in the 1990s, possibly reflecting unfavorable environmental conditions. Concurrently, there was a rapid increase in the number of monk seal sightings and births in the MHI. Hawaiian monk seals were once harvested for their meat, oil and skins, leading to extirpation in the MHI and near-extinction of the species by the 20th century (Hiruki and Ragen 1992, Ragen 1999). The species experienced a partial recovery by 1960, when hundreds of seals were counted on NWHI beaches. Since then, however, the species has declined in abundance. Though the ultimate cause(s) for the decline remain unknown, threats include: starvation; predation by sharks; competition with fish and fisheries; entanglement in marine debris; male aggression; beach erosion; and environmental changes that reduce prey availability. In the MHI, additional threats include disturbance of nursing pups and illegal killing, which likely reflects conflict over actual or perceived fisheries interactions (Kehaulani Watson et al. 2011, McAvoy 2012). With only ~1,212 individuals remaining the species' resilience to further perturbation is low. Other species in the same genus have gone extinct (i.e., Caribbean monk seal) or have been extirpated from the majority of their previous range (i.e., Mediterranean monk seal). We conclude that the Hawaiian monk seal's resilience to further perturbation is low, and its status is precarious.

2.2.4 Critical Habitat

Hawaiian monk seal critical habitat was originally designated on April 30, 1986 (51 FR 16047) and was extended on May 26, 1988 (53 FR 18988). It includes all beach areas, sand spits and islets (including all beach crest vegetation to its deepest extent inland), lagoon waters, inner reef waters, and ocean waters out to a depth of 20 fathoms (37 m) around the NWHI breeding atolls and islands. The marine component of this habitat serves as foraging areas, while terrestrial habitat provides resting, pupping and nursing habitat.

On June 2, 2011, NMFS published a proposed rule to revise critical habitat for Hawaiian monk seals (76 FR 32026), extending the current designation in the NWHI out to the 500 m depth contour (including Sand Island at Midway Atoll) and designating six new areas in the MHI (i.e., terrestrial and marine habitat from 5 m inland from the shoreline extending seaward to the 500 m depth contour around Kaula, Niihau, Kauai, Oahu, Maui Nui, and Hawaii Islands). A final rule has not yet been published.

3 Sea Turtles

Sea turtles are air-breathing reptiles with streamlined bodies and large flippers. They inhabit tropical and subtropical ocean waters throughout the world. Of the seven species of sea turtles found worldwide, the six species described below are found in U.S. waters and may be affected by the proposed action.

3.1 Leatherback Sea Turtle

The leatherback sea turtle is unique among sea turtles for its large size, wide distribution (due to thermoregulatory systems and behavior), and lack of a hard, bony carapace. It ranges from tropical to subpolar latitudes, worldwide. The species was first listed under the Endangered Species Conservation Act (35 FR 8491) and listed as endangered under the ESA since 1973. We used information available in the 5-year review (NMFS and USFWS 2007c) and the critical habitat designation (77 FR 61573) to summarize the status of the species, as follows.

3.1.1 Life History

Age at maturity remains elusive, with estimates ranging from 5 to 29 years (Spotila et al. 1996, Avens et al. 2009). Females lay up to seven clutches per season, with more than 65 eggs per clutch and eggs weighing >80 g (Reina et al. 2002, Wallace et al. 2007). The number of leatherback hatchlings that make it out of the nest on to the beach (i.e., emergent success) in approximately 50% worldwide (Eckert et al. 2012). Females nest every 1 – 7 years. Natal homing, at least within an ocean basin, results in reproductive isolation between five broad geographic regions: eastern and western Pacific, eastern and western Atlantic, and Indian Ocean. Leatherback sea turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters where they forage, primarily on jellyfish and tunicates. These gelatinous prey are relatively nutrient-poor, such that leatherbacks must consume large quantities to support their body weight. Leatherbacks weigh ~33 percent more on their foraging grounds than at nesting, indicating that they probably catabolize fat reserves to fuel migration and subsequent reproduction (James et al. 2005, Wallace et al. 2006). Sea turtles must meet an energy threshold before returning to nesting beaches (Rivalan et al. 2005, Sherrill-Mix and James 2008, Casey et al. 2010). Therefore, their remigration intervals (the time between nesting) are dependent upon foraging success and duration (Hays 2000, Price et al. 2004).

3.1.2 Population Dynamics

The global population of adult females has declined over 70 percent in less than one generation, from an estimated 115,000 adult females in 1980 to 34,500 adult females in 1995 (Pritchard 1982, Spotila et al. 1996). There may be as many as 34,000 – 94,000 adult leather backs in the North Atlantic, alone (Turtle Expert Working Group 2007), but dramatic reductions (> 80 percent) have occurred in several populations in the Pacific, which was once considered the stronghold of the species (Sarti Martinez 2000).

3.1.3 Status

The leatherback sea turtle is an endangered species whose once large nesting populations have experienced steep declines in recent decades. The primary threats to leatherback sea turtles include: fisheries bycatch, harvest of nesting females, and egg harvesting. As a result of these threats, once large rookeries are now functionally extinct, and there have been range-wide reductions in population abundance. Other threats include loss of nesting habitat due to development, tourism, and sand extraction. Lights on or adjacent to nesting beaches alter nesting adult behavior and are often fatal to emerging hatchlings as they are drawn to light sources and away from the sea. Plastic ingestion is common in leatherbacks and can block gastrointestinal tracts leading to death. Climate change may alter sex ratios (as temperature determines hatchling sex), range (through expansion of foraging habitat), and habitat (through the loss of nesting beaches, as a result of sea-level rise. The species' resilience to additional perturbation is low.

3.1.4 Critical Habitat

On March 23, 1979, leatherback critical habitat was identified adjacent to Sandy Point, St. Croix, Virgin Islands from the 183 m isobath to mean high tide level between 17° 42'12" N and 65°50'00" W (44 FR 17710). This habitat is essential for nesting, which has been increasingly threatened since 1979, when tourism increased significantly, bringing nesting habitat and people into close and frequent proximity; however, studies do not support significant critical habitat deterioration.

On January 20, 2012, NMFS issued a final rule to designate additional critical habitat for the leatherback sea turtle (50 CFR 226). This designation includes approximately 43,798 km2 stretching along the California coast from Point Arena to Point Arguello east of the 3000 m depth contour; and 64,760 km2 stretching from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 m depth contour. The designated areas comprise approximately 108558 km2 of marine habitat and include waters from the ocean surface down to a maximum depth of 80 m. They were designated specifically because of the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (i.e., jellyfish), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.

3.2 Hawksbill Sea Turtle

The hawksbill sea turtle has a sharp, curved, beak-like mouth. It has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical oceans. The species was first listed under the Endangered Species Conservation Act (35 FR 8491) and listed as endangered under the ESA since 1973. We used information available in the 5-year reviews (NMFS and USFWS 2007b, NMFS 2013e, NMFS and USFWS 2013) to summarize the status of the species, as follows.

3.2.1 Life History

Hawksbill sea turtles reach sexual maturity at 20 – 40 years of age. Females return to their natal beaches every 2 – 5 years to nest (an average of 3 – 5 times per season). Clutch sizes are large (up to 250 eggs). Sex determination is temperature dependent, with warmer incubation producing more females. Hatchlings migrate to and remain in pelagic habitats until they reach approximately 22 – 25 cm in straight carapace length. As juveniles, they take up residency in coastal waters to forage and grow. As adults, hawksbills use their sharp beak-like mouths to feed on sponges and corals.

3.2.2 Population Dynamics

Surveys at 88 nesting sites worldwide indicate that 22,004 – 29,035 females nest annually(NMFS 2013e, NMFS and USFWS 2013). In general, hawksbills are doing better in the Atlantic and Indian Ocean than in the Pacific Ocean, where despite greater overall abundance, a greater proportion of the nesting sites are declining.

3.2.3 Status

Long-term data on the hawksbill sea turtle indicate that 63 sites have declined over the past 20 to 100 years (historic trends are unknown for the remaining 25 sites). Recently, 28 sites (68 percent) have experienced nesting declines, 10 have experienced increases, three have remained stable, and 47 have unknown trends. The greatest threats to hawksbill sea turtles are overharvesting of turtles and eggs, degradation of nesting habitat, and fisheries interactions. Adult hawksbills are harvested for their meat and carapace, which is sold as tortoiseshell. Eggs are taken at high levels, especially in Southeast Asia where collection approaches 100 percent in some areas. In addition, lights on or adjacent to nesting beaches are often fatal to emerging hatchlings and alters the behavior of nesting adults. The species' resilience to additional perturbation is low.

3.2.4 Critical Habitat

On September 2, 1998, NMFS established critical habitat for hawksbill sea turtles around Mona and Monito Islands, Puerto Rico (63 FR 46693). Aspects of these areas that are important for hawksbill sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill sea turtle prey.

3.3 Kemp's Ridley Sea Turtle

The Kemp's ridley is the smallest of all sea turtle species and considered to be the most endangered sea turtle, internationally (Zwinenberg 1977, Groombridge 1982, TEWG 2000). Its range extends from the Gulf of Mexico to the Atlantic coast, with nesting beaches limited to a few sites in Mexico and Texas. The species was first listed under the Endangered Species Conservation Act (35 FR 8491) and listed as endangered under the ESA since 1973. We used information available in the revised recovery plan (NMFS et al. 2011) to summarize the status of the species, as follows.

3.3.1 Life History

Adult Kemp's ridley sea turtles have an average straight carapace length of 2.1 ft (65 cm). Females mature at 12 years of age. The average remigration is 2 years. Nesting occurs from April to July in large arribadas, primarily at Rancho Nuevo, Mexico. Females lay an average of 2.5 clutches per season. The annual average clutch size is 97 – 100 eggs per nest. The nesting location may be particularly important because hatchlings can more easily migrate to foraging grounds in deeper oceanic waters, where they remain for approximately 2 years before returning to nearshore coastal habitats. Juvenile Kemp's ridley sea turtles use these nearshore coastal habitats from April through November, but move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic coast) as water temperature drops. Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 ft (37 m) deep, although they can also be found in deeper offshore waters. As adults, Kemp's ridleys forage on swimming crabs, fish, jellyfish, mollusks, and tunicates.

3.3.2 Population Dynamics

Of the seven species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. From 1980 to 2003, the number of nests increased 15 percent annually. In 2009, an estimated 8,000 nesting females produced over 20,000 nests. In addition, a total of 911 nests were recorded on the Texas coast from 2002 – 2010.

3.3.3 Status

The Kemp's ridley was listed as endangered in response to a severe population decline, primarily the result of egg collection. In 1973, legal ordinances prohibited the harvest of sea turtles from May to August, and in 1990, the harvest of all sea turtles was prohibited by presidential decree. In 2002, Rancho Nuevo was declared a Sanctuary. A successful head-start program has resulted in the reestablishment of nesting at Texan beaches. While fisheries bycatch remains a threat, the use of turtle excluder devices mitigates take. Fishery interactions and strandings, possibly due to forced submergence, appear to be the main threats to the species. It is clear that the species is steadily increasing; however, the species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty. Therefore, its resilience to future perturbation is low.

3.3.4 Critical Habitat

On February 17, 2010, WildEarth Guardians, Santa Fe, New Mexico, submitted to USFWS and NMFS a petition to designate critical habitat for the Kemp's ridley sea turtle (available online at: http://www.nmfs.noaa.gov/pr/pdfs/petitions/kempsridley_criticalhabitat_feb2010.pdf). Critical habitat has not been designated for the species.

3.4 Olive Ridley Sea Turtle (Mexico's Pacific Coast Breeding Colonies)

The olive ridley sea turtle is a small, mainly pelagic, sea turtle with a circumtropical distribution. The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations on the Pacific coast of Mexico, and threatened wherever found except where listed as endangered (i.e., in all other areas throughout its range). We used information available in the 5-year review (NMFS and USFWS 2007d) to summarize the status of the endangered listing, as follows.

3.4.1 Life History

Olive ridley females mature at 10 – 18 years of age. They lay an average of two clutches per season (3-6 months in duration). The annual average clutch size is 100 – 110 eggs per nest. Olive ridleys commonly nest in successive years. Females nest in solitary or in arribadas, large aggregations coming ashore at the same time and location. As adults, Olive ridleys forage on crustaceans, fish, mollusks, and tunicates, primarily in pelagic habitats.

3.4.2 Population Dynamics

The eastern Pacific lineage is genetically and geographically isolated from other olive ridley lineages.

3.4.3 Status

Prior to 1950, abundance was conservatively estimated to be 10 million adults. Years of adult harvest reduced the population to just over one million adults by 1969. Shipboard transects along the Mexico and Central American coasts between 1992 and 2006 indicate an estimated 1.39 million adults. Based on the number of olive ridleys nesting in Mexico, populations appear to be increasing in one location (La Escobilla: from 50,000 nests in 1988 to more than one million in 2000) and stable at all others. Harvest prohibitions and the closure of a nearshore turtle fishery resulted in a partial recovery; however, remaining threats include Current bycatch in longline and trawl fisheries and the illegal harvest of eggs and turtles. Given its large population size, it is somewhat resilient to future perturbation.

3.4.4 Critical Habitat

No critical habitat has been designated for the olive ridley sea turtle.

3.5 Olive Ridley Sea Turtle (All Other Areas)

The olive ridley sea turtle is a small, mainly pelagic, sea turtle with a circumtropical distribution. The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations on the Pacific coast of Mexico, and threatened wherever found except where listed as endangered (i.e., in all other areas throughout its range). We used information available in the 5-year review (NMFS and USFWS 2007d) to summarize the status of the threatened listing, as follows.

3.5.1 Life History

See above (Olive ridley sea turtle, Mexico's Pacific coast breeding colonies).

3.5.2 Population Dynamics

Threatened olive ridley sea turtles nest in arribadas at a few beaches in the eastern Pacific, western Atlantic, and northern Indian Oceans. Solitary nesting is observed on many tropical beaches throughout the Atlantic, Pacific, and Indian Oceans. Arribadas now range in size from

335 to 2,000 nests in the western Atlantic, from 1,300 to 200,000 turtles in the eastern Pacific, and from 1,000 to 200,000 in the Indian Ocean.

3.5.3 Status

It is likely that solitary nesting locations once hosted large arribadas; since the 1960s, populations have experienced declines in abundance of 50 – 80 %. Many populations continue to decline. Olive ridley sea turtles continue to be harvested as eggs and adults, legally in some areas, and illegally in others. Incidental capture in fisheries is also a major threat. The olive ridley sea turtle is the most abundant sea turtle in the world; however, several populations are declining as a result of continued harvest and fisheries bycatch. Its large population size, however, allows some resilience to future perturbation.

3.5.4 Critical Habitat

No critical habitat has been designated for the olive ridley sea turtle.

3.6 Loggerhead Sea Turtle (North Pacific Ocean)

The loggerhead sea turtle is distinguished from other turtles by its large head and powerful jaws. The North Pacific Ocean DPS ranges throughout tropical to temperate waters in the North Pacific. The species was first listed as threatened under the Endangered Species Act in 1978 (43 FR 32800). In 2011, the North Pacific Ocean DPS was listed as endangered under the ESA (76 FR 58868). We used information available in the 2009 Status Review (Conant et al. 2009) and the final listing rule (76 FR 58868) to summarize the status of the species, as follows.

3.6.1 Life History

Mean age at first reproduction for female loggerhead sea turtles is 30 years (SD = 5). Females lay an average of three clutches per season. The annual average clutch size is 112 eggs per nest. The average remigration interval is 2.7 years. Nesting occurs primarily on Japanese beaches, where warm, humid sand temperatures incubate the eggs. Temperature determines the sex of the turtle during the middle of the incubation period. Turtles spend the post-hatchling stage in pelagic waters. The juvenile stage is spent first in the oceanic zone (Kuroshio Extension Bifurcation Region) and later in the neritic zone (i.e., coastal waters) in the eastern and central Pacific. Coastal waters in the eastern and western North Pacific provide important foraging habitat, inter-nesting habitat, and migratory habitat for adult loggerheads.

3.6.2 Population Dynamics

There are nine loggerhead DPSs, which are geographically separated and genetically isolated, as indicated by genetic, tagging, and telemetry data. The North Pacific DPS has a small nesting population. An 18-year time series of nesting data in Japan indicates a decline in the North Pacific population from 6,638 nests in 1990 to 2,064 nests in 1997. Since then, nesting has gradually increased to 7,000 – 8,000 nests, based on estimates taken in 2009).

3.6.3 Status

In the loggerhead sea turtle North Pacific Ocean DPS, historical evidence from Kamouda Beach indicates a substantial overall decline (50 – 90 percent) since 1950. Furthermore, population modeling in 2009 indicated that the North Pacific Ocean DPS appears to be declining, is at risk, and is thus likely to decline in the foreseeable future (Conant et al. 2009). The decline is a result of incidental capture in fishing gear, directed harvest, coastal development, increased human use of nesting beaches, and pollution. Coastal fisheries in Japan, the South China Sea, and Baja

California, Mexico are the biggest threat to the species. Drift gillnet fisheries in California and Oregon and the Hawaii-based longline fishery once took large numbers of loggerheads; however, seasonal and take-based closures have minimized the impact of these fisheries. The DPS remains at risk for extinction and its resilience to future perturbations is low.

3.6.4 Critical Habitat

No critical habitat has been designated for the North Pacific Ocean loggerhead sea turtle DPS.

3.7 Loggerhead Sea Turtle (Northwest Atlantic Ocean)

The loggerhead sea turtle is distinguished from other turtles by its large head and powerful jaws. The Northwest Atlantic Ocean DPS inhabits continental shelf and estuarine environments throughout tropical and temperate waters in the North Atlantic to 40˚ W. The species was first listed as threatened under the Endangered Species Act in 1978 (43 FR 32800). In 2011, the Northwest Atlantic Ocean DPS was listed as threatened under the ESA (76 FR 58868). We used information available in the 2009 Status Review (Conant et al. 2009) and the final listing rule (76 FR 58868) to summarize the status of the species, as follows.

3.7.1 Life History

Adult loggerhead sea turtles have a mean straight carapace length of 3 ft (92 cm). Mean age at first reproduction for female loggerhead sea turtles is 30 years (SD = 5). Mating occurs in the spring, and eggs are laid throughout the summer. Northwest Atlantic females lay an average of five clutches per season. The annual average clutch size is 115 eggs per nest. The average remigration interval is 3.7 years (Tucker 2010). Nesting occurs primarily on beaches along the southeastern coast of the United States, from southern Virginia to Alabama. Additional nesting occurs on beaches throughout the Gulf of Mexico and Caribbean Sea. Temperature determines the sex of the turtle during the middle of the incubation period. Post- hatchling loggerheads from southeast U.S. nesting beaches may linger for months in waters just off the nesting beach or become transported by ocean currents within the Gulf of Mexico and North Atlantic, where they become associated with Sargassum habitats, driftlines, and other convergence zones. The juvenile stage is spent first in the oceanic zone (e.g., waters around the Azores, Madeira, Morocco, and the Grand Banks off Newfoundland) and later in the neritic zone (i.e., continental shelf waters) from Cape Cod Bay, Massachusetts, south through Florida, the Caribbean, and the Gulf of Mexico. Neritic stage juveniles often inhabit relatively enclosed, shallow water estuarine habitats with limited ocean access. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish and vegetation at or near the surface (Dodd 1988). Adults inhabit shallow water habitats with large expanses of open ocean access, as well as continental shelf waters. Sub-adult and adult loggerheads prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom, coastal habitats.

3.7.2 Population Dynamics

There are nine loggerhead DPSs, which are geographically separated and genetically isolated, as indicated by genetic, tagging, and telemetry data. The Northwest Atlantic Ocean DPS is further divided into five recovery units or nesting subpopulations: Northern, Peninsular Florida, Dry Tortugas, Northern Gulf of Mexico, and Greater Caribbean. Using a stage/age demographic model, the adult female population size of the DPS is estimated at 20,000 – 40,000 females (NMFS 2009a). Peninsular Florida hosts more than 10,000 females nesting annually, which constitutes 87 percent of all nesting effort in the DPS. A 23 percent increase in nest counts from

1989 until 1998 was followed by a sharp decline in the subsequent decade (http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trends/); large fluctuations in population size often indicate the loss of resilience and susceptibility to population collapse (Dai et al. 2012, Scheffer et al. 2012). Nesting aggregations from Georgia to North Carolina host 1,000 to 9,999 females nesting annually. The other recovery units are much smaller but are still considered essential to the continued existence of the species.

3.7.3 Status

The loggerhead sea turtle Northwest Atlantic Ocean DPS was listed as threatened under the ESA as a result of bycatch mortality, resulting from domestic and international commercial fishing, particularly in gillnet, longline, and trawl fisheries. Turtle excluder devices on shrimp trawlers and the use of circle hooks in the longline fishery have reduced bycatch significantly; however bycatch remains the most significant threat to the DPS. The rangewide nesting trend of the DPS from 1989 until 2010 is slightly negative but not significantly different from zero. We conclude that, as a result of its relatively large abundance (20,000 – 40,000 females), the DPS is not currently at risk of extinction; however, its large fluctuations in population size indicates loss of resilience, such that it is likely to become endangered within the foreseeable future.

3.7.4 Critical Habitat

On July 18, 2013, NMFS proposed critical habitat for the Northwest Atlantic Ocean loggerhead DPS within the Atlantic Ocean and the Gulf of Mexico. Specific areas proposed for designation include 36 occupied marine areas within the range of the Northwest Atlantic Ocean DPS. These areas contain one or a combination of nearshore reproductive habitat, winter area, breeding areas, and migratory corridors. They also asked for comments on whether to include as critical habitat in the final rule some areas that contain foraging habitat and two large areas that contain Sargassum habitat.

3.8 Green Sea Turtle (All Other Areas)

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 lb (159 kg) and a straight carapace length of greater than 3.3 ft (1 m). It has a circumglobal distribution, occurring throughout nearshore tropical, subtropical, and, to a lesser extent, temperate waters. The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico, and threatened in all other areas throughout its range. On August 1, 2012, NMFS found that a petition to identify the Hawaiian population of green turtle as a DPS, and to delist the DPS, may be warranted (77 FR 45571). We used information available in the 2007 5-Year Review (NMFS and USFWS 2007a) to summarize the status of the species, as follows.

3.8.1 Life History

Age at first reproduction for females is 20 - 40 years. They lay an average of three nests per season with an average of 100 eggs per nest. The remigration interval (i.e., return to natal beaches) is 2 – 5 years. Nesting occurs primarily on beaches with intact dune structure, native vegetation, and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges, and other invertebrate prey.

3.8.2 Population Dynamics

Nesting data at 46 sites from 1990-2006 indicate that 108,761 to 150,521 females nest each year. At the 23 sites for which nesting trend data are available, ten are increasing, nine are stable, and four are decreasing. Where long term data ($\geq$ 20 years) are available (nine sites), nesting populations are stable or increasing in abundance. Nesting populations are doing relatively well in the Pacific, Western Atlantic, and Central Atlantic Ocean; whereas, populations are doing poorly in Southeast Asia, Eastern Indian Ocean, and Mediterranean.

3.8.3 Status

Once abundant in tropical and subtropical waters, globally, green sea turtles exist at a fraction of their historical abundance, as a result of over-exploitation. Egg harvest, the harvest of females on nesting beaches, and directed hunting of turtles in foraging areas remain the three greatest threats to their recovery. In addition, bycatch in drift-net, long-line, set-net, pound-net, and trawl fisheries kill thousands of green sea turtles annually. Increasing coastal development (including construction, beach erosion and renourishment, and artificial lighting) threatens nesting success and hatchling survival. Apparent increases in recent years are optimistic but must be viewed cautiously, as the datasets represent a fraction of a green sea turtle generation, up to 50 years. While the threats of harvest, coastal development, and fisheries bycatch continue, the species appears to be somewhat resilient to future perturbations.

3.8.4 Critical Habitat

On September 2, 1998, NMFS designated critical habitat for green sea turtles (63 FR 46694), which include coastal waters surrounding Culebra Island, Puerto Rico. Seagrass beds surrounding Culebra provide important foraging resources for juvenile, subadult, and adult green sea turtles. Additionally, coral reefs surrounding the island provide resting shelter and protection from predators. This area provides important developmental habitat for the species.

3.9 Green Sea Turtle (Florida and Mexico's Pacific Coast Breeding Colonies)

As described above, the green sea turtle was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico, and threatened in all other areas throughout its range. We used information available in the 2007 5-Year Review (NMFS and USFWS 2007a) to summarize the status of the species, as follows.

3.9.1 Life History

See above, except in Florida, nests contain an average of 136 eggs and the average remigration interval is 2 years. In addition to nesting on Florida beaches, green sea turtles are found in coastal waters throughout the state. Important neritic habitats include: Mosquito and Indian River Lagoons, Port Canaveral, St. Lucie Inlet, and Biscayne Bay.

3.9.2 Population Dynamics

Along the central and southeast coast of Florida, an estimated 200 – 1,100 females nest each year (Meylan et al. 1994, Weishampel et al. 2003). According to data collected from Florida's index nesting beach survey from 1989-2012, green sea turtle nest counts across Florida have increased approximately ten-fold from a low of 267 in the early 1990s to a high of 10,701 in 2011. In the Pacific Mexico, surveys from 2000 to 2006 indicate an average of 6,050 nests, and a 25-year dataset reveals an increasing trend for the largest nesting site (Colola).

3.9.3 Status

The historic and current threats for the Florida and Mexico's Pacific coast breeding populations are the same as described above for all other areas. Recent increases in nesting on Florida beaches are likely a result of a Florida statute prohibiting the killing of green sea turtles, ESA listing, the 1994 Florida State ban on gillnets and other entangling nets, CITES Appendix I listing, and turtle protections in other nations. Recent increases in the Mexican breeding populations are likely the result of nesting beach protection (1979) and a 1990 presidential decree protecting all sea turtles. However, the threats of harvest, coastal development, and fisheries bycatch continue. The populations' resilience to future perturbations is low but increasing with population size increases.

3.9.4 Critical Habitat

No critical habitat has been designated for the green sea turtle along Florida and Mexico's Pacific Coast.

4 Salmonids

Since 1997 NMFS promulgated a total of 29 limits to the ESA section 9(a) take prohibitions for 21 threatened Pacific salmon and steelhead Evolutionarily Significant Units (ESUs) or Distinct Population Segments (DPSs) (62 FR 38479, July 18, 1997; 65 FR 42422, July 10, 2000; 65 FR 42485, July 10, 2000; 67 FR 1116, January 9, 2002; 73 FR 7816, February 11, 2008). On June 28, 2005, as part of the final listing determinations for 16 ESUs of West Coast salmon, NMFS amended and streamlined the 4(d) protective regulations for threatened salmon and steelhead (70 FR 37160). NMFS took this action to provide appropriate flexibility to ensure that fisheries and artificial propagation programs are managed consistently with the conservation needs of threatened salmon and steelhead. Under this change, the section 4(d) protections apply to natural and hatchery fish with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed prior to release into the wild.

4.1 Atlantic Salmon (Gulf of Maine DPS)

The three generally recognized groups of Atlantic salmon (North American, European, and Baltic) range from northeastern North America through portions of the North Atlantic Ocean to Europe and northwestern Russia in both fresh and saltwater habitats. The North American group historically ranged from northern Quebec southeast to Newfoundland and southwest to Long Island Sound. It included Canadian populations and U.S. populations, including the listed Gulf of Maine (GOM) DPS. The GOM DPS was first listed as endangered by the USFWS and NMFS on November 17, 2000 (65 FR 69459). The listing was refined by the Services on June 19, 2009 (74 FR 29344) to include all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, and wherever these fish occur in the estuarine and marine environment. We used information available in the 2006 Status Review (Fay et al. 2006) and the Final Rule to List the Expanded Gulf of Maine DPS as Endangered Under the ESA (74 FR 29344) to summarize the status of the GOM DPS, as follows.

4.1.1 Life History

Adult Atlantic salmon typically spawn in early November and juveniles spend approximately two years feeding on small invertebrates and occasionally small vertebrates in freshwater until they weigh approximately two ounces and are six inches in length. Smoltification (the physiological and behavioral changes required for the transition to salt water) usually occurs at age two for the GOM DPS. The GOM DPS migrates more than 4,000 km in the open ocean to reach feeding areas in the Davis Strait between Labrador and Greenland. Adult salmon feed opportunistically and their diet is composed primarily of other fish. The majority of GOM DPS salmon (about 90 percent) spend two winters at sea before reaching maturity and returning to their natal rivers, with the remainder spending one or three winters at sea. At maturity, GOM DPS salmon typically weigh between eight to 15 pounds and average 30 inches in length.

4.1.2 Population Dynamics

Historically, the GOM DPS population was several orders of magnitude larger than contemporary populations. Foster and Atkins (1869) estimated that roughly 100,000 adult salmon returned to the Penobscot River alone before the river was dammed, whereas estimates of abundance for the entire GOM DPS exceeded 5,000 individuals in only four years from 1967 to 2007. From 2001 to 2007, abundance has been estimated between 819 (in 2002) and 1,416 (in 2004) individuals. Abundance was estimated at 1,014 individuals in 2007, the most recent year for which abundance records are available.

4.1.3 Status

The GOM DPS of Atlantic salmon was listed as endangered in 2000 in response to population decline caused by many factors, including overexploitation, degradation of water quality, and damming of rivers, all of which remain persistent threats. Atlantic salmon in the GOM DPS currently exhibit critically low spawner abundance, poor marine survival, and are still confronted with a variety of threats, including: poor water quality, land and water use practices, habitat loss, predation, incidental capture and poaching, genetic threats from hatchery programs, and climate change. The abundance of Atlantic salmon in the GOM DPS has been low and, in general, has been in decline over the past several decades. The proportion of fish of natural origin to hatchery-reared fish is very small (approximately 10 percent) and is continuing to decline. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels, but has not contributed to an increase in the overall abundance of salmon and has not been able to halt the decline of the naturally reared component of the GOM DPS. The 2006 status review reports an estimated extinction risk of 19 to 75 percent within the next 100 years for the GOM DPS, even when current levels of hatchery supplementation are considered. Even with current conservation efforts, returns of adult Atlantic salmon to the GOM DPS rivers remain extremely low. Based on the information above, the species would likely have a low resilience to additional perturbations.

4.1.4 Critical Habitat

On June 19, 2009, NMFS and the USFWS defined critical habitat for Atlantic salmon (74 FR 29300). The critical habitat includes all anadromous Atlantic salmon streams whose freshwater range occurs in watersheds from the Androscoggin River northward along the Maine coast northeastward to the Dennys River, and wherever these fish occur in the estuarine and marine environment. PCEs were identified within freshwater and estuarine habitats of the occupied range of the GOM DPS and include sites for spawning and incubation, juvenile rearing, and migration. Critical habitat and PCEs were not designated within marine environments because of the limited knowledge of the physical and biological features that the species uses during the marine phase of its life.

4.2 Chinook Salmon (General Overview)

We discuss the distribution, life history, population dynamics, status, and critical habitats of the nine species (here we use the word "species" to apply to distinct population segments, DPSs, and evolutionary significant units, ESUs) separately; however, because listed Chinook salmon species are virtually indistinguishable in the wild and comprise the same biological species, we begin this section describing characteristics common across ESUs. We used information available in status reviews (Good et al. 2005, Ford 2011), various salmon ESU listing documents, and biological opinions (NMFS 2012b) to summarize the status of the species.

Chinook salmon are the largest of the Pacific salmon and historically ranged from the Ventura River in California to Point Hope, Alaska in North America, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia in both fresh and saltwater habitats (Healey 1991). In freshwater, Chinook salmon prefer streams that are deeper and larger than those used by other Pacific salmon species.

4.2.1 Life History

Chinook salmon exhibit varied and complex life history strategies and can generally be described as one of two types: "stream-type" or "ocean type". Stream-type Chinook salmon ESUs reside in freshwater for a year or more following emergence before migrating to salt water; ocean-type Chinook salmon ESUs migrate to the ocean within their first year and typifies populations north of 56°N (Healey 1991). Stream-type ESUs usually return in late winter and early spring (spring-run) as immature adults and reside in deep pools during summer before spawning in fall. Ocean-type ESUs migrate to the ocean within their first year (sub-yearlings) and usually return as full mature adults in fall (fall-run) and spawn soon after river entry. Temperature and stream flow can significantly influence the timing of migrations and spawning, as well as the selection of spawning habitat (Geist et al. 2009, Hatten and Tiffan. 2009). All Chinook salmon are semelparous (i.e. they die after spawning).

The timing of return to fresh water, and ultimately spawning, often provides a temporal isolating mechanism for populations with different life histories. Return timing is often related to spawning location. Thus, differences in the timing of spawning migration also serve as a geographic isolating mechanism. Fall-run Chinook salmon generally spawn in the mainstem of larger rivers and are less dependent on flow, although early autumn rains and a drop in water temperature often provide cues for movements to spawning areas. Spring-run Chinook salmon take advantage of high flows from snowmelt to access the upper reaches of rivers.

Generally, Chinook salmon outmigrants (smolts) are about two to five inches long when they enter saline (often brackish) waters. The process of smoltification enables salmon to adapt to the ocean environment. Several factors can affect smoltification process, not only at the interface between fresh water and salt water, but higher in the watershed as the process of transformation begins long before fish enter salt waters. These factors include exposure to chemicals such as heavy metals and elevated water temperatures (Wedemeyer et al. 1980).

Chinook salmon feed on a variety of prey organisms depending upon life stage. In freshwater and brackish waters Chinook salmon primarily feed on small invertebrates and vertebrates. The diet of juvenile Chinook salmon in the ocean off Oregon and Washington is comprised primarily of juvenile fishes (cottids, pleuronectids, rockfishes, sandlance, smelts, anchovies, and sardines) as well as euphausiids (Emmett et al. 2006, Daly et al. 2012)). Adult Chinook salmon eat larger life stages of the same types of forage fishes during their oceanic life stage.

4.2.2 Population Dynamics

The population dynamics of each Chinook salmon ESU will be discussed separately, below.

4.2.3 Status

On June 28, 2005, as part of the final listing determinations for 16 ESUs of West Coast salmon, NMFS amended and streamlined the 4(d) protective regulations for threatened salmon and steelhead (70 FR 37160) as described in the *Protective Regulations for Threatened Salmonid Species* section of this document. Under this change, the section 4(d) protections apply to natural and hatchery fish with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed prior to release into the wild.

4.2.4 Critical Habitat

Areas designated as critical habitat are important for the species' overall conservation by protecting quality growth, reproduction, and feeding. At the time of designation, primary constituent elements (PCEs) are identified and include sites necessary to support one or more Chinook salmon life stage(s). These PCEs will be identified for each ESU below, but in general they may include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat, and estuarine areas. Physical or biological features that characterize these sites will also be discussed for each ESU separately, but they may include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. The critical habitat designation identified for each ESU contains additional details on the areas included as part of the designation, and the areas that were excluded from designation.

4.3 Chinook Salmon (California Coastal ESU)

The California Coastal Chinook salmon ESU includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River to the Russian River, California. Seven artificial propagation programs were included in the ESU, however on June 26, 2013, NMFS proposed to remove the artificial propagation programs from the ESU because the artificial propagation programs have been terminated (78 FR 38270). We used information available in the status review (Good et al. 2005), "An analysis of historical population structure for evolutionarily significant units of Chinook salmon, coho salmon, and steelhead in the North-Central California Coast Recovery Domain" (Bjorkstedt et al. 2005), "A framework for assessing the viability of Threatened and Endangered Salmon and Steelhead in the North-central California Coast Recovery Domain" (Spence et al. 2008), listing documents (64 FR 50393; 70 FR 37160), and previously issued biological opinions (NMFS 2008a, 2012b) to summarize the status of the species.

4.3.1 Life History

California Coastal Chinook salmon are a fall-run, ocean-type salmon. A spring-run (river-type) component existed historically, but is now considered extinct (Bjorkstedt et al. 2005). The different populations vary in run timing depending on latitude and hydrological differences between watersheds. Entry of California Coastal Chinook salmon into the Russian River depends on increased flow from fall storms, usually in November to January. Juveniles of this ESU migrate downstream from April through June and may reside in the estuary for an extended period before entering the ocean.

4.3.2 Population Dynamics

Historical estimates of escapement, based on professional opinion and evaluation of habitat conditions, suggest abundance was roughly 73,000 in the early 1960s with the majority of fish spawning in the Eel River. Comparison of historical and current abundance information indicates that independent populations of Chinook salmon are depressed in many basins (Bennett 2005). All spring-run populations once occupying the North Mountain Interior are considered extinct or nearly so. Redd counts in Mattole River in the northern portion of the ESU indicate a small but consistent population; the cooler northern climate likely provides for favorable conditions for these populations. The Eel River interior fall-run populations are severely depressed. Two functionally independent populations are believed to have existed along the southern coastal portion of the ESU; of these two, only the Russian River currently has a run of any significance. This is also the only population with abundance time series. The 2000 to 2007 median observed (at Mirabel Dam) Russian River Chinook salmon run size is 2,991 with a maximum of 6,103 (2003) and a minimum of 1,125 (2008) adults (Cook 2008, Sonoma County Water Agency 2008). The number of spawners has steadily decreased since its high returns in 2003 with 1,963 fish observed in 2007 and 1,125 observed by December 22, 2008.

4.3.3 Status

NMFS listed California Coastal Chinook salmon as threatened on September 16, 1999 (64 FR 50393) and reaffirmed their threatened status on June 28, 2005 (70 FR 37160). California Coastal Chinook salmon was listed due to the combined effect of dams that prevent them from reaching spawning habitat, logging, agricultural activities, urbanization, and water withdrawals in the river drainages that support them. This ESU is at considerable risk from population fragmentation and reduced spatial diversity. There is little connectivity between the southern and northern portions of their range. At the southern portion of the ESU, only the Russian River population has had a constant run that exceeded 1,000 adult spawning fish over the last 10 years. This places the ESU at risk from random catastrophic events, chronic stressors, and long-term environmental change. Life history diversity has been significantly reduced by loss of the spring-run race and reduction in coastal populations. Based on these factors, this ESU would likely have a low resilience to additional perturbations.

4.3.4 Critical Habitat

NMFS designated critical habitat for California Coastal Chinook salmon on September 2, 2005 (70 FR 52488). Specific geographic areas designated include the following CALWATER hydrological units: Redwood Creek, Trinidad, Mad River, Eureka Plain, Eel River, Cape Mendocino, Mendocino Coast and the Russian River. PCEs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. The spawning PCE in coastal streams is degraded by years of timber harvest that has produced large amounts of sand and silt in spawning gravel and reduced water quality by increased turbidity. Agriculture and urban areas have impacted rearing and migration PCEs in the Russian River by degrading water quality and by disconnecting the river from it floodplains by the construction of levees. Water management from dams within the Russian and Eel River watersheds maintain high flows and warm water during summer which benefits the introduced predatory Sacramento pikeminnow, which has resulted in excessive predation along migration corridors. Breaches of the sandbar at the mouth of the Russian River result in periodic mixing of salt water which degrades the estuary PCE by altering water quality and salinity conditions that support juvenile physiological transitions between fresh- and salt water. The current condition of PCEs for this ESU indicates that they are not currently functioning or are degraded; these conditions are likely to maintain low population abundances across the ESU.

4.4 Chinook Salmon (Central Valley Spring-run ESU)

The Central Valley spring-run Chinook salmon ESU includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California. Central Valley spring-run Chinook salmon have been extirpated from the San Joaquin River and its tributaries and the American River due to the construction of Friant and Folsom dams, respectively. Naturally spawning populations of Central Valley spring-run Chinook salmon currently are restricted to accessible reaches of the upper Sacramento River, and its tributaries Butte, Deer, and Mill Creeks and limited spawning occurs in the basins of smaller tributaries (California Department of Fish and Game 1998). This ESU includes one artificial propagation program. We used information available in the status review (Good et al. 2005), listing documents (64 FR 50393; 70 FR 37160), the draft recovery plan (NMFS 2009c) and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.4.1 Life History

The Chinook Central Valley ESU is a spring-run, ocean-type salmon. This ESU returns to the Sacramento River between March and July and spawning occurs from late August to early October, with a peak in September. Juveniles of this ESU require cool freshwater while they mature over the summer.

4.4.2 Population Dynamics

The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 700,000 fish between the late 1880s and the 1940s (Fisher 1994), although these estimates may reflect an already declining population, in part from the commercial gillnet fishery that occurred for this ESU. Median natural production of spring-run Chinook salmon from 1970 to 1989 was 30,220 fish. In the 1990s, the population experienced a substantial production failure with an estimated natural production ranging between 3,863 and 7,806 fish (with the exception of 1995 which had a natural production of an estimated 35,640 adults) during the years between 1991 and 1997. Numbers of naturally produced fish increased significantly in 1998 to an estimated 48,755 adults and estimated natural production has remained above 10,000 fish since then (USFWS and U.S. Bureau of Reclamation 2007).

The Sacramento River trends show long- and short- term negative trend and negative population growth. Meanwhile, the median production of Sacramento River tributary populations increased from a low of 4,248 with only one year exceeding 10,000 fish before 1998 to a combined natural production of more than 10,000 spring-run Chinook in all years after 1998 (USFWS and U.S. Bureau of Reclamation 2007). Time series data for Mill, Deer, Butte, and Big Chico Creeks spring-run Chinook salmon (through 2006) indicate that all three tributary spring-run Chinook populations experienced population growth. Although the populations are small, Central Valley spring-run Chinook salmon have some of the highest population growth rates of Chinook salmon in the Central Valley.

4.4.3 Status

NMFS originally listed Central Valley spring-run Chinook salmon as threatened on September 16, 1999 (64 FR 50393), and reaffirmed their status on June 28, 2005 (70 FR 37160). This species was listed due to loss of historical spawning habitat, degradation of remaining habitat, and threats to genetic diversity from hatchery salmon. Risks persist to the spatial structure and diversity of the ESU. Only three extant independent populations exist, and they are especially vulnerable to disease or catastrophic events because they are in close proximity. In addition, until there are means to spatially separate the spring-run and fall-run populations in the lower basin of the Feather River, some level of genetic introgression of the races is expected to continue. Based on these factors, this ESU would likely have a low resilience to additional perturbations.

4.4.4 Critical Habitat

NMFS designated critical habitat for Central Valley spring-run Chinook salmon on September 2, 2005 (70 FR 52488). In total, Central Valley spring-run Chinook salmon occupy 37 watersheds (freshwater and estuarine). The total area of habitat designated as critical includes about 1,100 miles of stream habitat and about 250 square miles of estuarine habitat in the San Francisco-San Pablo-Suisun Bay complex. PCEs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Spawning and rearing PCEs are degraded by high water temperature caused by the loss of access to historic spawning areas in the upper watersheds which maintained cool and clean water throughout the summer. The rearing PCE is degraded by floodplain habitat being disconnected from the mainstem of larger rivers throughout the Sacramento River watershed, thereby reducing effective foraging. The migration PCE is degraded by lack of natural cover along the migration corridors. Juvenile migration is obstructed by water diversions along Sacramento River and by two large state and federal water-export facilities in the Sacramento-San Joaquin Delta. Contaminants from agriculture and urban areas have degraded rearing and migration PCEs to the extent that they have lost their functions necessary to serve their intended role to conserve the species. Water quality impairments in the designated critical habitat of this ESU include inputs from fertilizers, insecticides, fungicides, herbicides, surfactants, heavy metals, petroleum products, animal and human sewage, sediment in the form of turbidity, and other anthropogenic pollutants. Pollutants enter the surface waters and riverine sediments as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. The current condition of PCEs for this ESU indicates they are not currently functioning or are degraded; these conditions are likely to maintain low population abundances across the ESU.

4.5 Chinook Salmon (Lower Columbia River ESU)

This Chinook salmon ESU includes all naturally spawned populations of Chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon, east of the Hood River and the White Salmon River, and includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River. Twenty artificial propagation programs are included in the ESU (70 FR 37160; 76 FR 50448). We used information available in status reviews (Good et al. 2005, Ford 2011, NMFS 2011d), "Historical population structure of Pacific salmonids in the Willamette River and Lower Columbia River Basins" (Myers et al. 2006), the recovery plan (NMFS 2013c), listing documents (64 FR 14308; 70 FR 37160), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.5.1 Life History

Lower Columbia River Chinook salmon have three life history types: early fall run, ocean-type ("tule" salmon); late fall run, stream-type ("bright" salmon); and spring-run, stream-type. Presently, the fall-runs are the predominant life history types, though spring-run Lower Columbia River Chinook salmon were numerous historically.

Both fall-runs of Lower Columbia River Chinook salmon enter fresh water from August through October to spawn in large river mainstems; however, the bright salmon has a delayed entry to spawning grounds and resides in the river for a longer time between river entry and spawning. Tule salmon spawn from late September to November, with peak spawning activity in mid-October and brights spawn from November to January, with peak spawning in mid-November. Most tule salmon remain at sea from one to five years (more commonly three to five years) and return to spawn at two to six years of age. Brights return to fresh water predominately as three- and four-year-olds.

Spring-run Chinook salmon enter fresh water in March through June to spawn in upstream tributaries in August and September. The spring-run Chinook salmon migrates to the sea as yearlings, typically in spring, though some may over-winter in the mainstem Columbia River before outmigrating (Lower Columbia Fish Recovery Board 2010). The natural timing of Lower Columbia River spring-run Chinook salmon emigration is obscured by hatchery releases. Most remain at sea from one to five years (more commonly two to four years) and return to spawn at three to six years of age (Lower Columbia Fish Recovery Board 2010).

4.5.2 Population Dynamics

It is estimated that 31 independent Chinook salmon populations (22 fall- and late fall-runs and nine spring- runs) existed historically in the Lower Columbia River. Of those 31 populations, it is estimated that that eight to 10 historical populations have been extirpated, most of them spring-run populations. Historically, the number of spring-run Chinook salmon returning to the Lower Columbia River may have almost equaled that of fall-run Chinook salmon. However, the majority of spring-run LCR Chinook salmon populations are now extirpated and total returns are substantially lower for the fall-run component in recent years.

Historical records of Chinook salmon abundance are sparse. However, cannery records suggest a peak run of 4.6 million fish (43 million lbs) in 1883 (Lichatowich 1999). Recent trend indicators for most populations are negative. The majority of populations for which data are available have a long-term population growth trend of less than one; indicating the population is not replacing itself and is in decline (Bennett 2005). Only the late-fall run population in Lewis River has an abundance and population trend that may be considered viable. The Sandy River is the only stream system supporting measurable natural production of spring-run Chinook salmon;

however, the population is at risk from low abundance and negative to low population growth rates (productivity) (McElhany et al. 2007).

4.5.3 Status

NMFS listed Lower Columbia River Chinook salmon as threatened on March 24, 1999 (64 FR 14308) and reaffirmed their threatened status on June 28, 2005 (70 FR 37160). This ESU was listed due to the combined effect of dams that reduce access to spawning habitat, logging, agricultural activities, urbanization, threats to genetic diversity from hatchery salmon, and overexploitation. Though the basin-wide spatial structure has remained generally intact, the loss of about 35 percent of historical habitat has affected distribution within several Columbia River subbasins. The ESU is at risk from generally low abundances in all but one population, combined with most populations having a negative or stagnant long-term population growth. Though fish from conservation hatcheries do help to sustain several LCR Chinook salmon runs in the short-term, hatchery production is unlikely to result in sustainable wild populations in the long-term. Further, the genetic diversity of all populations (except the late fall-run) has been eroded by large hatchery influences. Having only one population that may be viable puts the ESU at considerable risk from environmental stochasticity and random catastrophic events. The near-loss of the spring-run life history type limits the ESU's ability to maintain its fitness in the face of environmental change. Based on these factors, this ESU would likely have a moderate (late fall-run salmon in Lewis River) to low (all other populations) resilience to additional perturbations.

4.5.4 Critical Habitat

NMFS designated critical habitat for LCR Chinook salmon on September 2, 2005 (70 FR 52630). It includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Hood Rivers as well as specific stream reaches in a number of tributary subbasins. PCEs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Timber harvest, agriculture, and urbanization have degraded spawning and rearing PCEs by reducing floodplain connectivity and water quality, and by removing natural cover in several rivers. Hydropower development projects have reduced timing and magnitude of water flows, thereby altering the water quantity needed to form and maintain physical habitat conditions and support juvenile growth and mobility. Adult and juvenile migration PCEs are affected by several dams along the migration route.

4.6 Chinook Salmon (Upper Columbia River Spring-run ESU)

The Upper Columbia River spring-run Chinook salmon ESU includes all naturally spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River. Six artificial propagation programs are part of this ESU. We used information available in status reviews (Good et al. 2005, Ford 2011, NMFS 2011m), listing documents (63 FR 11482; 64 FR 14308; 70 FR 37160), the recovery plan (Upper Columbia Salmon Recovery Board 2007), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.6.1 Life History

Upper Columbia River spring-run salmon are a stream-type salmon. Salmon in this ESU return to the upper Columbia tributaries from April through July, with the run peaking in mid-May. Spawning occurs in the late summer, peaking in mid- to late August. Juvenile spring-run Chinook salmon spend a year in fresh water before emigrating to salt water in the spring of their second year. Most returning adults are four- and five-year-old fish that have spent two and three years at sea, respectively.

4.6.2 Population Dynamics

The ESU historically consisted of four populations; of these, one is now extinct. Spawning escapements have declined within all extant populations (in Wenatchee, Entiat, and Methow rivers) since 1958. In the most recent five-year geometric mean (1997 to 2001), spawning escapement for naturally produced fish was 273 for the Wenatchee population, 65 for the Entiat population, and 282 for the Methow population, only eight to 15 percent of the minimum abundance thresholds, though escapement did increase substantially in 2000 and 2001 in all three river systems. Based on 1980 to 2004 returns, the average annual growth rate for this ESU is estimated at 0.93 (meaning the population is not replacing itself) (Fisher and Hinrichsen 2006). Assuming that population growth rates were to continue at 1980 to 2004 levels, Upper Columbia River spring-run Chinook salmon populations are projected to have very high probabilities of decline within 50 years.

4.6.3 Status

NMFS listed Upper Columbia River Spring-run Chinook salmon as endangered on March 24, 1999 (64 FR 14308), and reaffirmed their endangered status on June 28, 2005 (70 FR 37160). The ESU was listed due to the combined effects of dams that prevent them from reaching spawning habitat; habitat degradation from irrigation diversions, hydroelectric development, livestock grazing, and urbanization; and reduced genetic diversity from artificial propagation efforts. The Interior Columbia Basin Technical Review Team characterizes the spatial structure risk to Upper Columbia River Spring-run Chinook populations as “low” or “moderate” and the diversity risk as “high” (Interior Columbia Technical Review Team 2008a, b, c). The high risk is a result of reduced genetic diversity from homogenization of populations that occurred under the Grand Coulee Fish Maintenance Project in 1939 to 1943. Abundance data showed an increase in spawner returns in 2000 and 2001, though this increase was not sustained in subsequent years. Population viability analyses for this species (using the Dennis Model) suggest that these Chinook salmon face a significant risk of extinction: a 75 to 100 percent probability of extinction within 100 years (given return rates for 1980 to present). Based on these factors, this ESU would likely have a very low resilience to additional perturbations.

4.6.4 Critical Habitat

NMFS designated critical habitat for Upper Columbia River spring-run Chinook salmon on September 2, 2005 (70 FR 52630). The designation includes all Columbia River estuaries and river reaches upstream to Chief Joseph Dam and several tributary subbasins. PCEs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Spawning and rearing PCEs are somewhat degraded in tributary systems by urbanization, grazing, irrigation, and diversion. These activities have resulted in excess erosion of fine sediment and silt that smother spawning gravel and reduction in flow necessary for successful incubation, formation of physical rearing conditions, and juvenile mobility. Moreover siltation further affects critical habitat by reducing water quality through contaminated agricultural runoff; and removing natural cover. Adult and juvenile migration PCEs are heavily degraded by Columbia River Federal dam projects and a number of mid-Columbia River Public Utility District dam projects also obstruct the migration corridor.

4.7 Chinook Salmon (Puget Sound ESU)

The Puget Sound Chinook salmon ESU includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound from the North Fork Nooksack River to the Elwha River on the Olympic Peninsula in Washington. Thirty-six hatchery populations were included as part of the ESU and five were considered essential for recovery and listed (spring-run salmon from Kendall Creek, North Fork Stillaguamish River, White River, and Dungeness River, and fall-run salmon from the Elwha River). On June 26, 2013, NMFS proposed to change the number of artificial propagation considered to be part of the ESU to 27 (78 FR 38270). We used information available in the status review (Good et al. 2005), "Independent populations of Chinook salmon in Puget Sound" (Ruckelshaus et al. 2006), listing documents (63 FR 11482; 64 FR 14308; 70 FR 37160), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.7.1 Life History

Chinook salmon in this area generally have an "ocean-type" life history. Puget Sound populations include both early-returning (August) and late-returning (mid-September to October) Chinook salmon spawners (Healey 1991). However, within these generalized life histories, significant variation occurs in residence time in fresh water and estuarine environments. For example, Hayman et al. (1996) described three juvenile Chinook salmon life histories with varying residency times in the Skagit River system in northern Puget Sound. Puget Sound Chinook salmon generally return to freshwater habitats as three- to four-year-olds.

4.7.2 Population Dynamics

This ESU has lost 16 spawning aggregations (nine from the early fall-run type) that were either independent historical populations or major components of the remaining 22 existing independent historical populations identified. The disproportionate loss of early-run life history diversity represents a significant loss of the evolutionary legacy of the historical ESU. Estimates of the historic abundance range from 1,700 to 51,000 potential Puget Sound Chinook salmon spawners per population. During the period from 1996 to 2001, the geometric mean of natural spawners in populations of Puget Sound Chinook salmon ranged from 222 to just over 9,489 fish. Long-term trends in abundance and median population growth rates for naturally spawning populations indicate that approximately half of the populations are declining and the other half are increasing in abundance over the length of available time series. However, the median overall long-term trend in abundance indicates that most of these populations are barely replacing themselves. Eight of 22 populations are declining over the short-term, compared to 11 or 12 populations that have long-term declines. Populations with the greatest long-term population growth rates are the North Fork Nooksack and White rivers.

4.7.3 Status

NMFS listed Puget Sound Chinook salmon as threatened in 1999 (64 FR 14308) and reaffirmed its status as threatened on June 28, 2005 (70 FR 37160). The ESU was listed due to habitat loss and degradation from the combined effects of damming, forest practices, agricultural practices, and urbanization; reduced genetic diversity from artificial propagation efforts; and overharvest. The spatial structure of the ESU is compromised by extinct and weak populations being disproportionably distributed to the mid- to southern Puget Sound and the Strait of Juan de Fuca. A large portion (at least 11) of the extant runs is sustained, in part, through artificial propagation. Of the populations with greater than 1,000 natural spawners, only two have a low fraction of hatchery fish. This places the ESU at risk from random catastrophic events, chronic stressors, and long-term environmental change. Life history diversity has been significantly reduced by the disproportionate loss of the early fall-run life history. Based on these factors, this ESU would likely have a low resilience to additional perturbations.

4.7.4 Critical Habitat

NMFS designated critical habitat for Puget Sound Chinook salmon on September 2, 2005 (70 FR 52630). Specific geographic area include portions of the Nooksack River, Skagit River, Sauk River, Stillaguamish River, Skykomish River, Snoqualmie River, Lake Washington, Green River, Puyallup River, White River, Nisqually River, Hamma Hamma River and other Hood Canal watersheds, the Dungeness/Elwha Watersheds, and nearshore marine areas of the Strait of Georgia, Puget Sound, Hood Canal and the Strait of Juan de Fuca. PCEs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat, and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. Forestry practices have heavily impacted migration, spawning, and rearing PCEs in the upper watersheds of most rivers systems within critical habitat designated for the Puget Sound Chinook salmon. Degraded PCEs include reduced conditions of substrate supporting spawning, incubation and larval development caused by siltation of gravel; and degraded rearing habitat by removal of cover and reduction in channel complexity. Urbanization and agriculture in the lower alluvial valleys of mid- to southern Puget Sound and the Strait of Juan de Fuca have reduced channel function and connectivity, reduced available floodplain habitat, and affected water quality. Thus, these areas have degraded spawning, rearing, and migration PCEs. Hydroelectric development and flood control also obstruct Puget Sound Chinook salmon migration in several basins. The most functional PCEs are found in northwest Puget Sound: the Skagit River basin, parts of the Stillaguamish River basin, and the Snohomish River basin where federal land overlap with critical habitat designated for the Puget Sound Chinook salmon. However, estuary PCEs are degraded in these areas by reduction in the water quality from contaminants, altered salinity conditions, lack of natural cover, and modification and lack of access to tidal marshes and their channels.

4.8 Chinook Salmon (Sacramento River Winter-run ESU)

The Sacramento River winter-run Chinook salmon ESU includes all naturally spawned populations of winter-run Chinook salmon entering and using the Sacramento River system in the Central Valley, California. The ESU now consists of a single spawning population. Two hatchery populations were included as part of the ESU, however on June 26, 2013, NMFS proposed that one artificial propagation program be removed from the ESU, as the program has been terminated (78 FR 38270). We used information available in status reviews (Good et al.

2005, NMFS 2011h), listing documents (54 FR 32085, 55 FR 10260, 69 FR 33102, 70 FR 37160), the draft recovery plan (NMFS 2009c), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.8.1 Life History

The winter-run Chinook salmon have characteristics of both stream- and ocean-type life histories. Adults enter fresh water in winter or early spring but delay spawning until late spring (May to June). Fry emerge from the gravel in late June to early July and continue through October (Fisher 1994). Young winter-run Chinook salmon start migrating to sea as early as mid-July with a peak movement over the Red Bluff Diversion Dam in September. Some offspring move downstream as fry while other rear in the upper Sacramento River and move down as smolt. Normally fry have passed the Red Bluff Diversion Dam by October while smolts may pass over the dam until March. Juvenile winter-runs occur in the Delta primarily from November through early May. Winter-run juveniles remain in the Delta until they are from five to 10 months of age, and then begin emigrating to the ocean as early as November and continue through May (Fisher 1994). Returning adults can be between two to six years of age, but the majority return as three-year olds.

4.8.2 Population Dynamics

Construction of Shasta Dams in the 1940s eliminated access to historic spawning habitat for winter-run Chinook salmon. As a result the ESU has been reduced to a single spawning population which is entirely dependent upon the provision of suitably cool water from Shasta Reservoir during periods of spawning, incubation and rearing. Winter-runs may have been as large as 200,000 fish based upon commercial fishery records from the 1870s (Fisher 1994). During the first three years of operation of the counting facility at the Red Bluff Diversion Dam (1967 to 1969), an average of 86,500 winter-run Chinook salmon were counted (California Department of Fish and Game 2009). Critically low levels were reached during the drought of 1987 to 1992 with an absolute bottom of 191 fish counted. The three-year average run size for the period of 1989 to 1991 was 388 fish. The population grew rapidly from the early 1990s to mid-2005; mean run size increased from 1,363 adults before 2000 to 8,470 adults between 2000 and 2006 (USFWS and U.S. Bureau of Reclamation 2007). Abundance has declined in subsequent years (4,461 adults estimated for 2007 and a preliminary estimate between 2,600 to 2,950 adults for 2008), and the 10-year trend in abundance is negative.

4.8.3 Status

The SR winter-run Chinook salmon ESU was first listed as threatened on August 4, 1989 under an emergency rule (54 FR 32085). On January 4, 1994, NMFS reclassified the ESU as an endangered species due to several factors, including: (1) the continued decline and increased variability of run sizes since its listing as a threatened species in 1989; (2) the expectation of weak returns in coming years as the result of two small year classes (1991 and 1993); and (3) continuing threats to the species (59 FR 440). On June 14, 2004, NMFS proposed to reclassify the ESU as threatened (69 FR 33102), but its status as endangered was upheld in the final listing determination on June 28, 2005 (70 FR 37160). Good et al. (2005) found that the SR winter-run Chinook salmon ESU was in danger of extinction. The major concerns of the BRT were that there is only one extant population, and it is spawning outside of its historical range in artificially-maintained habitat that is vulnerable to drought and other catastrophes. Additionally, the ESU is expected to have lost some genetic diversity through bottleneck effects in the late

1980s and early 1990s and hatchery releases may also have affected population genetics. Abundance data showed an increase in spawner returns from 1990s to mid-2005, though this increase was not sustained in subsequent years. The population growth rate for this ESU is negative, indicating the population has been declining and is not self-sustaining. Based on these factors, this ESU would likely have a very low resilience to additional perturbations.

4.8.4 Critical Habitat

NMFS designated critical habitat for this species on June 16, 1993 (58 FR 33212). The designation includes: the Sacramento River from Keswick Dam, Shasta County (river mile 302) to Chipps Island (river mile 0) at the westward margin of the Sacramento-San Joaquin Delta, and other specified estuarine waters. PCEs include specific water temperature criteria, minimum instream flow criteria, and water quality standards. In addition, biological features vital for the ESU include unimpeded adult upstream migration routes, spawning habitat, egg incubation and fry emergence areas, rearing areas for juveniles, and unimpeded downstream migration routes for juveniles. As there is overlap in designated critical habitat for both the Sacramento River Winter-run Chinook salmon and the spring-run Chinook salmon, the conditions of PCEs for both ESUs are similar. Spawning and rearing PCEs are degraded by high water temperature caused by the loss of access to historic spawning areas in the upper watersheds where water maintain lower temperatures. The rearing PCE is further degraded by floodplain habitat disconnected from the mainstems of larger rivers throughout the Sacramento River watershed. The migration PCE is also degraded by the lack of natural cover along the migration corridors. Rearing and migration PCEs are further affected by pollutants entering the surface waters and riverine sediments as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Juvenile migration is obstructed by water diversions along Sacramento River and by two large state and federal water-export facilities in the Sacramento-San Joaquin Delta. The current condition of PCEs for the Sacramento River Winter-run Chinook salmon indicates that they are not currently functioning or are degraded. Their conditions are likely to maintain low population abundances across the ESU.

4.9 Chinook Salmon (Snake River Fall-run ESU)

The Snake River (SR) Fall-run Chinook salmon ESU includes all naturally spawned populations of fall-run Chinook salmon in the mainstem Snake River below Hells Canyon Dam; and in the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins. Four artificial propagation programs are included in the ESU. We used information available in status reviews (Good et al. 2005, Ford 2011, NMFS 2011i), listing documents (57 FR 14653, 70 FR 37160), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.9.1 Life History

Prior to dam construction, fall Chinook salmon were primarily ocean-type; however, today both an ocean-type and reservoir-type occur (Connor et al. 2005). Adult ocean-type salmon in the ESU enter the Columbia River in July and August and spawn from October to November. Juveniles emerge from the gravels in March and April of the following year, moving downstream from natal spawning and early rearing areas from June through early autumn. Reservoir-type juveniles overwinter in pools created by dams before migrating to sea; this response is likely due to early development in cooler temperatures which prevents rapid growth.

Phenotypic characteristics have shifted in apparent response to environmental changes from hydroelectric dams (Connor et al. 2005).

4.9.2 Population Dynamics

The SR Fall-run Chinook salmon ESU consists of one extant population that is confined to a small fraction (15 percent) of its historical range. Two populations have been extirpated. Estimated annual returns for the period 1938 to 1949 were at 72,000 fish. By the 1950s, numbers had declined to an annual average of 29,000 fish (Bjornn and Horner 1980). Numbers of SR Fall-run Chinook salmon continued to decline during the 1960s and 1970s as approximately 80 percent of their historic habitat were eliminated or severely degraded by the construction of the Hells Canyon complex (1958 to 1967) and the lower Snake River dams (1961 to 1975). The abundance of natural-origin spawners of the ESU for 2001 (2,652 adults) exceeded 1,000 fish for the first time since counts began at the Lower Granite Dam in 1975. The total spawning escapement into natural areas above Lower Granite Dam has remained relatively high since the rapid increase in the late 1990s. The current 5-year geometric mean total escapement is above 10,000, substantially greater than the 1997−2001 geometric mean reported in the previous BRT review. A relatively high proportion of the estimated spawners are of hatchery origin (78% for the most recent 5-year cycle). However natural-origin returns have also increased substantially over the geometric mean estimates for the 2005 BRT review and the cycle just prior to the 1997 listing decision.

4.9.3 Status

NMFS listed Snake River fall-run Chinook salmon as endangered in 1992 (57 FR 14653), but reclassified their status as threatened on June 28, 2005 (70 FR 37160). The ESU was listed due to habitat loss and degradation from the combined effects of damming; forest, agricultural, mining and wastewater management practices; and overharvest. Both long- and short-term trends in natural returns are positive. Productivity is likely sustained largely by a system of small artificial rearing facilities in the lower Snake River Basin. Depending upon the assumptions made regarding the reproductive contribution of hatchery fish, long- and short-term trends in productivity are at or above replacement. Low abundances in the 1990s combined with a large proportion of hatchery derived spawners likely have reduced genetic diversity from historical levels; however, the salmon in this ESU remain genetically distinct from similar fish in other basins. The population remains at a moderate risk of becoming extinct (probability between five and 25 percent in 100 years). Based on these factors, this ESU would likely have a moderate resilience to additional perturbations.

4.9.4 Critical Habitat

NMFS designated critical habitat for Snake River fall-run Chinook salmon on December 28, 1993 (58 FR 68543). This critical habitat encompasses the waters, waterway bottoms, and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to listed Snake River salmon (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams. Specific PCEs were not designated in the critical habitat final rule; instead four "essential habitat" categories were described: 1) spawning and juvenile rearing areas, 2) juvenile migration corridors, 3) areas for growth and development to adulthood, and 4) adult migration corridors. The "essential features" that characterize these sites include substrate/spawning gravel; water quality, quantity, temperature, velocity; cover/shelter; food; riparian vegetation; space; and safe passage conditions. Hydropower operations and flow management practices have impacted spawning and rearing habitat and migration corridors throughout the ESU's range. The major degraded essential habitat and features include: safe passage for juvenile migration; rearing habitat water quality; and spawning areas with gravel, water quality, cover/shelter, riparian vegetation, and space to support egg incubation and larval growth and development. Water quality impairments in the designated critical habitat are common within the range of this ESU. Pollutants such as petroleum products, pesticides, fertilizers, and sediment in the form of turbidity enter the surface waters and riverine sediments from the headwaters of the Snake, Salmon, and Clearwater Rivers to the Columbia River estuary; traveling along with contaminated stormwater runoff, aerial drift and deposition, and via point source discharges.

4.10 Chinook Salmon (Snake River Spring/Summer-run ESU)

The SR Spring/Summer-run Chinook ESU includes all naturally spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins. Fifteen artificial propagation programs are included in the ESU, however on June 26, 2013, NMFS proposed the number of artificial propagation programs included in the ESU be changed to 11 (78 FR 38270). We used information available in status reviews (Matthews and Waples 1991, Good et al. 2005, NMFS 2011i), Interior Columbia Basin Technical Recovery Team reports (Interior Columbia Technical Review Team 2003), listing documents (57 FR 14653, 70 FR 37160), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.10.1 Life History

Snake River spring/summer-run Chinook salmon have a stream-type life history. Spring-run salmon of this ESU pass Bonneville Dam beginning in early March to mid-June and spawn from mid- to late August. Summer-run salmon return to the Columbia River from June through August and spawn approximately one month later than spring-run salmon. Summer-run salmon tend to spawn lower in the Snake River drainages than spring-run fish; however, an overlap of summer-run and spring-run spawning areas does occur. In both run types eggs incubate over the winter, and hatch in late winter and early spring of the following year. Juvenile fish mature in fresh water for one year before they migrate to the ocean in the spring of their second year of life. Depending on the tributary and the specific habitat conditions, juveniles may migrate extensively from natal reaches into alternative summer-rearing or overwintering areas. Salmon of this ESU return from the ocean to spawn primarily as four and five year-old fish, after two to three years in the ocean.

4.10.2 Population Dynamics

The Interior Columbia Basin Technical Recovery Team has identified 32 populations in five major population groups (Upper Salmon River, South Fork Salmon River, Middle Fork Salmon River, Grande Ronde/Imnaha, Lower Snake Mainstem Tributaries) for this species. Historic populations above Hells Canyon Dam are considered extinct. The status review reports that total annual salmon production of this ESU may have exceeded 1.5 million adults in the late 1800s. Total (natural plus hatchery origin) returns fell to roughly 100,000 spawners by the late 1960s (Fulton 1968). Abundance of summer run Chinook salmon have increased since low returns in the mid-1990s (lowest run size was 692 fish in 1995). The 1997 to 2008 geometric mean total return for the summer run component at Lower Granite Dam was slightly more than 8,700 fish, compared to the geometric mean of 3,076 fish for the years 1987 to 1996 (Data from the

Columbia Basin Fisheries Agencies and Tribes http://www.fpc.org/). However, over 80 percent of the 2001 return and over 60 percent of the 2002 return originated from hatcheries.

4.10.3 Status

NMFS listed Snake River spring/summer-run Chinook salmon as threatened on April 22, 1992 (57 FR 14653), and reaffirmed their status on June 28, 2005 (70 FR 37160). The ESU was listed due to habitat loss and degradation from the combined effects of damming; forest, agricultural, mining, and wastewater management practices; overharvest; and artificial propagation. There is no obvious long-term positive trend, though recent trends are approaching one, indicating the population is nearly replacing itself. Risks to individual populations within the ESU may be greater than the extinction risk for the entire ESU due to low levels of annual abundance of individual populations. Multiple spawning sites are accessible and natural spawning and rearing are well distributed within the ESU. However, many spawning aggregates have also been extirpated, which has increased the spatial separation of some populations. The South Fork and Middle Fork Salmon Rivers currently support the bulk of natural production in the drainage. There is no evidence of wide-scale genetic introgression by hatchery populations. The high variability in life history traits indicates sufficient genetic variability within the ESU to maintain distinct subpopulations adapted to local environments. Based on these factors, this ESU would likely have a moderate resilience to additional perturbations.

4.10.4 Critical Habitat

NMFS designated critical habitat for Snake River spring/summer-run Chinook salmon on December 28, 1993 (58 FR 68543). This critical habitat encompasses the waters, waterway bottoms, and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to listed Snake River salmon (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Specific PCEs were not designated in the critical habitat final rule; instead four “essential habitat” categories were described: 1) spawning and juvenile rearing areas, 2) juvenile migration corridors, 3) areas for growth and development to adulthood, and 4) adult migration corridors. The “essential features” that characterize these sites include substrate/spawning gravel; water quality, quantity, temperature, velocity; cover/shelter; food; riparian vegetation; space; and safe passage conditions. Hydropower operations and flow management practices have impacted spawning and rearing habitat and migration corridors in some regions. The Interior Columbia Basin Technical Review Team reports that the Panther Creek population was extirpated because of legacy and modern mining-related pollutants that created a chemical barrier to fish passage. Water quality impairments are common in the range of the critical habitat designated for this ESU. Pollutants such as petroleum products, pesticides, fertilizers, and sediment in the form of turbidity enter the surface waters and riverine bottom substrate from the headwaters of the Snake, Salmon, and Clearwater Rivers to the Columbia River estuary as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges.

4.11 Chinook Salmon (Upper Willamette River ESU)

The Upper Willamette River Chinook salmon ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River, and its tributaries, above Willamette Falls, Oregon. Seven artificial propagation programs are included in the ESU, however on June 26, 2013, NMFS proposed to change the number of artificial propagation programs included in the ESU to six (78 FR 38270). We used information available in status reviews (Good et al. 2005, NMFS 2011n), the recovery plan (Oregon Department of Fish and Wildlife and NMFS 2011), "Historical population structure of Pacific salmonids in the Willamette River and Lower Columbia River Basins" (Myers et al. 2006), listing documents (64 FR 14308, 70 FR 37160), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.11.1 Life History

Upper Willamette River Chinook salmon are a spring-run, stream-type salmon. Adults appear in the lower Willamette River in February, but the majority of the run ascends Willamette Falls in April and May, with a peak in mid- to late May. Present-day salmon ascend the Willamette Falls via a fish ladder. The migration of spring Chinook salmon over Willamette Falls extends into July and August and overlaps with the beginning of the introduced fall-run of Chinook salmon. The adults hold in deep pools over summer and spawn between August to October, with a peak in September. Fry emerge from December to March and juvenile migration varies among three distinct emigration "runs": fry migration in late winter and early spring; sub-yearling (less than one year old) migration in fall to early winter; and yearlings (greater than one year old) migrating in late winter to spring. Sub-yearlings and yearlings rear in the mainstem Willamette River where they also use floodplain wetlands in the lower Willamette River during the winter-spring floodplain inundation period. Fall-run Chinook salmon spawn in the Upper Willamette but are not considered part of the ESU because they are not native. Salmon of this ESU return from the ocean to spawn primarily as four and five year-old fish, after two to three years in the ocean.

4.11.2 Population Dynamics

Historically, this ESU included sizable numbers of spawning salmon in the Santiam River, the middle fork of the Willamette River, and the McKenzie River, as well as smaller numbers in the Molalla River, Calapooia River, and Albiqua Creek. Most natural spring-run Chinook salmon populations of this ESU are likely extirpated or nearly so; the spring-run in the McKenzie River is the only known remaining naturally reproducing population in this ESU. The total abundance of adult spring-run Chinook salmon (hatchery-origin + natural-origin fish) passing Willamette Falls has remained relatively steady over the past 50 years (ranging from approximately 20,000 to 70,000 fish). However, the current abundance is an order of magnitude below the peak abundance levels observed in the 1920s (approximately 300,000 adults). Total number of fish increased during the period from 1996 to 2004 when it peaked at more than 96,000 adult spring-run Chinook salmon passing Willamette Falls. Since then, the run has steadily decreased with only about 14,000 fish counted in 2008, the lowest number since 1960. ESU abundance increased again to about 25,000 adult spring-run Chinook salmon in 2009. Runs consist of a high, but uncertain, fraction of hatchery-produced fish.

4.11.3 Status

NMFS listed Upper Willamette River Chinook salmon as threatened on March 24, 1999 (64 FR 14308) and reaffirmed their status on June 28, 2005 (70 FR 37160). The ESU was listed due to habitat loss and degradation from the combined effects of damming; agricultural practices; urbanization; overharvest; and artificial propagation. The McKenzie River population is the only remaining self-sustaining naturally reproducing independent population. The other natural-origin populations in this ESU have very low current abundances, and long- and short-term population trends are negative. The spatial distribution of the species has been reduced by the loss of 30 to 40 percent of the total historic habitat. This loss has restricted spawning to a few areas below dams. Access of fall-run Chinook salmon to the upper Willamette River and the mixing of hatchery stocks within the ESU have threatened the genetic integrity and diversity of the species. Much of the genetic diversity that existed between populations has been homogenized. Based on these factors, this ESU would likely have a low resilience to additional perturbations.

4.11.4 Critical Habitat

NMFS designated critical habitat for this species on September 2, 2005 (70 FR 52630). Designated critical habitat includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Willamette River as well as specific stream reaches in a number of subbasins. PCEs include freshwater spawning and rearing sites, freshwater migration corridors. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. The migration PCE is degraded by dams altering migration timing and water management altering the water quantity necessary for mobility and survival. Migration, rearing, and estuary PCEs are also degraded by loss of riparian vegetation and in-stream cover. Pollutants such as petroleum products, fertilizers, pesticides, and fine sediment enter the stream through runoff, point source discharge, drift during application, and non-point discharge where agricultural and urban development occurs. Degraded water quality in the lower Willamette River where important floodplain rearing habitat is present affects the ability of this habitat to sustain its role to conserve the species. The current condition of PCEs identified in this critical habitat indicates that migration and rearing PCEs are not currently functioning or are degraded and impact their ability to serve their intended role for species conservation.

4.12 Chum Salmon (General Overview)

We discuss the distribution, life history, population dynamics, status, and critical habitats of the two species (here we use the word “species” to apply to distinct population segments, DPSs, and evolutionary significant units, ESUs) separately; however, because listed chum salmon species are virtually indistinguishable in the wild and comprise the same biological species, we begin this section describing characteristics common across ESUs. We used information available in status reviews (Johnson et al. 1997, Good et al. 2005), various listing documents, and biological opinions (NMFS 2012b) to summarize the status of the species.

Because their range extends farther along the shores of the Arctic Ocean than other Pacific salmonid, chum salmon have the widest natural geographic and spawning distribution of the Pacific salmonids. Chum salmon have been documented to spawn from Korea and the Japanese island of Honshu, east around the rim of the North Pacific Ocean to Monterey Bay, California.

Historically, chum salmon were distributed throughout the coastal regions of western Canada and the U.S. Presently, major spawning populations occur as far south as Tillamook Bay on the northern Oregon coast.

4.12.1 Life History

In general, North American chum salmon migrate north along the coast in a narrow coastal band that broadens in southeastern Alaska. Chum salmon usually spawn in the lower reaches of rivers during summer and fall. Redds are dug in the mainstem or in side channels of rivers from just above tidal influence to nearly 100 km from the sea. The time to hatching and emergence from the gravel redds are influenced by DO, gravel size, salinity, nutritional conditions, behavior of alevins in the gravel, and incubation temperature (Bakkala 1970, Schroder 1977, Salo 1991).

Chum salmon juveniles use shallow, low flow habitats for rearing that include inundated mudflats, tidal wetlands and their channels, and sloughs. The duration of estuarine residence for chum salmon juveniles are known for only a few estuaries. Observed residence time ranged from four to 32 days, with about 24 days as the most common.

Immature salmon distribute themselves widely over the North Pacific Ocean and maturing adults return to the home streams at various ages, usually at two to five years of age, and in some cases up to seven years (Bigler 1985). This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus Oncorhynchus (e.g., steelhead, coho, and most types of Chinook and sockeye salmon). Stream-type salmonids usually migrate to sea at a larger size, after months or years of freshwater rearing. Thus, survival and growth for juvenile chum salmon depend less on freshwater conditions than on favorable estuarine conditions. Another behavioral difference between chum salmon and other salmonid species is that chum salmon form schools. Presumably, this behavior reduces predation (Pitcher 1986) especially if fish movements are synchronized to swamp predators (Miller and Brannon 1982). All chum salmon are semelparous (i.e., they die after spawning) and exhibit obligatory anadromy (i.e., there are no recorded landlocked or naturalized freshwater populations; they must spend portions of their lives in both salt and freshwater habitats).

Chum salmon feed on a variety of prey organisms depending upon life stage and size. In freshwater Chum salmon feed primarily on small invertebrates; in saltwater, their diet consists of copepods, tunicates, mollusks, and fish.

4.12.2 Population Dynamics
The population dynamics of each chum salmon ESU will be discussed separately, below.

4.12.3 Status
On June 28, 2005, as part of the final listing determinations for 16 ESUs of West Coast salmon, NMFS amended and streamlined the 4(d) protective regulations for threatened salmon and steelhead (70 FR 37160) as described in the *Protective Regulations for Threatened Salmonid Species* section of this document. Under this change, the section 4(d) protections apply to natural and hatchery fish with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed prior to release into the wild.

4.12.4 Critical Habitat
Areas designated as critical habitat are important for the species' overall conservation by protecting quality growth, reproduction, and feeding. At the time of designation, primary constituent elements (PCEs) are identified and include sites necessary to support one or more chum salmon life stage(s). For both ESUs discussed below, PCEs include freshwater spawning, rearing, and migration areas; estuarine and nearshore marine areas free of obstructions; and offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. The critical habitat designation identified for each ESU contains additional details on the areas included as part of the designation, and the areas that were excluded from designation.

4.13 Chum Salmon (Columbia River ESU)
The Columbia River chum salmon ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon. Three artificial

propagation programs are part of the ESU. We used information available in status reviews (Good et al. 2005, Ford 2011, NMFS 2011d), listing documents (63 FR 11774, 64 FR 14508, 70 FR 37160), recovery plans (Lower Columbia Fish Recovery Board 2010, Oregon Department of Fish and Wildlife 2010, NMFS 2013c), "Historical population structure of Pacific salmonids in the Willamette River and Lower Columbia River Basins" (Myers et al. 2006), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.13.1 Life History
Salmon of this ESU return to the Columbia River from mid-October to November and spawning occurs from early November to late December. Adults generally spawn in the lower reaches of rivers, digging redds along the edges of the mainstem and in tributaries or side channels. Some spawning sites are located in areas where geothermally-warmed groundwater or mainstem flow upwells through the gravel. Chum salmon fry emigrate to estuaries from March through May shortly after emergence. Like ocean-type Chinook salmon, juvenile chum salmon rear in estuaries for an extended period (weeks to months) before beginning their long distance oceanic migration, primarily from February to June. The period of estuarine residence is a critical life history phase and plays a major role in determining the size of the subsequent adult run back to fresh water. Chum salmon remain in the North Pacific and Bering Sea for two to six years, with most adults returning to the Columbia River as four-year-olds.

4.13.2 Population Dynamics
Historically, the ESU was composed of 17 populations in Oregon and Washington between the mouth of the Columbia River and the Cascade crest. Of these populations, 15 of them (six in Oregon and nine in Washington) are so depleted that either their baseline probability of persistence is very low or they are extirpated or nearly so. An extensive 2000 survey in Oregon streams supports that chum salmon almost had been extirpated from the Oregon portion of this ESU. Over the last century, Columbia River chum salmon returns have collapsed from hundreds of thousands to just a few thousand per year. Only two populations (Grays River and the Lower Gorge) with any significant spawning remain today, both in Washington. The estimated size of the Lower Gorge population is at 400 to 500 individuals, down from a historical level of greater than 8,900. A significant increase in spawner abundance occurred in 2001 and 2002 to around 10,000 adults. However, spawner surveys indicate that the abundance again decreased to low levels during 2003 through 2008 though the spawner surveys may underestimate abundance since the proportion of tributary and mainstem spawning differ between years and the surveys do not include spawners in the Columbia River mainstem. In the 1980s, estimates of the Grays River population ranged from 331 to 812 individuals. However, the population increased in 2002 to as many as 10,000 individuals. Based on data for number of spawners per river mile, this increase continued through 2003 and 2004. However, fish abundance fell again to less than 5,000 fish during the years 2005 through 2008.

4.13.3 Status
NMFS listed Columbia River chum salmon as threatened on March 25, 1999 (64 FR 14508) and reaffirmed their status on June 28, 2005 (71 FR 37160). The ESU was listed due to habitat loss and degradation from the combined effects of water withdrawal, conveyance, storage, and flood control; logging and agriculture; mining; urbanization; and overharvest. Much of the historical spatial structure has been lost on both the population and the ESU levels by extirpation (or near-extirpation) of many local stocks and the widespread loss of estuary habitats. Estimates of

abundance and trends are available only for the Grays River and Lower Gorge populations, both of which have long- and short-term productivity trends at or below replacement. Limited distribution also increases risk to the ESU from local disturbances. Although hatchery production of chum salmon has been limited and hatchery effects on diversity are thought to have been relatively small, diversity has been greatly reduced at the ESU level because of presumed extirpations and the low abundance in the remaining populations (fewer than 100 spawners per year for most populations). Based on these factors, this ESU would likely have a low resilience to additional perturbations.

4.13.4 Critical Habitat

NMFS originally designated critical habitat for Columbia River chum salmon on February 16, 2000 (65 FR 7764); critical habitat was re-designated on September 2, 2005 (70 FR 52630). Designated critical habitat includes areas in the following subbasins: Middle Columbia/Hood, Lower Columbia/Sandy, Lewis, Lower Columbia/Clatskanie, Lower Cowlitz, and Lower Columbia subbasin and river corridor. PCEs for this ESU and physical or biological features that characterize them are described in Section 3.0.4. Limited information exists on the quality of essential habitat characteristics for this ESU; however, the migration PCE has been significantly impacted by dams obstructing adult migration and access to historic spawning locations and water quality and cover for estuary and rearing PCEs have decreased in quality to the extent that the PCEs are not likely to maintain their intended function to conserve the species.

4.14 Chum Salmon (Hood Canal Summer-run ESU)

The Hood Canal summer-run chum salmon ESU includes all naturally spawned populations in Hood Canal and its tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington. Eight artificial propagation programs are included in the ESU, however on June 26, 2013, NMFS proposed to change the number of artificial propagation programs included in the ESU to four (78 FR 38270). We used information available in status reviews (Good et al. 2005, NMFS 2011g), listing documents (63 FR 11774, 64 FR 14508, 70 FR 37160), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.14.1 Life History

Salmon of this ESU enter natal rivers from late August until October (Washington Department of Fisheries et al. 1993) and spawning occurs from mid-September through mid-October. Adults generally spawn in low gradient, lower mainstem reaches of natal streams, typically in center channel areas due to the low flows encountered in the late summer and early fall and fry emerge between January and May. After hatching, fry move rapidly downstream to subestuarine habitats where they rear for an average of 23 days before entering the ocean. Summer-run chum salmon seem to have a longer incubation time than fall-run chum salmon in the same streams. Consequently, offspring of summer-run chum salmon have lower average weight and less lipid content than offspring of fall-run chum salmon. Thus, prey availability during their early life history is important for fry survival. Most adult salmon of this ESU return from the ocean to spawn as three- and four-year old fish.

4.14.2 Population Dynamics

Historically, this ESU consisted of two independent populations (the Strait of Juan de Fuca and Hood Canal populations) that, together, contained an estimated 16 stocks (Sands et al. 2007). Of the 16 historic stocks, seven are considered extirpated, primarily from the eastern side of Hood Canal. Of the extant Strait of Juan de Fuca stocks, three spawn in rivers and streams entering the eastern Strait of Juan de Fuca and Admiralty Inlet. The Hood Canal population consists of six extant stocks within the Hood Canal watershed. HC Summer-run chum salmon are part of an extensive rebuilding program developed and implemented in 1992 by state and tribal co-managers. The largest supplemental program occurs at the Big Quilcene River fish hatchery. Reintroduction programs occur in Big Beef (Hood Canal population) and Chimacum (Strait of Juan de Fuca population) creeks. Adult returns for some of the HC Summer-run chum salmon stocks showed modest improvements in 2000, with upward trends continuing in 2001 and 2002. The recent five-year mean abundance is variable among stocks, ranging from one fish to nearly 4,500 fish. Productivity in the last five-year period (2005 to 2009) has been very low, especially compared to the relatively high productivity observed during the five to 10 previous years (1994 to 2004).

4.14.3 Status

NMFS listed Hood Canal summer-run chum salmon as threatened on March 25, 1999 (64 FR 14508), and reaffirmed their status on June 28, 2005 (70 FR 37160). The ESU was listed due to habitat loss and degradation from the combined effects of water withdrawal, conveyance, storage, and flood control; logging and agriculture; mining; urbanization; overharvest; and artificial propagation. Much of the historical spatial structure and connectivity has been lost on both the population and the ESU levels by extirpation of many local stocks and the widespread loss of estuary and lower floodplain habitats. Long-term trends in productivity are above replacement only for the Quilcene and Union River stocks; however, most stocks remain depressed. The overall trend in spawning abundance is generally stable (meaning adults are replacing themselves) for the Hood Canal population (all natural spawners and natural-origin only spawners) and for the Strait of Juan de Fuca population (all natural spawners). Only the Strait of Juan de Fuca population’s natural-origin only spawners shows a significant positive trend. Estimates of the fraction of naturally spawning hatchery fish exceed 60 percent for some stocks, which indicates that reintroduction programs are supplementing the numbers of total fish spawning naturally in streams. There is also concern that the Quilcene hatchery stock has high rates of straying, and may represent a risk to historical population structure and diversity. Based on these factors, this ESU would likely have a low resilience to additional perturbations.

4.14.4 Critical Habitat

NMFS designated critical habitat for Hood Canal summer-run chum salmon on September 2, 2005 (70 FR 52630). Designated critical habitat includes the Skokomish River, Hood Canal subbasin, which includes the Hamma Hamma and Dosewallips rivers and others, the Puget Sound subbasin, Dungeness/Elwha subbasin, and nearshore marine areas of Hood Canal and the Strait of Juan de Fuca. This includes a narrow nearshore zone within several Navy security/restricted zones and approximately eight miles of habitat that was unoccupied at the time of the designation (including Finch, Anderson and Chimacum creeks), but has been re-seeded. PCEs for this ESU and physical or biological features that characterize them are described in Section 3.0.4. The spawning PCE is degraded by excessive fine sediment in the gravel and the rearing PCE is degraded by loss of access to sloughs in the estuary and nearshore areas and excessive predation. Low flow in several rivers also adversely affects most PCEs. In estuarine areas, both migration and rearing PCEs of juveniles are impaired by loss of functional floodplain areas necessary for growth and development of juvenile chum salmon. These degraded conditions likely maintain low population abundances across the ESU.

4.15 Coho Salmon (General Overview)

We discuss the distribution, life history, population dynamics, status, and critical habitats of the four species (here we use the word "species" to apply to distinct population segments, DPSs, and evolutionary significant units, ESUs) separately; however, because listed coho salmon species are virtually indistinguishable in the wild and comprise the same biological species, we begin this section describing characteristics common across ESUs. We used information available in status reviews (Good et al. 2005), various listing documents, and biological opinions (NMFS 2012b) to summarize the status of the species.

The species was historically distributed throughout the North Pacific Ocean from central California to Point Hope, Alaska, through the Aleutian Islands, and from the Anadyr River, Russia, south to Hokkaido, Japan.

4.15.1 Life History

Coho salmon exhibit a stream-type life history. Most coho salmon enter rivers between September and February. In many systems, coho salmon wait to enter until fall rainstorms have provided the river with sufficiently strong flows and depth. Coho salmon spawn from November to January, and occasionally into February and March. Some spawning occurs in third-order streams, but most spawning activity occurs in fourth- and fifth-order streams with gradients of three percent or less. After fry emerge in spring, they disperse upstream and downstream to establish and defend territories weak water currents such as backwaters and shallow areas near stream banks. Juveniles rear in these areas during the spring and summer. In early fall juveniles move to river margins, backwater, and pools. During winter juveniles typically reduce feeding activity and growth rates slow down or stop. By March of their second spring, juveniles feed heavily on insects and crustaceans and grow rapidly before smoltification and outmigration (Olegario 2006). Relative to species such as chum salmon, Chinook salmon, and steelhead, coho salmon smolts usually spend a short time (one to three days) in the estuary with little feeding (Thorpe 1994, Miller and Sadro 2003). After entering the ocean, immature coho salmon initially remain in nearshore waters close to the parent stream. North American coho salmon will migrate north along the coast in a narrow coastal band that broadens in southeastern Alaska. During this migration, juvenile coho salmon tend to occur in both coastal and offshore waters.

Along the Oregon/California coast, coho salmon primarily return to rivers to spawn as three-year olds, having spent approximately 18 months rearing in fresh water and 18 months in salt water. In some streams, a smaller proportion of males may return as two-year olds. The presence of two-year old males can allow for substantial genetic exchange between brood years. The relatively fixed three-year life cycle exhibited by female coho salmon limits demographic interactions between brood years. This makes coho salmon more vulnerable to environmental perturbations than other salmonids that exhibit overlapping generations, i.e., the loss of a coho salmon brood year in a stream is less likely than for other Pacific salmon to be reestablished by females from other brood years. All coho salmon are semelparous and anadromous.

Coho salmon feed on a variety of prey organisms depending upon life stage and size. While at sea, coho salmon tend to eat fish including herring, sand lance, sticklebacks, sardines, shrimp and surf smelt. While in estuaries and in fresh water coho salmon are significant predators of Chinook, pink, and chum salmon, as well as aquatic and terrestrial insects. Smaller fish, such as fry, eat chironomids, plecoptera and other larval insects, and typically use visual cues to find their prey.

4.15.2 Population Dynamics
The population dynamics of each Chinook salmon ESU will be discussed separately, below.

4.15.3 Status
On June 28, 2005, as part of the final listing determinations for 16 ESUs of West Coast salmon, NMFS amended and streamlined the 4(d) protective regulations for threatened salmon and steelhead (70 FR 37160) as described in the *Protective Regulations for Threatened Salmonid Species* section of this document. Under this change, the section 4(d) protections apply to natural and hatchery fish with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed prior to release into the wild.

4.15.4 Critical Habitat
Critical habitat will be discussed for each coho salmon ESU separately, below.

4.16 Coho Salmon (Central California Coast ESU)
The Central California Coast coho salmon ESU includes all naturally spawned populations of coho salmon from Punta Gorda in northern California south to and including the San Lorenzo River in central California, as well as populations in tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin River system. The ESU also includes four artificial propagation programs. We used information available in status reviews (Weitkamp et al. 1995, Good et al. 2005, NMFS 2011a, Spence and Williams 2011), "An analysis of historical population structure for evolutionarily significant units of Chinook salmon, coho salmon, and steelhead in the North-Central California Coast Recovery Domain" (Bjorkstedt et al. 2005), listing documents (60 FR 38011; 61 FR 56138; 70 FR 37160), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.16.1 Life History
Both run and spawn timing of coho salmon in this region are late (both peaking in January) relative to northern populations, with little time spent in fresh water between river entry and spawning. Spawning runs coincide with the brief peaks of river flow during the fall and winter. Most juveniles of this ESU undergo smoltification and start their seaward migration one year after emergence from the redd. Juveniles spending two winters in fresh water have, however, been observed in at least one coastal stream within the range of the ESU. Smolt outmigration generally peaks in April and May (Shapovalov and Taft 1954). In general, coho salmon within California exhibit a three-year life cycle. However, two-year old males commonly occur in some streams.

4.16.2 Population Dynamics
The ESU consisted historically of 11 functionally independent populations and a larger number of dependent populations. One of the two historically independent populations in the Santa Cruz mountains (*i.e.,* south of the Golden Gate Bridge) is extirpated. Coho salmon are considered effectively extirpated from the San Francisco Bay. The Russian River population, once the largest and most dominant source population in the ESU, is now at high risk of extinction because of low abundance and failed productivity. The Lost Coast to Navarro Point to the north contains the majority of coho salmon remaining in the ESU.

Limited information exists on abundance of coho salmon for this ESU. About 200,000 to 500,000 coho salmon were produced statewide in the 1940s. This escapement declined to about 99,000 by the 1960s with approximately 56,000 (56 percent) originating from streams within this ESU. The estimated number of coho salmon produced within the ESU in the late 1980s had further declined to 6,160 (46 percent of the estimated statewide production). Additionally, information on the abundance and productivity trends for the naturally spawning component of this ESU is extremely limited. There are no long-term time series of spawner abundance for individual river systems. Returns increased in 2001 in streams within the northern portion of the ESU; however, returns in 2006/07 and 2007/08 were extremely low (MacFarlane et al. 2008) and about 500 fish returned in 2010 across the entire range. Hatchery raised smolt have been released infrequently but occasionally in large numbers in rivers throughout the ESU. Releases have included transfer of stocks within California and between California and other Pacific states as well as smolt raised from eggs collected from native stocks.

4.16.3 Status

NMFS listed the central California coast coho salmon ESU as threatened on October 31, 1996 (61 FR 56138) and later reclassified their status as endangered on June 28, 2005 (70 FR 37160). The ESU was listed due to habitat loss and degradation from the combined effects of logging, agricultural, and mining activities; urbanization; stream channelization; damming; wetland loss; overharvest; artificial propagation; and prolonged drought and poor ocean conditions. ESU spatial structure has been substantially modified due to lack of viable source populations and loss of dependent populations. Limited information exists on abundance for central California coast coho salmon; therefore, the best data available are presence-absence surveys used as a proxy for abundance changes. At the time of the 1996 listing, coho salmon occurred in 47 percent of streams (62) and were considered extirpated from 53 percent (71) of streams that historically harbored coho salmon within the ESU (Brown et al. 1994). Later reviews have concluded that the number of occupied streams relative to historic has not changed and may actually have declined. Additionally, the low rates of return from 2006 to 2010 suggest that all three year classes are faring poorly across the species’ range. Though hatchery salmon have been released, genetic studies show little homogenization of populations (i.e., transfer of stocks between basins) has had little effect on the geographic genetic structure of the ESU (Hedgecock 2002). Salmon in this ESU likely have considerable diversity in local adaptations given that the ESU spans a large latitudinal diversity in geology and ecoregions, and include both coastal and inland river basins. Based on these factors, this ESU would likely have a low resilience to additional perturbations.

4.16.4 Critical Habitat

NMFS designated critical habitat for central California coast coho salmon on May 5, 1999 (64 FR 24049). Designated critical habitat includes accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River (inclusive) in California. Critical habitat for this species also includes two streams entering San Francisco Bay: Arroyo Corte Madera Del Presidio and Corte Madera Creek. Specific PCEs were not designated in the critical habitat final rule; instead five “essential habitat” categories were described: 1) juvenile summer and winter rearing areas; 2) juvenile migration corridors; 3) areas for growth and development to adulthood; 4) adult migration corridors; and 5) spawning areas. The “essential features” that characterize these sites include adequate 1) substrate; 2) water quality; 3) water quantity; 4) water temperature; 5) water velocity; 6) cover/shelter; 7) food; 8) riparian vegetation; 9) space; and 10) safe passage conditions. NMFS (2008a) evaluated the condition of each habitat feature in terms of its current condition relative to its role and function in the conservation of the species. The assessment of habitat showed a distinct trend of increasing degradation in quality and quantity of all essential features as the habitat progresses south through the species range, with the area from the Lost Coast to the Navarro Point supporting the most favorable habitats and the Santa Cruz Mountains supporting the least. However, all populations are generally degraded regarding spawning and incubation substrate, and juvenile rearing habitat. Elevated water temperatures occur in many streams across the entire ESU.

4.17 Coho Salmon (Lower Columbia River ESU)

The lower Columbia River coho salmon ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Oregon and Washington, from the mouth of the Columbia up to and including the Big White Salmon and Hood Rivers, Washington; and the Willamette River to Willamette Falls, Oregon. This ESU includes 25 artificial propagation programs, however on June 26, 2013, NMFS proposed the number of artificial propagation programs included in the ESU be changed to 23 (78 FR 38270). We used information available in status reviews (Johnson et al. 1991, Good et al. 2005, Ford 2011, NMFS 2011d), recovery plans (Lower Columbia Fish Recovery Board 2010, Oregon Department of Fish and Wildlife 2010, NMFS 2013c), “Viability status of Oregon salmon and steelhead populations in the Willamette and lower Columbia basins (McElhany et al. 2007), listing documents (70 FR 37160; 78 FR 2725), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.17.1 Life History

The majority of the Lower Columbia River coho salmon are of hatchery origin. Hatchery runs are currently managed for two distinct runs: early-returning and late-returning. Early-returning coho salmon return to the Columbia River in mid-August and to spawning tributaries in early September, with peak spawning from mid- October to early November. Late-returning coho salmon return from late September through December and enter spawning tributaries from October through January. Most late-returning spawning occurs from November through January. Fry emerge from redds during a three-week period between early March and late July. Juveniles rear in fresh water for a year and smolt outmigration occurs from April through June with a peak in May. Juvenile coho are present in the Columbia River estuary from March to August. In general, salmon of this ESU return to freshwater as three-year-olds.

Analysis of run timing of coho salmon suggests that the Clackamas River population is composed of one late returning population and one early returning population. The late-returning population is believed to be descended from the native Clackamas River population and the early-returning population is believed to descend from hatchery fish introduced from Columbia River populations outside the Clackamas River basin. The naturally produced coho salmon return to spawn between December and March.

4.17.2 Population Dynamics

The ESU historically consisted of 24 independent populations. The vast majority (over 90 percent) of these are either extirpated or nearly so. Of the 24 populations, only two have significant natural production: the Sandy and Clackamas Rivers. Wild coho salmon re-appeared in two additional basins (Scappoose and Clatskanie) after a 10-year period during the 1980s and 1990s when they were largely absent. Prior to 1900, the Columbia River had an estimated annual run of more than 600,000 adults with about 400,000 spawning in the lower Columbia River. By the 1950s, the estimated number of coho salmon returning to the Columbia River had decreased to 25,000 adults (about five percent of historic levels). Massive hatchery releases since 1960 have increased the Columbia River run size. Between 1980 and 1989, the run varied from 138,000 adults to a historic high of 1,553,000 adults. However, only a small portion of these spawned naturally, and available information indicates that the naturally produced portion has continuously declined since the 1950s. The current number of naturally spawning fish during October and late November ranges from 3,000 to 5,500 fish. The majority of these are of hatchery origin. The 1996 to 1999 geometric mean for the late run in the Clackamas River, the only-run which is considered consisting mainly of native coho salmon, was 35 fish. Both long- and short-term trends and median population growth rate for the natural origin (late-run) portion of the Clackamas River coho salmon are negative but with large confidence intervals. The short-term trend for the Sandy River population is close to one, indicating a relatively stable population during the years 1990 to 2002. The long-term trend for this same population shows that the population has been decreasing (trend = 0.54) and there is a 43 percent probability that the median population growth rate was less than one.

4.17.3 Status

NMFS listed Lower Columbia River coho salmon as threatened on June 28, 2005 (70 FR 37160). Lower Columbia River coho salmon have been—and continue to be—affected by habitat degradation, hydropower impacts, harvest, and hatchery production. Out of the 24 populations that make up this ESU, 21 are considered to have a very low probability of persisting for the next 100 years, and none is considered viable. The very low persistence probability for most Lower Columbia River coho salmon populations is related to low abundance and productivity, loss of spatial structure, and reduced diversity. Though data quality has been poor because of inadequate spawning surveys and, until recently, the presence of unmarked hatchery-origin spawners, most populations are believed to have very low abundance of natural-origin spawners (50 fish or fewer). The spatial structure of some populations is constrained by migration barriers (such as tributary dams) and development in lowland areas. Low abundance, past stock transfers, other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among coho salmon populations. It is likely that hatchery effects have also decreased population productivity. The generally poor baseline population status of coho salmon reflects long-term trends: natural-origin coho salmon in the Columbia Basin have been in decline for the last 50 years. Based on these factors, this ESU would likely have very low resilience to additional perturbations.

4.17.4 Critical Habitat

NMFS proposed critical habitat designation of approximately 2,288 miles of freshwater and estuarine habitat in Oregon and Washington on January 14, 2013 (78 FR 2725). A final designation has not been made.

4.18 Coho Salmon (Oregon Coast ESU)

The Oregon Coast coho salmon ESU includes all naturally spawned populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco (63 FR 42587). One hatchery population, the Cow Creek hatchery coho salmon, is considered part of the ESU. We used information available in the status review (Good et al. 2005), "Scientific conclusions of the status review for Oregon coast coho salmon (*Oncorhynchus kisutch*)" (Stout et al. 2012). "Identification of historical populations of coho salmon (*Oncorhynchus kisutch*) in the Oregon

Coast Evolutionarily Significant Unit" (Lawson et al. 2007), listing documents (63 FR 42587; 73 FR 7816), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.18.1 Life History

In general, adults begin to migrate into rivers at the first fall freshet, usually in late October or early November, though there is some variation in run timing among watersheds. A delay in rain can delay river entry considerably. Some coho may spend up to two months in fresh water before spawning. Spawning usually occurs from November through January and may continue into February. Juveniles emerge from the gravel in spring and typically spend a summer and winter in fresh water before migrating to the ocean as smolts, usually in April or May of their second spring. Timing varies between years, among river systems, and based on small-scale habitat variability. Salmon in this ESU generally exhibit a three-year life cycle, though two- year-old males commonly occur in some streams and on average make up 20 percent of spawning males.

4.18.2 Population Dynamics

Lawson et al. (2007) considered the ESU to have historically consisted of 13 functionally independent populations and eight potentially dependent populations. Historical escapement in the 10 largest basins has been estimated to about 2.4 to 2.9 million spawners. The estimated median population of native spawners during the years 1990 to 1999 was 46,291 (min. 21,139, max. 82,661) spawners. After 1999, total ESU abundance increased. A median of 186,769 native spawners was estimated for the period 2000 through 2012 (min. 66,271, max. 356,243) (Oregon Department of Fish and Wildlife 2013). The encouraging increases in spawner abundance in 2000 to 2002 were preceded by three consecutive brood years (the 1994 to 1996 brood years returning in 1997 to 1999, respectively) exhibiting recruitment failure.[2] At the time of the 2005 status report, these three years of recruitment failure were the only such instances observed in the abundance time series since 1950. The increases in natural spawner abundance from 2000 to 2002 increases were primarily observed in populations in the northern portion of the ESU. Despite the increase in spawner abundance in 2000 to 2002, the long-term trends in ESU productivity remained negative due to the low abundances observed during the 1990s. Recent data indicate that the total abundance of natural spawners in the OC coho salmon ESU again steadily decreased until 2007 with an estimated spawner abundance of 66,271 fish or approximately 25 percent of the 2002 peak abundance (258,418 spawners) (Oregon Department of Fish and Wildlife 2013). Thus, recruitment failed during the five years from 2002 through 2007. Abundance increased each year from 179,686 native spawners in 2008 to the highest recorded abundance of native spawners in the time series: 356,243 native spawners in 2012; however, abundance in 2012 was estimated at 99,142 native spawners, indicating another recruitment failure.

4.18.3 Status

NMFS listed the Oregon coast coho salmon as a threatened species on February 11, 2008 (73 FR 7816). The ESU was listed because its biological status had not improved since NMFS's January 19, 2006 determination that the ESU's listing was not warranted (71 FR 3033) and current efforts being made to protect the species did not provide sufficient certainty of implementation or

[2] Recruitment failure is when a given year class of natural spawners fails to replace itself when its offspring return to the spawning grounds three years later.

effectiveness to mitigate the assessed level of extinction risk. Current coho salmon coastal distribution has not changed markedly compared to historical distribution; however, river alterations and habitat destruction have significantly modified use and distribution within several river basins. Genetic diversity has been reduced by legacy effects of freshwater and tidal habitat loss, very low spawner returns within the past 20 years, and past high levels of hatchery releases; however, with recent reductions in hatchery releases, diversity should improve. Based on these factors, this ESU would likely have a moderate resilience to additional perturbations.

4.18.4 Critical Habitat

NMFS designated critical habitat for Oregon Coast coho salmon on February 11, 2008 (73 FR 7816). The designation includes 72 of 80 watersheds within the range of the ESU, totals approximately 6,600 stream miles, and includes all or portions of the Nehalem, Nestucca/Trask, Yaquina, Alsea, Umpqua, and Coquille basins. PCEs include: spawning sites with water and substrate quantity to support spawning, incubation, and larval development; freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth, foraging, behavioral development (e.g., predator avoidance, competition), and mobility; freshwater migratory corridors free of obstruction with adequate water quantity and quality conditions; and estuarine, nearshore and offshore areas free of obstruction with adequate water quantity, quality and salinity conditions that support physiological transitions between fresh- and saltwater, predator avoidance, foraging and other life history behaviors.

PCEs vary widely throughout the critical habitat area designated the ESU; many watersheds have been heavily impacted and support low quality PCEs, while habitat in other watersheds have sufficient quality for supporting the conservation purpose of designated critical habitat. The spawning PCE has been impacted in many watersheds from the inclusion of fine sediment into spawning gravel from timber harvest and forestry related activities, agriculture, and grazing. These activities have also diminished the channels' rearing and overwintering capacity by reducing the amount of large woody debris in stream channels, removing riparian vegetation, disconnecting floodplains from stream channels, and changing the quantity and dynamics of stream flows. The rearing PCE has been degraded by elevated water temperatures in 29 of the watersheds within the Nehalem, North Umpqua, and the inland watersheds of the Umpqua subbasins. Water quality is impacted by contaminants from agriculture and urban areas in low lying areas in the Umpqua subbasin, and in coastal watersheds within the Siletz/Yaquina, Siltcoos, and Coos subbasins. Reductions in water quality have been observed in 12 watersheds due to contaminants and excessive nutrition. The migration PCE has been impacted throughout the ESU by culverts and road crossings that restrict passage.

4.19 Coho Salmon (Southern Oregon/Northern California Coast ESU)

The Southern Oregon/Northern California Coast coho salmon ESU consists of all naturally spawning populations of coho salmon that reside below long-term, naturally impassible barriers in streams between Punta Gorda, California and Cape Blanco, Oregon. This ESU also includes three artificial propagation programs. We used information available in status reviews (Good et al. 2005, NMFS 2011l, Williams et al. 2011), the draft recovery plan (NMFS 2012d), listing documents (62 FR 24588; 70 FR 37160), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.19.1 Life History

In this ESU, river entry occurs earlier in the north and later in the south. In Oregon, salmon of this ESU enter rivers in September or October; south of the Klamath River Basin to the Mattole River, California salmon entry occurs in November and December; and river entry occurs from mid-December to mid-February in rivers farther south. Because coho salmon enter rivers late and spawn late south of the Mattole River, they spend much less time in the river prior to spawning compared to populations farther north. Juveniles emerge from the gravel in spring, and typically spend a summer and winter in fresh water before migrating to the ocean as smolts in their second spring. Coho salmon adults spawn at age three, spending about a year and a half in the ocean.

4.19.2 Population Dynamics

Data on population abundance and trends are limited for this ESU. Historical point estimates of coho salmon abundance for the early 1960s and mid-1980s suggest that California statewide coho spawning escapement in the 1940s ranged between 200,000 and 500,000 fish. Numbers declined to about 100,000 fish by the mid-1960s with about 43 percent originating from this ESU. In 1994, Brown et al. estimated that about 7,000 wild and naturalized coho salmon were produced in the California portion of this ESU. Though long-term data on salmon abundance are scarce, the available monitoring data indicate that spawner abundance has generally declined for populations in this ESU. The Shasta River population has declined in abundance by almost 50 percent from one generation to the next; two partial counts from Prairie Creek, a tributary of Redwood Creek, and Freshwater Creek, a tributary of Humboldt Bay show negative trends; and data from the Rogue River basin also show recent negative trends. Estimates from Huntley Park in the Rogue River basin show a strong return year of approximately 25,000 spawners in 2004, followed by a decline to 2,566 fish in 2009. The 12-year average estimated wild adult coho salmon in the Rogue River basin between 1998 and 2009 (excluding 2008)[3] is 8,050 fish. Based on extrapolations from cannery pack, the Rogue River had an estimated adult coho salmon abundance of 114,000 in the late 1800s (Meengs and Lackey 2005).

4.19.3 Status

NMFS listed the Southern Oregon/Northern California coast coho salmon as threatened on May 7, 1997 (62 FR 24588), and reaffirmed their status on June 28, 2005 (70 FR 37160). The ESU was listed due to habitat loss and degradation from the combined effects of logging, agricultural, and mining activities; road building; urbanization; stream channelization; damming; wetland loss; beaver trapping, water withdrawals; overharvest; drought; flooding; poor ocean conditions and El Niño; and artificial propagation. Though distribution has been reduced and fragmented within the ESU, extant populations can still be found in all major river basins within the ESU. Presence-absence data indicate a disproportionate loss of southern populations compared to the northern portion of the ESU. Though long-term data on salmon abundance are scarce, the available monitoring data indicate that spawner abundance has generally declined for populations in this ESU. Many populations have been extirpated, are near extirpation, or are severely depressed. Based on available data, the draft recovery plan (NMFS 2012d) concluded that this ESU is at high risk of extinction and is not viable. Based on these factors, this ESU would likely have a very low resilience to additional perturbations.

[3] 2008 data were excluded from the average because the extremely low numbers were not consistent with that seen upstream at Gold Ray Dam, suggesting other reasons (sampling issues, data errors, etc.) for the dramatic drop in fish numbers from 2007 to 2008.

4.19.4 Critical Habitat

NMFS designated critical habitat for Southern Oregon/Northern California Coast coho salmon on May 5, 1999 (64 FR 24049). Designated critical habitat includes all accessible river reaches between Cape Blanco, Oregon, and Punta Gorda, California and consists of the water, substrate, and river reaches (including off-channel habitats) in specified areas. Accessible reaches are those within the historical range of the ESU that can still be occupied by any life stage of coho salmon. Specific PCEs were not designated in the critical habitat final rule; instead five "essential habitat" categories were described: 1) juvenile summer and winter rearing areas; 2) juvenile migration corridors; 3) areas for growth and development to adulthood; 4) adult migration corridors; and 5) spawning areas. The "essential features" that characterize these sites include adequate: 1) substrate; 2) water quality; 3) water quantity; 4) water temperature; 5) water velocity; 6) cover/shelter; 7) food; 8) riparian vegetation; 9) space; and 10) safe passage conditions. Critical habitat designated for this ESU is generally of good quality in northern coastal streams. Spawning essential habitats have been degraded throughout the ESU by logging activities that have increased fine particles in spawning gravel. Rearing essential habitats have been considerably degraded in many inland watersheds from the loss of riparian vegetation resulting in unsuitably high water temperatures. Rearing and juvenile migration essential habitat quality has been reduced from the disconnection of floodplains and off-channel habitat in low gradient reaches of streams, consequently reducing winter rearing capacity.

4.20 Sockeye Salmon (General Overview)

We discuss the distribution, life history, population dynamics, status, and critical habitats of the two species (here we use the word "species" to apply to distinct population segments, DPSs, and evolutionary significant units, ESUs) separately; however, because listed sockeye salmon species are virtually indistinguishable in the wild and comprise the same biological species, we begin this section describing characteristics common across ESUs. We used information available in the status review (Good et al. 2005), various listing documents, and biological opinions (NMFS 2012b) to summarize the status of the species.

Sockeye salmon occur in the North Pacific and Arctic oceans and associated freshwater systems. In North America, the species ranges north from the Klamath River in California to Bathurst Inlet in the Canadian Arctic. In Asia sockeye salmon range from northern Hokkaido in Japan north to the Anadyr River in Siberia. The largest populations occur north of the Columbia River.

4.20.1 Life History

Most sockeye salmon exhibit a lake-type life history (i.e., they spawn and rear in or near lakes), though some salmon exhibit a river-type life history. Spawning generally occurs in late summer and fall, but timing can vary greatly among populations. In lakes, salmon commonly spawn along "beaches" where underground seepage provides fresh oxygenated water. Incubation is a function of water temperature, but generally lasts between 100 to 200 days (Burgner 1991). Sockeye salmon fry primarily rear in lakes; river-emerged and stream-emerged fry migrate into lakes to rear. Juvenile sockeye salmon generally rear in lakes from one to three years after emergence, though some river-spawned salmon may migrate to sea in their first year. Juvenile sockeye salmon feeding behaviors change as they transition through life stages after emergence to the time of smoltification. In the early fry stage from spring to early summer, juveniles forage exclusively in the warmer littoral (i.e., shoreline) zone where they depend mostly on fly larvae and pupae, copepods, and water fleas. In summer, underyearling sockeye salmon move from the littoral habitat to a pelagic (i.e., open water) existence where they feed on larger zooplankton; however, flies may still make up a substantial portion of their diet. Older and larger fish may also prey on fish larvae. Distribution in lakes and prey preference is a dynamic process that changes daily and yearly depending on many factors, including: water temperature; prey abundance; presence of predators and competitors; and size of the juvenile. Peak emigration to the ocean occurs in mid-April to early May in southern sockeye populations (lower than 52ºN latitude) and as late as early July in northern populations (62ºN latitude) (Burgner 1991). Adult sockeye salmon return to their natal lakes to spawn after spending one to four years at sea. The diet of adult salmon consists of amphipods, copepods, squid, and other fish.

Certain populations of *O. nerka* become resident in the lake environment and are referred to as "kokanee". Kokanee and sockeye often co-occur in many interior lakes, where access to the sea is possible but energetically costly; kokanee are rarely found in coastal lakes, where the migration to sea is relatively short and energetic costs are minimal. In some cases a single population will give rise to both the anadromous and freshwater life history form. Both sockeye and kokanee are semelparous.

4.20.2 Population Dynamics

The population dynamics of each sockeye salmon ESU will be discussed separately, below.

4.20.3 Status

On June 28, 2005, as part of the final listing determinations for 16 ESUs of West Coast salmon, NMFS amended and streamlined the 4(d) protective regulations for threatened salmon and steelhead (70 FR 37160) as described in the *Protective Regulations for Threatened Salmonid Species* section of this document. Under this change, the section 4(d) protections apply to natural and hatchery fish with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed prior to release into the wild.

4.20.4 Critical Habitat

Critical habitat for each sockeye salmon ESU is discussed separately, below.

4.21 Sockeye Salmon (Ozette Lake ESU)

The Ozette Lake sockeye salmon ESU includes all naturally spawned anadromous populations of sockeye salmon that migrate into and rear in in Ozette Lake, Ozette River, Coal Creek, and other tributaries flowing into Ozette Lake, near the northwest tip of the Olympic Peninsula in Olympic National Park, Washington. Composed of only one population, the Ozette Lake sockeye salmon ESU consists of five spawning aggregations or subpopulations, grouped according to their spawning locations: Umbrella and Crooked creeks, Big Rive, and Olsen's and Allen's beaches. Two artificial populations are also considered part of this ESU. Sockeye salmon stock reared at the Makah Tribe's Umbrella Creek Hatchery were included in the ESU, but were not considered essential for recovery of the ESU. However, once the hatchery fish return and spawn in the wild, their progeny are considered to be listed under the ESA. We used information available in status reviews (Good et al. 2005, NMFS 2011f), the recovery plan (NMFS 2009d), "Viability Criteria for the Lake Ozette Sockeye Salmon Evolutionarily Significant Unit" (Rawson et al. 2009), listing documents (63 FR 11750, 64 FR 14528), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.21.1 Life History

Salmon of this ESU enter Ozette Lake through the Ozette River from April to early August and spawning is delayed until late October to February. Spawning occurs primarily in lakeshore upwelling areas of the lake, though minor spawning may occur below the lake in the Ozette River or its tributary, Coal Creek. Native sockeye salmon do not presently spawn in tributary streams to Ozette Lake, though spawning may have occurred there historically. Hatchery salmon, however, do spawn in the Ozette Lake tributaries of Umbrella Creek and Big River. Fry in Ozette Lake and the tributaries emerge from late-February through May and disperse to open areas of the lake to rear. Juveniles rear for one year in the lake and emigrate seaward in their second spring. At the time of emigration, smolts are relatively large, averaging four and a half to five inches in length. Most adult salmon of this ESU return from the ocean to spawn as four-year old fish. Ozette Lake also supports a population of kokanee which is not listed under the ESA.

4.21.2 Population Dynamics

The Ozette Lake sockeye salmon ESU is composed of one historical population with multiple spawning aggregations. Historically at least four beaches in the lake were used for spawning; today only two beach spawning locations, Allen's and Olsen's beaches, are used. The historical abundance of Ozette Lake sockeye salmon is poorly documented, but may have been as high as 50,000 individuals (Blum 1988). Declines began to be reported in the 1920s. Escapement estimates (run size minus broodstock take) from 1996 to 2006 are variable and range from a low of 1,404 individuals in 1997 to a high of 6,461 individuals in 2004, with a median of approximately 3,800 sockeye per year (geometric mean: 3,353). No statistical estimation of trends for this ESU are reported. However, comparing four year averages (to include four brood years in the average because the species primarily spawn as four-year olds) shows an increase during the period 2000 to 2006. For return years 1996 to 1999 the run size averaged 2,460 sockeye salmon; for years 2000 to 2003 the run size averaged just over 4,420 fish; and for years 2004 to 2006, the average abundance estimate was 4,167 sockeye. The supplemental hatchery program began with out-of-basin stocks and make up an average of 10 percent of the run. The proportion of beach spawners originating from the hatchery is unknown, but it is likely that straying is low. Based on estimates of habitat carrying capacity, a viable sockeye salmon population in the Lake Ozette watershed would range between 35,500 to 121,000 spawners.

4.21.3 Status

NMFS listed the Ozette Lake sockeye salmon ESU as threatened on March 25, 1999 (64 FR 14528), and reaffirmed their threatened status on June 28, 2005 (70 FR 37160). The ESU was listed due to habitat loss and degradation from the combined effects of logging; road building; predation; invasive plant species; and overharvest. Ozette Lake sockeye salmon have not been commercially harvested since 1982 and only minimally harvested by the Makah Tribe since 1982 (0 to 84 fish per year); there are also no known marine area harvest impacts to fish of this ESU. Overall abundance is substantially below historical levels and it is not known if this decrease in abundance is a result of fewer spawning aggregations, lower abundances at each aggregation, or a combination of both factors. The proportion of beach spawners is assumed to be low; therefore, hatchery originated fish are not believed to have had a major effect on the genetics of the naturally spawned population. However, Ozette Lake sockeye have a relatively low genetic diversity compared to other *O. nerka* populations examined in Washington State (Crewson et al. 2001). Genetic differences do occur between age cohorts, but as different age groups do not spawn with each other, the population may be more vulnerable to significant reductions in population structure due to catastrophic events or unfavorable conditions affecting one year class. Based on these factors, this ESU would likely have a low resilience to additional perturbations.

4.21.4 Critical Habitat

NMFS designated critical habitat for Ozette Lake sockeye salmon on September 2, 2005 (70 FR 52630). It encompasses areas within the Hoh/Quillayute subbasin, Ozette Lake, and the Ozette Lake watershed. The entire occupied habitat for this ESU is within the single watershed for Ozette Lake. PCEs identified for Lake Ozette sockeye salmon are areas for spawning, freshwater rearing and migration, estuarine areas free of obstruction, nearshore marine areas free of obstructions, and offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, and adequate passage conditions. Spawning habitat has been affected by loss of tributary spawning areas and exposure of much of the available beach spawning habitat due to low water levels in summer. Further, native and non-native vegetation as well as sediment have reduced the quantity and suitability of beaches for spawning. The rearing PCE is degraded by excessive predation and competition with introduced non-native species, and by loss of tributary rearing habitat. Migration habitat may be adversely affected by high water temperatures and low water flows in summer which causes a thermal block to migration (La Riviere 1991).

4.22 Sockeye Salmon (Snake River ESU)

The Snake River sockeye salmon ESU includes all anadromous and residual sockeye from the Snake River basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake Captive Broodstock Program. Redfish Lake is located in the Salmon River basin, a subbasin within the larger Snake River basin. We used information available in status reviews (Gustafson et al. 1997, Good et al. 2005, NMFS 2011i), listing documents (58 FR 68543, 70 FR 37160), and previously issued biological opinions (NMFS 2008b, 2012b) to summarize the status of the species.

4.22.1 Life History

Snake River sockeye salmon are unique compared to other sockeye salmon populations. Sockeye salmon returning to Redfish Lake travel a greater distance from the sea (approximately 900 miles) to a higher elevation (6,500 ft) than any other sockeye salmon population and are the southern-most population of sockeye salmon in the world (Bjornn et al. 1968). Salmon of this ESU are separated by 700 or more river miles from two other extant upper Columbia River populations in the Wenatchee River and Okanogan River drainages. These latter populations return to lakes at substantially lower elevations (Wenatchee at 1,870 ft, Okanagon at 912 ft) and occupy different ecoregions.

No natural origin anadromous adults have returned since 1998 and the species is currently entirely supported by adults produced through a captive propagation program. Historically, salmon of this ESU entered the Columbia River system in June and July, and arrived at Redfish Lake between August and September. Spawning occurred in lakeshore gravel and generally peaked in October. Fry emerged in the spring (generally April and May) then migrated to open waters of the lake to feed. Juvenile sockeye remained in the lake for one to three years before migrating through the Snake and Columbia Rivers to the ocean. While pre-dam reports indicate that sockeye salmon smolts migrate in May and June, PIT-tagged sockeye smolts from Redfish Lake pass Lower Granite Dam from mid-May to mid-July. Adult anadromous sockeye spent two or three years in the open ocean before returning to Redfish Lake to spawn. A resident form of Snake River sockeye salmon also occurs in Redfish Lake. The residuals are nonanadromous (i.e. they complete their entire life cycle in fresh water); however, studies have shown that some ocean migrating juveniles are progeny of resident females (Rieman et al. 1994). The resident salmon spawn at the same time and in the same location as anadromous sockeye salmon.

4.22.2 Population Dynamics

The only extant sockeye salmon population in the Snake River basin at the time of listing occurred in Redfish Lake. Other lakes in the Salmon River basin that historically supported sockeye salmon include Alturas Lake above Redfish Lake which was extirpated in the early 1900s as a result of irrigation diversions, though residual sockeye may still exist in the lake. From 1955 to 1965, the Idaho Department of Fish and Game eradicated sockeye salmon from Pettit, Stanley, and Yellowbelly lakes, and built permanent structures on each of the lake outlets that prevented re-entry of anadromous sockeye salmon (Chapman and Witty 1993). Other historic sockeye salmon populations within the Snake River basin now considered extinct include Wallowa Lake (Grande Ronde River drainage, Oregon), Payette Lake (Payette River drainage, Idaho), and Warm Lake (South Fork Salmon River drainage, Idaho).

Adult returns to Redfish Lake during the period 1954 through 1966 ranged from 11 to 4,361 fish (Bjornn et al. 1968). In 1985, 1986, and 1987, 11, 29, and 16 sockeye, respectively, were counted at the Redfish Lake weir. Only 18 natural origin sockeye salmon have returned to the Stanley Basin since 1987. The first adult returns from the captive brood stock program returned to the Stanley Basin in 1999. From 1999 through 2005, a total of 345 captive brood adults that had migrated to the ocean returned to the Stanley Basin. Recent years have seen an increase in returns to over 600 in 2008 and more than 700 returning adults in 2009.

4.22.3 Status

NMFS listed Snake River sockeye salmon as endangered on November 20, 1991 (56 FR 58619), and reaffirmed their status on June 28, 2005 (70 FR 37160). Subsequent to the 1991 listing, the residual form of sockeye residing in Redfish Lake was identified and in 1993, NMFS determined that residual sockeye salmon in Redfish Lake was part of the ESU. The ESU was listed due to habitat loss and degradation from the combined effects of damming and hydropower development; overexploitation; fisheries management practices; and poor ocean conditions. Recent annual abundances of natural origin sockeye salmon in the Stanley Basin have been extremely low. This species is currently entirely supported by adults produced through the captive propagation program. No natural origin anadromous adults have returned since 1998 and the abundance of residual sockeye salmon in Redfish Lake is unknown. Current smolt-to-adult survival of sockeye originating from the Stanley Basin lakes is rarely greater than 0.3 percent (Hebdon et al. 2004). Based on these factors, this ESU would likely have a very low resilience to additional perturbations.

4.22.4 Critical Habitat

NMFS designated critical habitat for SR sockeye salmon on December 28, 1993 (58 FR 68543). It encompass the waters, waterway bottoms, and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to salmon of this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams). Specific PCEs were not designated in the critical habitat final rule; instead four “essential habitat” categories were described: 1) spawning and juvenile rearing areas, 2) juvenile migration corridors, 3) areas for growth and development to adulthood, and 4) adult migration corridors. The “essential features” that characterize these sites include substrate/spawning gravel; water quality, quantity, temperature, velocity; cover/shelter; food; riparian vegetation; space; and safe passage conditions. The quality and quantity of rearing and juvenile migration essential habitats have been reduced from activities such as tilling, water withdrawals, timber harvest, grazing, mining, and alteration of floodplains and riparian vegetation. These activities disrupt access to foraging areas, increase the amount of fines in the steam substrate that support production of aquatic insects, and reduce instream cover. Adult and juvenile migration essential habitat is affected by four dams in the Snake River basin that obstructs migration and increases mortality of downstream migrating juveniles. Water quality impairments in designated critical habitat include inputs from fertilizers, insecticides, fungicides, herbicides, surfactants, heavy metals, acids, petroleum products, animal and human sewage, dust suppressants (*e.g.*, magnesium chloride), radionuclides, sediment in the form of turbidity, and other anthropogenic pollutants. Pollutants enter the surface waters and riverine sediments from the headwaters of the Salmon River to the Columbia River estuary as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges.

4.23 Steelhead Trout (General Overview)

We discuss the distribution, life history, population dynamics, status, and critical habitats of the eleven species (here we use the word “species” to apply to distinct population segments, DPSs, and evolutionary significant units, ESUs) separately; however, because listed steelhead trout species are virtually indistinguishable in the wild and comprise the same biological species, we begin this section describing characteristics common across DPSs. We used information available in the 2005 West Coast salmon and steelhead status review (Good et al. 2005), various salmon ESU listing documents, and biological opinions (NMFS 2012b) to summarize the status of the species.

Steelhead is the common name of the anadromous form of *O. mykiss*. They are a Pacific salmonid with freshwater habitats that include streams extending from northwestern Mexico to Alaska in North America to the Kamchatka peninsula in Russia. Non-anadromous *O. mykiss* do not migrate to the ocean and remain in freshwater all their lives. These fish are commonly called rainbow trout.

4.23.1 Life History

Though steelhead have a longer run time than other Pacific salmonids and do not tend to travel in large schools, they can be divided into two basic run-types: the stream-maturing type (summer steelhead) and the ocean-maturing type (winter steelhead). Summer steelhead enter fresh water as sexually immature adults between May and October (Nickelson et al. 1992, Busby et al. 1996) and hold in cool, deep pools during summer and fall before moving to spawning sites as mature adults in January and February (Barnhart 1986, Nickelson et al. 1992). Winter steelhead return to fresh water between November and April as sexually mature adults and spawn shortly after river entry (Nickelson et al. 1992, Busby et al. 1996). Steelhead typically spawn in small tributaries rather than large, mainstem rivers and spawning distribution often overlaps with coho salmon, though steelhead tend to prefer higher gradients (generally two to seven percent, but up to 12 percent or more) and their distributions tend to extend further upstream than coho salmon. Summer steelhead commonly spawn higher in a watershed than do winter steelhead, sometimes even using ephemeral streams from which juveniles are forced to emigrate as flows diminish.

Fry usually inhabit shallow water along banks and stream margins of streams (Nickelson et al. 1992) and move to faster flowing water such as riffles as they grow. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson et al. 1992). In Oregon and California, steelhead may enter estuaries where sand bars create low salinity lagoons. Migration of juvenile steelhead to these lagoons occurs throughout the year, but is concentrated in the late spring/early summer and in the late fall/early winter periods (Shapovalov and Taft 1954, Zedonis 1992). Juveniles rear in fresh water for one to four years, then smolt and migrate to the ocean in March and April (Barnhart 1986). Steelhead typically reside in marine waters for two or three years prior to returning to their natal streams to spawn as four or five-year olds. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby et al. 1996). Females spawn more than once more commonly than males, but rarely more than twice before dying (Nickelson et al. 1992). Iteroparity is also more common among southern steelhead populations than northern populations (Busby et al. 1996).

Steelhead feed on a variety of prey organisms depending upon life stage, season, and prey availability. In freshwater juveniles feed on common aquatic stream insects such as caddisflies, mayflies, and stoneflies but also other insects (especially chironomid pupae), zooplankton, and benthic organisms (Pert 1993, Merz 2002). Older juveniles sometimes prey on emerging fry, other fish larvae, crayfish, and even small mammals, though these are not a major food source (Merz 2002). The diet of adult oceanic steelhead is comprised primarily of fish and squid (Light 1985, Burgner et al. 1992).

4.23.2 Status

On June 28, 2005, as part of the final listing determinations for 16 ESUs of West Coast salmon, NMFS amended and streamlined the 4(d) protective regulations for threatened salmon and steelhead (70 FR 37160) as described in the *Protective Regulations for Threatened Salmonid Species* section of this document. Under this change, the section 4(d) protections apply to natural and hatchery fish with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed prior to release into the wild.

4.23.3 Population Dynamics

The population dynamics of each steelhead DPS will be discussed separately, below.

4.23.4 Critical Habitat

NMFS designated critical habitat for all but one of the listed steelhead DPSs on September 2, 2005 (70 FR 52488). Proposed designation of critical habitat for the Puget Sound steelhead will be discussed separately in Section 6.6.5. Areas designated as critical habitat are important for the species' overall conservation by protecting quality growth, reproduction, and feeding. At the time of designation, PCEs are identified and include sites necessary to support one or more steelhead life stage(s). PCEs in steelhead designated habitat include freshwater spawning and rearing sites, freshwater migration corridors, nearshore marine habitat, and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. The critical habitat section for each listed DPS below identifies the areas included as part of the designation and discusses the current status of critical habitat.

4.24 Steelhead (California Central Valley DPS)

The California Central Valley steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in the Sacramento and San Joaquin Rivers and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries. The DPS also includes two artificial propagation programs: the Coleman National Fish Hatchery and Feather River Hatchery. We used information available in status reviews (Good et al. 2005, NMFS 2011c), the draft recovery plan (NMFS 2009c), listing documents (69 FR 33102; 71 FR 834), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.24.1 Life History

Members of this DPS have the longest freshwater migration of any population of winter steelhead. Adults return to freshwater essentially continuously from July to May, with peaks in September and February. Spawning occurs from December to April, with peaks from January to March (McEwan and Jackson 1996). Spawning occurs in small streams and tributaries directly downstream of dams. Juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurs in spring, with a much smaller peak in fall. Emigrating juveniles use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean; some may use tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea (Hallock et al. 1961).

4.24.2 Population Dynamics

The California Central Valley steelhead DPS may have consisted of 81 historical and independent populations (Lindley et al. 2006). Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries. Until recently, steelhead were considered extirpated from the San Joaquin River system; in 2004, a total of 12 steelhead smolts were collected in monitoring trawls at the Mossdale station in the lower San Joaquin River (California Department of Fish and Game, unpubl. data). Historically, annual steelhead run size for this ESU may have approached one to two million adults. By the early 1960s, the run size had declined to about 40,000 adults (McEwan 2001). Steelhead were counted at the Red Bluff Diversion Dam until 1993; counts declined from an average of 11,187 from 1967 to 1977 to an average of approximately 2,000 through the early 1990s. Estimated total annual run size for the entire Sacramento-San Joaquin system was no more than 10,000 adults during the early 1990s (McEwan and Jackson 1996, McEwan 2001). Based on catch ratios at Chipps Island in the Delta and using generous survival assumptions, the average number of steelhead females spawning naturally in the entire Central Valley during the years 1980 to 2000 was estimated at approximately 3,600.

4.24.3 Status

NMFS listed the California Central Valley steelhead DPS as threatened on March 19, 1998, and reaffirmed their status on January 5, 2006 (71 FR 834). Factors contributing to the listing of this DPS include the loss of most historical spawning and rearing habitat above impassable dams, restriction of natural production areas, the apparent continuing decline in abundance, and lack of monitoring efforts to assess the DPS's abundance and trends. The DPS's present distribution has been greatly reduced: about 80 percent of historic habitat has been lost behind dams and about 38 percent of habitat patches that supported independent populations are no longer accessible to steelhead (Lindley et al. 2006). Though previously thought to be extirpated from these areas, populations may exist in Big Chico and Butte Creeks and steelhead have also been observed in Clear Creek and Stanislaus River (Demko and Cramer 2000). A few wild steelhead are produced in the American and Feather Rivers. Though annual monitoring data for calculating trends are lacking, available data indicate the DPS has had a significant long-term downward trend in abundance. The losses of populations and reductions in abundance have reduced genetic diversity in the DPS. Hatchery-origin fish have also compromised the genetic diversity of the majority of the spawning runs. Based on these factors, this DPS would likely have a low resilience to additional perturbations.

4.24.4 Critical Habitat

Designated critical habitat for the California Central Valley steelhead DPS encompasses about 2,300 miles of stream habitat and about 250 square miles of estuarine habitat in the San Francisco-San Pablo-Suisan Bay estuarine complex and includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the lower San Joaquin River to the confluence with the Merced River, including its tributaries, and the waterways of the Delta. The critical habitat is degraded, and does not provide the conservation value necessary for species recovery. In addition, the Sacramento-San Joaquin River Delta provides very little function necessary for juvenile steelhead rearing and smoltification. The spawning PCE is subject to variations in flows and temperatures, particularly over the summer months. The rearing PCE is degraded by channelized, leveed, and riprapped river reaches, and sloughs common in the Sacramento-San Joaquin system. These areas typically have low habitat complexity, low abundance of food organisms, offer little protection from fish or avian predators, and commonly have elevated temperatures. The current conditions of migration corridors are substantially degraded. Both migration and rearing PCEs have reduced water quality from several contaminants introduced by dense urbanization and agriculture along the mainstems and in the Delta. In the Sacramento River, the migration corridor for both juveniles and adults is obstructed by the Red Bluff Diversion Dam gates from May 15 through September 15. The migration PCE is also obstructed by complex channel configuration making it difficult for fish to migrate successfully to the western Delta and the ocean. State and federal pumps and associated fish facilities alter flows in the Delta and impede and obstruct a functioning migration corridor. The estuarine PCE in the Delta is affected by contaminants from agricultural and urban runoff and release of wastewater treatment plants effluent. However, some complex, productive habitats with floodplains remain in the system and flood bypasses (i.e., Yolo and Sutter bypasses).

4.25 Steelhead (Central California Coast DPS)

The Central California Coast steelhead DPS includes all naturally spawned populations of steelhead in coastal streams from the Russian River to Aptos Creek; the drainages of San Francisco, San Pablo, and Suisun Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers; and tributary streams to Suisun Marsh including Suisun Creek, Green Valley Creek, and an unnamed tributary to Cordelia Slough (commonly referred to as Red Top Creek). The DPS does not include the Sacramento-San Joaquin River Basin of the California Central Valley. Two artificial propagation programs are considered to be part of the DPS: the Don Clausen Fish Hatchery, and Kingfisher Flat Hatchery/Scott Creek (Monterey Bay Salmon and Trout Project). We used information available in status reviews (Good et al. 2005, NMFS 2011b), the recovery outline (NMFS 2007a), “An analysis of historical population structure for evolutionarily significant units of Chinook salmon, coho salmon, and steelhead in the North-Central California Coast Recovery Domain" (Bjorkstedt et al. 2005), listing documents (61 FR 41541, 62 FR 43937; 71 FR 834), and previously issued biological opinions (NMFS 2008a, 2012b) to summarize the status of the species.

4.25.1 Life History

The DPS, like those to the south, is entirely composed of winter-run fish. Adults return to the Russian River and migrate upstream from December to April. Most spawning occurs from January to April. Smolts emigrate between March and May (Shapovalov and Taft 1954, Hayes et al. 2004), typically at one to four years of age, though recent studies indicate that growth rates in Soquel Creek likely prevent juveniles from undergoing smoltification until age two (Sogard et al. 2009).

4.25.2 Population Dynamics

The Central California Coast steelhead DPS consisted of nine historic functionally independent populations and 23 potentially independent populations. Of the historic functionally independent populations, at least two are extirpated and most of the remaining populations are nearly extirpated. Historically, the entire CCC steelhead DPS may have consisted of an average runs size of 94,000 adults in the early 1960s. Information on current steelhead populations in the DPS consists of anecdotal, sporadic surveys that are limited to only smaller portions of watersheds. Though it is not possible to calculate long-term trends for individual watersheds or the entire DPS, the limited data that do exist indicate that abundance has declined for all populations sampled compared to historical data. Current runs in the basins that originally contained the two largest steelhead populations for the DPS, the San Lorenzo and the Russian Rivers, both have been estimated at less than 15 percent of their abundances compared to 30 years earlier. The interior Russian River winter-run steelhead has the largest runs with an estimate of an average of over 1,000 spawners.

4.25.3 Status

NMFS listed the Central California Coast steelhead as threatened on August 18, 1997 (62 FR 43937), and reaffirmed their status on January 5, 2006 (71 FR 834). Factors contributing to the listing of this DPS include the generalized listing factors for West Coast salmon (i.e., destruction and modification of habitat, overutilization for recreational purposes, and natural and human-made factors), as well as the more specific issue of sedimentation and channel restructuring due to floods. Spatial structure has been reduced throughout the DPS. Impassible dams have cut off substantial portions of habitat in some basins and it is estimated that 22 percent of the DPS's historical habitat has been lost behind (primarily man-made) barriers, including significant portions of the upper Russian River. Long-term population sustainability is extremely low for the southern populations in the Santa Cruz Mountains and in the San Francisco Bay, and declines in juvenile southern populations are consistent with the more general estimates of declining abundance in the region. The interior Russian River population may be able to be sustained over the long-term, but hatchery management has eroded the population's genetic diversity. Though the information for individual populations is limited, available information strongly suggests that no population is viable. Based on these factors, this DPS would likely have a low resilience to additional perturbations.

4.25.4 Critical Habitat

Designated critical habitat for the Central California coast steelhead DPS includes the Russian River watershed, coastal watersheds in Marin County, streams within the San Francisco Bay, and coastal watersheds in the Santa Cruz Mountains, southeast to Aptos Creek. The spawning PCE have reduced quality throughout the critical habitat; sediment fines in spawning gravel have reduced the ability of the substrate attribute to provide well oxygenated and clean water to eggs and alevins. The forage PCE has been degraded in some areas where high proportions of fines in bottom substrate limit the production of aquatic stream insects adapted to high velocity water. Elevated water temperatures and impaired water quality have further reduced the quality, quantity, and function of the rearing PCE within most streams. These impacts have diminished the ability of designated critical habitat to conserve the Central California Coast steelhead.

4.26 Steelhead (Lower Columbia River DPS)

The Lower Columbia River steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in streams and tributaries to the Columbia River between the Cowlitz and Wind Rivers, Washington, and the Willamette and Hood Rivers, Oregon. The DPS also includes seven hatchery populations. We used information available in status reviews (Busby et al. 1996, Good et al. 2005, Ford 2011, NMFS 2011d), recovery plans (Lower Columbia Fish Recovery Board 2010, Oregon Department of Fish and Wildlife 2010, NMFS 2013c), listing documents (61 FR 41541, 63 FR 13347, 71 FR 834), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.26.1 Life History

The Lower Columbia River steelhead DPS includes populations of summer- and winter-run steelhead. Summer-run steelhead return sexually immature to the Columbia River from May to October, and spend several months in fresh water prior to spawning between February and April. Winter-run steelhead enter fresh water from December to May at sexual maturity. Peak spawning occurs from April to May. Where both races spawn in the same stream, summer-run steelhead tend to spawn at higher elevations than winter-run steelhead. Fry emerge from March to July, with peaks between April and May. Steelhead smolts generally migrate at ages ranging from one to four years, but most smolt after two years in freshwater. Emigration of both summer- and winter-run steelhead generally occurs from March to June, with peak migration in April to May. Both winter- and summer-run adults normally return to freshwater after two years in the ocean.

4.26.2 Population Dynamics

The Lower Columbia River steelhead had 17 historically independent winter-run steelhead populations and six independent summer-run steelhead populations (McElhany et al. 2003, Myers et al. 2006). All historic populations are considered extant. All populations declined from 1980 to 2000, with sharp declines beginning in 1995. Historical counts in some of the larger tributaries (Cowlitz, Kalama, and Sandy Rivers) suggest the population probably exceeded 20,000 fish. During the 1990s, fish abundance dropped to 1,000 to 2,000 fish. Recent abundance estimates of natural-origin spawners range from extirpation of some populations above impassable barriers to over 700 fishes in the Kalama and Sandy winter-run populations. A number of the populations have a substantial fraction of hatchery-origin spawners in spawning areas. Many of the long-and short-term trends in abundance of individual populations are negative.

4.26.3 Status and trends

NMFS listed Lower Columbia River steelhead as threatened on March 19, 1998 (63 FR 13347), and reaffirmed their status on January 5, 2006 (71 FR 834). Factors contributing to the listing of this DPS include the generalized listing factors for West Coast salmon (i.e., destruction and modification of habitat, overutilization for recreational purposes, and natural and human-made factors), as well as the more specific issue of genetic introgression from hatchery stocks. Spatial structure remains relatively high for most populations (Lower Columbia Fish Recovery Board 2010, Oregon Department of Fish and Wildlife 2010). Except in the North Fork Lewis subbasin, where dams have impeded access to historical spawning habitat, most summer-run steelhead populations continue to have access to historical production areas in forested, mid- to-high-elevation subbasins that remain largely intact. Most populations of winter-run steelhead have maintained their spatial structure, though many of these habitats no longer support significant production (Lower Columbia Fish Recovery Board 2010, Oregon Department of Fish and Wildlife 2010). Out of the 23 populations in this DPS, 16 are considered to have a low or very low probability of persisting over the next 100 years, and six populations have a moderate probability of persistence (Lower Columbia Fish Recovery Board 2010, Oregon Department of Fish and Wildlife 2010). Only the summer-run Wind population is considered viable. The low to very low baseline persistence probabilities of most Lower Columbia River steelhead populations reflects low abundance and productivity. In addition, it is likely that genetic and life history diversity has been reduced as a result of pervasive hatchery effects and population bottlenecks. Although current Lower Columbia River steelhead populations are depressed compared to historical levels and long-term trends show declines, many populations are substantially healthier than their salmon counterparts, typically because of better habitat conditions in core steelhead production areas (Lower Columbia Fish Recovery Board 2010). Based on these factors, this DPS would likely have a moderate resilience to additional perturbations.

4.26.4 Critical Habitat

Designated critical habitat for the Lower Columbia River steelhead DPS includes the following subbasins: Middle Columbia/Hood, Lower Columbia/Sandy, Lewis, Lower Columbia/Clatskanie, Upper Cowlitz, Cowlitz, Clackamas, and Lower Willamette. The Lower Columbia River corridor is also included in the designated critical habitat. Critical habitat is affected by reduced quality of rearing and juvenile migration PCEs within the lower portion and alluvial valleys of many watersheds. Contaminants from agriculture further affect both water quality and food production in these degraded reaches of tributaries and in the mainstem Columbia River. Several dams affect adult migration PCE by obstructing the migration corridor. Watersheds which consist of a large proportion of Federal lands (e.g., the Sandy River watershed) have relatively healthy riparian corridors that support attributes of the rearing PCE such as cover, forage, and suitable water quality.

4.27 Steelhead (Middle Columbia River DPS)

The Middle Columbia River steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in streams from above the Wind River, Washington, and the Hood Rivers, Oregon and upstream to, and including, the Yakima River, Washington, excluding *O. mykiss* from the Snake River Basin. The DPS also includes seven artificial propagation programs. Steelhead from the Snake River basin (described in Section 6.7) are not included in this DPS. We used information available in status reviews (Busby et al. 1996, Good et al. 2005, Ford 2011, NMFS 2011e), the recovery plan (NMFS 2009b), listing documents

(63 FR 11798, 64 FR 14517, 71 FR 834), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.27.1 Life History

Middle Columbia River steelhead populations are mostly of the summer-run type, with the exception of inland winter-run steelhead that occur in the Klickitat River and Fifteenmile Creek. Adult summer-run steelhead enter fresh water from June through August and adults may spend up to a year in freshwater before spawning. The majority of juveniles smolt and emigrate to the ocean as two-year olds. About equal numbers of adults in the DPS return to freshwater after spending one or two years in the ocean; however, summer-run steelhead in Klickitat River have a life cycle more like Lower Columbia River steelhead where most of returning adults have spent two years in the ocean.

4.27.2 Population Dynamics

The Interior Columbia Technical Review Team identified 16 extant populations in four major population groups (Cascades Eastern Slopes Tributaries, John Day River, Walla Walla and Umatilla Rivers, and Yakima River) and one extant unaffiliated population (Rock Creek) (Interior Columbia Technical Review Team 2003). There are three extirpated populations: two in the Cascades Eastern Slope major population group and one in the Walla Walla and Umatilla Rivers major population group. Historic run estimates for the Yakima River indicate that annual species abundance may have exceeded 300,000 returning adults. The 10-year geometric mean for each population ranges from a low of 85 fish (Upper Yakima River) to 1,800 fish (Lower Mainstem John Day). The 10-year average proportion of hatchery-origin spawners ranges from two percent (Walla Walla Mainstem) to 39 percent (Eastside Deschutes); the majority of populations have a hatchery proportion of spawners between six to eight percent. Fifteenmile Creek has no hatchery-origin spawners.

4.27.3 Status

NMFS listed Middle Columbia River steelhead as threatened on March 25, 1999 (64 FR 14517), and reaffirmed their threatened status on January 5, 2006 (71 FR 834). Factors contributing to the listing of this DPS include the generalized listing factors for West Coast salmon (i.e., destruction and modification of habitat, overutilization for recreational purposes, and natural and human-made factors), as well as impacts from artificial propagation. NMFS considers spatial structure and diversity of the DPS to be at moderate risk. Relative to the brood cycle just prior to listing (1992 to 1996 spawning year), current brood cycle (five-year geometric mean) natural abundance is substantially higher (more than twice) for seven of the populations, lower for three, and at similar levels for four populations. Three populations have insufficient data to calculate long-term trends. Short-term trends are positive for all but three populations. Viability ratings for the 17 populations are: four viable, seven maintained, one highly variable, and five high risk. Impacts from Tribal fisheries targeting Chinook salmon continue to harvest approximately five percent of summer-run steelhead in the Middle Columbia, Upper Columbia, and Snake River Basins per year. Based on these factors, this DPS would likely have a moderate resilience to additional perturbations.

4.27.4 Critical Habitat

Designated critical habitat for the Middle Columbia River steelhead DPS includes the following subbasins: Upper Yakima, Naches, Lower Yakima, Middle Columbia/Lake Wallula, Walla Walla, Umatilla, Middle Columbia/Hood, Klickitat, Upper John Day, North Fork John Day, Middle Fork John Day, Lower John Day, Lower Deschutes, Trout, the Upper Columbia/Priest Rapids subbasins, and the Columbia River corridor. The current condition of Middle Columber River critical habitat is moderately degraded. Quality of juvenile rearing and migration PCEs has been reduced in several watersheds and in the mainstem Columbia River by contaminants from agriculture that affect both water quality and food production. Loss of riparian vegetation from grazing has resulted in high water temperatures in the John Day basin. Reduced quality of the rearing PCEs has diminished its contribution to the conservation value necessary for the recovery of the species. Several dams affect adult migration PCE by obstructing the migration corridor.

4.28 Steelhead (Northern California DPS)

The Northern California steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in California coastal river basins from Redwood Creek southward to, but not including, the Russian River. The DPS also includes two artificial propagation programs: the Yeager Creek Hatchery and the North Fork Gualala River Hatchery (Gualala River Steelhead Project). We used information available in status reviews (Busby et al. 1996, Good et al. 2005, NMFS 2011b), the recovery outline (NMFS 2007b), "An analysis of historical population structure for evolutionarily significant units of Chinook salmon, coho salmon, and steelhead in the North-Central California Coast Recovery Domain" (Bjorkstedt et al. 2005), "A framework for assessing the viability of Threatened and Endangered Salmon and Steelhead in the North-central California Coast Recovery Domain" (Spence et al. 2008), listing documents (61 FR 41541, 62 FR 43937; 71 FR 834), and previously issued biological opinions (NMFS 2008a, 2012b) to summarize the status of the species.

4.28.1 Life History

This DPS includes both winter- and summer-run steelhead. In the Mad and Eel Rivers, immature steelhead may return to fresh water as "half-pounders" after spending only two to four months in the ocean. Generally, a half-pounder will overwinter in fresh water and return to the ocean in the following spring. Juvenile out-migration appears more closely associated with size than age; though juveniles generally, throughout their range in California, spend two years in fresh water. Smoltification occurs when they are between 14 to 21 cm in length.

4.28.2 Population Dynamics

Historically, this DPS encompassed 42 independent populations of winter-run steelhead (19 functionally independent and 23 potentially independent) and 10 independent populations of summer-run steelhead. All historic populations of winter-run salmon are extant. Of the 10 summer-run steelhead populations, four are extant and six are assumed to be either extirpated or extremely depressed. Long-term data sets are limited for the Northern California steelhead. Prior to 1960, estimates of abundance specific to this DPS were available from dam counts. Cape Horn Dam in the upper Eel River reported annual average numbers of adults as 4,400 in the 1930s); Benbow Dam in the South Fork Eel River reported annual averages of 19,000 in the 1940s; and the Sweasey Dam in the Mad River reported annual averages of 3,800 in the 1940s. Estimates of steelhead spawning populations for many rivers in this DPS totaled 198,000 by the mid-1960s. For winter-run populations that have had recent counts, returns have not exceeded more than a few hundred fish, with the exception of a portion of the Gualala River population (counts of adult steelhead have averaged 1,915 fish) and at the Mad River Hatchery (average of 2,300 adults). The only summer-run steelhead population with a comprehensive time series of abundance is the Middle Fork Eel River, which has been monitored since the mid-1960s. Counts have averaged 780 fish over the period of record and 609 fish in the past 16 years. Both short-term and long-term trends are negative, though not significantly.

4.28.3 Status

NMFS listed Northern California steelhead as threatened on June 7, 2000 (65 FR 36074), and reaffirmed their status on January 5, 2006 (71 FR 834). Factors contributing to the listing of this DPS include the generalized listing factors for West Coast salmon (i.e., destruction and modification of habitat, overutilization for recreational purposes, and natural and human-made factors), as well as the more specific issue of the introduction of a salmonid predator, the Sacramento pikeminnow (formerly known as Sacramento squawfish [*Ptychocheilus grandis*], and concern about the influence of hatchery stocks on native fish (i.e., genetic introgression and ecological interactions). Overall, spatial structure of the DPS is relatively intact and all diversity strata appear to be represented by extant populations. However, spatial structure and distribution within most watersheds has been adversely affected by barriers and high water temperatures. The scarcity of time series of abundance at the population level spanning more than a few years hinders assessment of the DPS's status; population level estimates of abundance are available for four of the 42 winter-run populations and for one of the 10 summer-run populations. Trend information from the available datasets suggests a mixture of patterns, with slightly more populations showing declines than increases, though few of these trends are statistically significant. Where population level estimates of abundance are available, only the Middle Fork Eel River summer-run populations are considered to have a low-risk of extinction. The remaining populations for which adult abundance has been estimated appear to be at either moderate- or high-risk of extinction. Although surveys within the summer-run steelhead watersheds do not encompass all available summer habitats, the chronically low numbers observed during surveys suggest that those populations are likely at high risk of extinction. The high number of hatchery fish in the Mad River basin, coupled with uncertainty regarding relative abundances of hatchery and wild spawners is also of concern. Based on these factors, this DPS would likely have a low resilience to additional perturbations.

4.28.4 Critical Habitat

Designated critical habitat for the Northern California steelhead DPS includes the following CALWATER hydrological units: Redwood Creek, Trinidad, Mad River, Eureka Plain, Eel River, Cape Mendocino, and the Mendocino Coast. The total area of critical habitat includes about 3,000 miles of stream habitat and about 25 square miles of estuarine habitat, mostly within Humboldt Bay. The current condition of designated critical habitat is moderately degraded. Portions of the rearing PCE, especially the interior Eel River, are affected by elevated temperatures from riparian vegetation removal. Spawning PCE attributes (i.e., the quality of substrate that supports spawning, incubation, and larval development) have been generally degraded throughout designated critical habitat by silt and sediment fines. The adult migration PCE function has been reduced by bridges and culverts that restrict access to tributaries in many watersheds, especially in watersheds with forest road construction.

4.29 Steelhead (Puget Sound DPS)

This Puget Sound DPS includes all naturally-spawned anadromous winter-run and summer-run steelhead in the river basins of Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington. The DPS is bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive). Hatchery production of steelhead is widespread throughout the DPS, but only two artificial propagation programs are included in the DPS. On June 26, 2013, NMFS proposed to change the number of artificial propagation programs included in the DPS to six (78 FR 38270). We used information available in status reviews (NMFS 2005b, 2007e, Ford 2011, NMFS 2011g), the recovery outline (NMFS 2013d), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.29.1 Life History

The Puget Sound steelhead DPS contains both winter-run and summer-run steelhead, but is dominated by winter-run fish. Adult winter-run steelhead generally return to Puget Sound tributaries from December to April. Spawning occurs from January to mid-June and peaks from mid-April through May. Less information exists for summer-run steelhead as their smaller run size and higher altitude headwater holding areas have not been conducive for monitoring. Based on information from four streams, adult run time occurs from mid-April to October with a higher concentration from July to September. The majority of juveniles reside in the river system for two years with a minority migrating to the ocean as one or three-year olds. Smoltification and seaward migration occur from April to mid-May. Puget Sound steelhead spend one to three years in the ocean before returning to freshwater (Busby et al. 1996). Due to the protection of the fjord-like marine environment of Puget Sound, juveniles and adults may hold there during emigration and immigration.

4.29.2 Population Dynamics

Fifty-three populations of steelhead have been identified in this DPS, of which 37 are winter-run. In the early 1980s, run size for this DPS was calculated at about 100,000 winter-run fish and 20,000 summer-run fish. Available data for calculating abundance and trends are not comprehensive for the DPS, primarily represent winter-run steelhead populations, and date from 1985. Since 1985 Puget Sound winter-run steelhead abundance has shown a widespread declining trend over much of the DPS. Four of the 16 winter-run populations evaluated exhibit estimates of long-term population positive growth rates, only one significantly. Thirteen winter-run steelhead populations have sufficient data to determine recent annual abundances (2005 to 2009). Of the 13 populations, two have geometric mean abundances greater than 4,500 fish annually. The remaining populations have low geometric mean abundances; none exceeds 1,000 fish annually and only two populations exceed 500 fish annually.

4.29.3 Status

NMFS listed Puget Sound steelhead as threatened on May 11, 2007 (72 FR 26722). Factors contributing to the listing of this DPS include habitat loss and degradation from damming, agricultural practices, and urbanization; historic overexploitation; predation; poor oceanic and climatic conditions; and impacts from artificial propagation. Spatial structure, complexity, and connectivity have been reduced throughout the DPS. Most populations of steelhead in Puget Sound have declining estimates of mean population growth rates (typically three to 10 percent annually) and extinction risk within 100 years for most populations is estimated to be moderate to high. Effects of hatchery fish on the natural populations remain unknown. Based on these factors, this DPS would likely have a low resilience to additional perturbations.

4.29.4 Critical Habitat

NMFS proposed designation of critical habitat for the Puget Sound steelhead on January 14, 2013 (78 FR 2725). Designated critical habitat would include approximately 1,880 mi (3,026 km) of freshwater and estuarine habitat in Puget Sound, Washington, and exclude a number of areas from designation. Notable is the proposed exclusion of nearshore areas. Though the physical or biological features of critical habitat proposed for Puget Sound steelhead are the same as those designated for Puget Sound Chinook and Hood Canal summer-run chum, watershed conservation values for steelhead may be different because of differences in population structure and habitat use.

4.30 Steelhead (Snake River DPS)

The Snake River basin steelhead DPS includes all naturally spawned steelhead populations below natural and man-made impassable barriers in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the U.S./Canada border. Six artificial propagation programs are also included in the DPS. We used information available in status reviews reviews (Good et al. 2005, Ford 2011, NMFS 2011i), listing documents (62 FR 43937, 71 FR 834), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.30.1 Life History

Snake River basin steelhead are generally classified as summer-run fish. They return to the Columbia River from late June to October and spawn the following spring (March to May). Two life history patterns are recognized within the DPS, primarily based on ocean age and adult size upon return: A-run and B-run. A-run steelhead are typically smaller, have shorter freshwater and ocean residences (generally one year in the ocean), and begin their up-river migration earlier in the year. B-run steelhead are larger, spend more time in fresh water and the ocean (generally two years in ocean), and appear to start upstream migration later in the year. Snake River basin steelhead smoltification usually occurs at two to three years of age.

4.30.2 Population Dynamics

The Interior Columbia Technical Review Team identified six historical major population groups in the Snake River steelhead DPS: Clearwater River, Salmon River, Grande Ronde River, Imnaha River, Lower Snake River, and Hells Canyon Tributaries. The Hells Canyon population is now extirpated; construction of Hells Canyon Dam blocked passage of upstream of the dam. The five extant major population groups support 24 extant independent populations (Interior Columbia Technical Review Team 2003). Population data are lacking for the Snake River steelhead DPS. Annual return estimates are limited to counts of the aggregate return (both A-run and B-run steelhead) over Lower Granite Dam, estimates for two populations in the Grande Ronde major population group, and index area or weir counts for portions of several other populations. The recent geometric five-year mean abundance (2003 to 2008) for Lower Granite Dam was 18,847 natural-origin returning adults. This natural origin return average represented 10 percent of total returns (of both natural and artificial origin fish) over Lower Granite Dam. The previous five-year geometric mean abundance (1997 to 2001) was 10,693 natural-origin returning adults and represented 13 percent of total returns. The five-year periods for the two Grande Ronde populations for which population-level abundance data series are available are the same as above. The recent five-year geometric mean abundance of natural origin steelhead for the Joseph Creek population was 1,925 fish compared to 2,134 fish for the previous five-year period. These returns are made up entirely of natural origin fish. The recent five-year geometric mean abundance of natural origin steelhead for the Upper Grande Ronde River was 1,425 fish compared to 1,332 fish for the previous five-year period. The returns represent 99 and 76 percent of total returns, respectively.

4.30.3 Status

NMFS listed Snake River Basin steelhead as threatened on August 18, 1997 (62 FR 43937), and reaffirmed their status on January 5, 2006 (71 FR 834). Factors contributing to the listing of this DPS include the generalized listing factors for West Coast salmon (i.e., destruction and modification of habitat, overutilization for recreational purposes, and natural and human-made factors), and, more specifically, widespread habitat blockage from hydrosystem management and potentially deleterious genetic effects from straying and introgression from hatchery fish. The level of natural production in the two populations with full data series and one of the index areas is encouraging, but the status of most populations in the DPS remains highly uncertain. The DPS is not currently considered to be viable due to high risk population ratings, uncertainty about the viability status of many populations, and overall lack of population data. A great deal of uncertainty remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites. Based on these factors, this DPS would likely have a low resilience to additional perturbations.

4.30.4 Critical Habitat

Designated critical habitat for the Snake River Basin steelhead DPS includes the following subbasins: Hells Canyon, Imnaha River, Lower Snake/Asotin, Upper Grand Ronde River, Wallowa River, Lower Grand Ronde, Lower Snake/Tucannon, Upper Salmon, Pahsimeroi, Middle Salmon-Panther, Lemhi, Upper Middle Fork Salmon, Lower Middle Fork Salmon, Middle Salmon, South Fork Salmon, Lower Salmon, Little Salmon, Upper and Lower Selway, Lochsa, Middle and South Fork Clearwater, and the Clearwater subbasins, and the Lower Snake/Columbia River corridor. The current condition of critical habitat designated for Snake River basin steelhead is moderately degraded. Critical habitat is affected by reduced quality of juvenile rearing and migration PCEs within many watersheds. Contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Loss of riparian vegetation to grazing has resulted in high water temperatures in the John Day basin. These factors have substantially reduced the rearing PCEs' contribution to the conservation value necessary for species recovery. Several dams affect adult migration PCE by obstructing the migration corridor.

4.31 Steelhead (South-central California Coast DPS)

The South-central California coast steelhead DPS includes all naturally spawned steelhead populations in streams from the Pajaro River watershed (inclusive) to, but not including, the Santa Maria River, (71 FR 5248) in northern Santa Barbara County, California. There are no artificially propagated steelhead stocks within the range of the DPS. We used information available in status reviews reviews (Busby et al. 1996, Good et al. 2005, NMFS 2011j, Williams et al. 2011), the recovery plan (NMFS 2013f), "Steelhead of the South-central/Southern California coast: population characterization for recovery planning" (Boughton et al. 2006), "Viability criteria for steelhead of the South-central and Southern California Coast" (Boughton et al. 2007), listing documents (61 FR 41541, 62 FR 43937; 71 FR 834), and previously issued biological opinions (NMFS 2012b, 2013a) to summarize the status of the species.

4.31.1 Life History

NMFS recognizes two life-history types of winter-run steelhead in the South-central California coast DPS: fluvial-anadromous and lagoon-anadromous. Freshwater resident steelhead (rainbow trout) are not included in the DPS. Fluvial-anadromous fish spend one or two summers (occasionally more) in freshwater streams as juveniles, then smolt and migrate to the ocean, using the estuary only for acclimation to saltwater and as a migration corridor (and occasionally for spring feeding). Lagoon-anadromous fish spend either their first or second summer as juveniles in a seasonal lagoon at the mouth of a stream. Adults of both winter-run types spend two to three years in the ocean before returning to freshwater.

4.31.2 Population Dynamics
The steelhead populations in this region have declined dramatically from estimated annual runs totaling 27,000 adults near the turn of the 19th century to approximately 4,740 adults in 1965, with a large degree of inter-annual variability. These run-size estimates are based on information from only five major watersheds in the northern portion of the DPS. Run-size estimates from coastal and inland watersheds south of the Big Sur have not been estimated or recorded. Only one population in the DPS has sufficient data to compute a trend for adult escapement, the Carmel River above San Clemente Dam. This population experienced a decline of 22 percent per year from 1963 to 1993 and an average five-year adult count of 16 adult spawners. The most recent counts (2012 to 2013) in the Carmel River indicate 452 adults at the San Clemente Dam and 204 adults at the Los Padres Dam.

4.31.3 Status
NMFS listed South-Central California Coast steelhead as threatened August 18, 1997 (62 FR 43937), and reaffirmed their status on January 5, 2006 (71 FR 834). Factors contributing to the listing of this DPS include the generalized listing factors for West Coast salmon (i.e., destruction and modification of habitat, overutilization for recreational purposes, and natural and human-made factors), as well as the more specific concerns about genetic effects from widespread stocking of rainbow trout. The DPS consists of 12 discrete sub-populations which represent localized groups of interbreeding individuals. None of these sub-populations are considered to be viable. Most of the sub-populations are characterized by low population abundance, variable or negative population growth rates, and reduced spatial structure and diversity. Though steelhead are present in most streams in the DPS, their populations are small, fragmented, and unstable, or more vulnerable to stochastic events. In addition, severe habitat degradation and the compromised genetic integrity of some populations pose a serious risk to the survival and recovery of the DPS. The DPS is in danger of extinction. Based on these factors, this DPS would likely have a low resilience to additional perturbations.

4.31.4 Critical Habitat
Designated critical habitat for the South-Central California coast steelhead DPS includes the following CALWATER hydrological units: Pajaro River, Carmel River, Santa Lucia, Salinas River and Estero Bay. Migration and rearing PCEs are degraded throughout designated critical habitat by elevated stream temperatures and contaminants from urban and agricultural areas. The estuarine PCE is impacted due to breaching of estuarine areas, removal of structures, and contaminants.

4.32 Steelhead (Southern California DPS)
The Southern California Steelhead DPS includes all naturally spawned populations of steelhead in streams from the Santa Maria River, San Luis Obispo County, California (inclusive) to the U.S.-Mexico Border (62 FR 43937; 67 FR 21586). No artificially propagated steelhead stocks are currently recognized within the range of the DPS; however, two artificial propagation

programs, the Don Clausen Fish Hatchery and the Kingfisher Flat Hatchery (Monterey Bay Salmon and Trout Project) have been proposed for inclusion in the DPS, as they were inadvertently omitted from the original listing (78 FR 38270). We used information available in status reviews (Busby et al. 1996, Good et al. 2005, NMFS 2011k, Williams et al. 2011), the recovery plan (NMFS 2012f), "Contraction of the southern range limit for anadromous *Oncorhynchus mykiss*" (Boughton et al. 2005), listing documents (62 FR 43937; 71 FR 834), and previously issued biological opinions (NMFS 2012b, 2013b) to summarize the status of the species.

4.32.1 Life History

Life history of the Southern California Steelhead is similar to that of the South-Central California Coast steelhead; see Section 4.31.1 for additional information.

4.32.2 Population Dynamics

Limited information exists for Southern California steelhead runs. Run-size estimates from coastal and inland watersheds south of the Los Angeles Watershed have generally not been estimated or recorded and no long term (greater than 20 years) time-series data are available for any of the populations. Based on combined estimates for only four major watersheds in the northern portion of the DPS, steelhead runs declined from estimated historic levels of 32,000 to 46,000 adults to less than 500 adults in 1996. More recent counts from various monitoring locations in the DPS have reported very small runs of less than 10 fish, with the exception of a monitoring location in Santa Ynez River that reported 16 adults in 2008.

4.32.3 Status

NMFS listed the Southern California steelhead as endangered on August 18, 1997 (62 FR 43937), and reaffirmed their status on January 5, 2006 (71 FR 834). Factors contributing to the listing of this DPS include the generalized listing factors for West Coast salmon (i.e., destruction and modification of habitat, overutilization for recreational purposes, and natural and human-made factors), as well as the more specific concern about the widespread, dramatic declines in abundance relative to historical levels. Construction of dams and a corresponding increase in water temperatures have excluded steelhead distribution in many watersheds throughout southern California. Streams in southern California containing steelhead have declined over the last decade, with a southward proportional increase in loss of populations. Consequently, the DPS has experienced a contraction of its southern range. This range contraction affects the DPS's ability to maintain genetic and life history diversity for adaptation to environmental change. The 2005 status review concluded the chief causes for the DPS's decline include urbanization, water withdrawals, channelization of creeks, human-made barriers to migration, and the introduction of exotic fishes and riparian plants. The most recent status review indicates these threats are essentially unchanged and the species remains in danger of extinction. Based on these factors, this DPS would likely have a very low resilience to additional perturbations.

4.32.4 Critical Habitat

Designated critical habitat for the Southern California steelhead DPS includes the following CALWATER hydrological units: Santa Maria River, Santa Ynez, South Coast, Ventura River, Santa Clara Calleguas, Santa Monica Bay, Callequas and San Juan hydrological units. All PCEs have been affected by degraded water quality by pollutants from densely populated areas and agriculture within the DPS. Elevated water temperatures impact rearing and juvenile migration PCEs in all river basins and estuaries. Rearing and spawning PCEs have been affected throughout the DPS by water management or reduction in water quantity. The spawning PCE has been affected by the combination of erosive geology features and land management activities that have resulted in excessive fines in spawning gravel of most rivers.

4.33 Steelhead (Upper Columbia River DPS)

The Upper Columbia River steelhead DPS includes all naturally spawned steelhead populations below natural and man-made impassable barriers in streams in the Columbia River basin upstream from the Yakima River, Washington, to the U.S.-Canada border. The DPS also includes six artificial propagation programs. We used information available in status reviews reviews (Good et al. 2005, Ford 2011, NMFS 2011m), the recovery plan (Upper Columbia Salmon Recovery Board 2007), listing documents (62 FR 43937; 71 FR 834; 74 FR 42605), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.33.1 Life History

All Upper Columbia River steelhead are summer-run fish. Adults return in the late summer and early fall. Most adults migrate quickly to their natal tributaries, though a portion of returning adults overwinter in mainstem reservoirs, beyond upper-mid-Columbia dams in April and May of the following year. Spawning occurs in the late spring of the year following river entry. Juvenile steelhead spend one to seven years rearing in fresh water before migrating to sea. Smolt emigrate primarily at ages two and three, though some smolts in the DPS have been reported at ages up to seven. Most adult steelhead return to fresh water after one or two years in the ocean.

4.33.2 Population Dynamics

The Upper Columbia River steelhead consists of five historic independent populations, four of which are extant (Wenatchee, Entiat, Methow, and Okanogan) and one that is functionally extinct (Crab Creek). Two additional major population groups likely existed prior to the construction of Grand Coulee and Chief Joseph dams. No direct counts of adult steelhead in the DPS are available prior to dam construction. Estimates of spawning escapement for all four extant populations are available through the 2008/2009 cycle year, along with preliminary estimates of the aggregate counts over Priest Rapids Dam for the 2009/2010 cycle year. The most recent five-year geometric mean abundance (2005 to 2009) of natural origin fish ranges from 116 to 819 adults in the four populations and is 3,604 adults for the aggregate count. These abundances represent nine to 47 percent of total spawner abundances (natural origin and hatchey origin). The most recent five-year average of percent of natural origin fish for the aggregate count is 19 percent.

4.33.3 Status

NMFS originally listed Upper Columbia River steelhead as endangered on August 18, 1997 (62 FR 43937). NMFS changed the listing to threatened on January 5, 2006 (71 FR 834). After litigation resulting in a change in the DPS' status to endangered and then again to threatened. On August 24, 2009, NMFS reaffirmed the species' status as threatened (74 FR 42605). Factors contributing to the listing of this DPS include the generalized listing factors for West Coast salmon (i.e., destruction and modification of habitat, overutilization for recreational purposes, and natural and human-made factors), as well as the more specific issues of extremely low estimates of adult replacement ratios, habitat degradation, juvenile and adult mortality in the hydrosystem, unfavorable marine and freshwater environmental conditions, overharvest, and genetic homogenization from composite broodstock collections. Though steelhead in the DPS must pass over several dams to access spawning areas, three of the four populations are rated as low risk for spatial structure. The proportions of hatchery-origin returns in natural spawning areas remain extremely high across the DPS and continue to be a major concern. Though there has been an increase in abundance and productivity for all populations, the improvements have been minor, and none of the populations meet recovery criteria. All populations remain at high risk of extinction and the DPS, as a whole, is not viable. Based on these factors, this DPS would likely have a low resilience to additional perturbations.

4.33.4 Critical Habitat

Designated critical habitat for the Upper Columbia River steelhead DPS includes the following subbasins: Chief Joseph, Okanogan, Similkameen, Methow, Upper Columbia/Entiat, Wenatchee, Lower Crab, and the Upper Columbia/Priest Rapids subbasins, and the Columbia River corridor. Currently, designated critical habitat is moderately degraded. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development. The water quality and food production features of juvenile rearing and migration PCEs in several watersheds and the mainstem Columbia River have been degraded by contaminants from agriculture. Several dams affect the adult migration PCE by obstructing the migration corridor.

4.34 Steelhead (Upper Willamette River DPS)

The UWR steelhead DPS includes all naturally spawned winter-run steelhead populations below natural and manmade impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River (inclusive). No artificially propagated populations are included in the DPS. Hatchery summer-run steelhead occur in the Willamette Basin, but they are an out-of-basin population and not included in the DPS. We used information available in status reviews reviews (Busby et al. 1996, Good et al. 2005, Ford 2011, NMFS 2011n), the recovery plan (Oregon Department of Fish and Wildlife and NMFS 2011), listing documents (64 FR 14517; 71 FR 834), and previously issued biological opinions (NMFS 2012b) to summarize the status of the species.

4.34.1 Life History

Native steelhead in the Upper Willamette are late-migrating winter-run fish. Steelhead enter fresh water in January and February (Howell et al. 1985), but do not ascend to spawning areas until late March or April, later than other winter-run steelhead. Spawning occurs from April to June. The majority of juveniles smolt and emigrate after two years. Peak smolt emigration past Willamette Falls occurs from early April to early June, with a peak in early- to mid-May (Howell et al. 1985). Smolts generally migrate through the Columbia River via Multnomah Channel rather than the mouth of the Willamette River. Most adults return to fresh water after spending two years in the ocean

4.34.2 Population Dynamics

Four basins on the east side of the Willamette River historically supported independent steelhead populations, all of which remain extant. There is intermittent spawning and rearing in tributaries on the west side of the Willamette River, but these areas are not considered to be independent populations. Because native winter-run steelhead also return outside of the DPS boundaries, Willamette Falls counts represent the best estimate for the DPS abundance. The average number of steelhead passing Willamette Falls in the 1990s was less than 5,000 fish. The number increased to over 10,000 fish in 2001 and 2002. The geometric and arithmetic mean number of steelhead passing Willamette Falls for the period 1998 to 2001 were 5,819 and 6,795 fish, respectively. More recent abundances have declined. The total abundance of steelhead at Willamette Falls in 2008 was 4,915 adults. In 2009, the abundance was 2,110 fish.

4.34.3 Status

NMFS originally listed Upper Willamette steelhead as threatened on March 25, 1999 (64 FR 14517), and reaffirmed their status on January 5, 2006 (71 FR 834). Factors contributing to the listing of this DPS include the generalized listing factors for West Coast salmon (i.e., destruction and modification of habitat, overutilization for recreational purposes, and natural and human-made factors), as well as the more specific issues of damming, water diversions, poor ocean conditions and overharvest. Though access to historical spawning grounds has been lost behind dams, the DPS remains spatially well-distributed. Three populations are considered to be in the moderate to high risk category for spatial structure and one is in the low risk category. The DPS continues to demonstrate an overall low abundance pattern. The elimination of winter-run hatchery releases reduces threats from artificial propagation, but non-native summer steelhead hatchery releases are still a concern. Human population growth within the Willamette Basin continues to be a significant risk factor for the populations. This DPS remains at a moderate risk of extinction. Based on these factors, this DPS would likely have a moderate resilience to additional perturbations.

4.34.4 Critical Habitat

Designated critical habitat for the Upper Willamette River steelhead DPS includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Willamette River and specific stream reaches in the subbasins: Upper Willamette, North Santiam, South Santiam, Middle Willamette, Molalla/Pudding, Yamhill, Tualatin, and Lower Willamette. Designated critical habitat is currently degraded. The water quality and food production features of juvenile rearing and migration PCEs in several watersheds and the mainstem Columbia River have been degraded by contaminants from agriculture. Several dams affect the adult migration PCE by obstructing the migration corridor.

5 Eulachon

Eulachon are small smelt native to eastern North Pacific waters from the Bering Sea to Monterey Bay, California, or from 61º N to 31º N (Hart and McHugh 1944, Eschmeyer et al. 1983, Minckley et al. 1986, Hay and McCarter 2000) .

5.1 Eulachon (Southern DPS)

Eulachon that spawn in rivers south of the Nass River of British Columbia to the Mad River of California comprise the southern DPS of eulachon. This species is designated based upon timing of runs and genetic distinctions (Hart and McHugh 1944, McLean et al. 1999, Hay and McCarter 2000, McLean and Taylor 2001, Beacham et al. 2005) .

5.1.1 Life History

Adult eulachon are found in coastal and offshore marine habitats (Allen and Smith 1988, Hay and McCarter 2000, Willson et al. 2006) . Larval and post larval eulachon prey upon phytoplankton, copepods, copepod eggs, mysids, barnacle larvae, worm larvae, and other eulachon larvae until they reach adult size (WDFW and ODFW 2001). The primary prey of adult eulachon are copepods and euphausiids, malacostracans and cumaceans (Smith and Saalfeld

1955, Barraclough 1964, Drake and Wilson 1991, Sturdevant et al. 1999, Hay and McCarter 2000) .

Although primarily marine, eulachon return to freshwater to spawn. Adult eulachon have been observed in several rivers along the west coast (Odemar 1964, Moyle 1976, Minckley et al. 1986, Emmett et al. 1991, Jennings 1996, Wright 1999, Larson and Belchik 2000, Musick et al. 2000, WDFW and ODFW 2001). For the southern population of eulachon, most spawning is believed to occur in the Columbia River and its tributaries as well as in other Oregonian and Washingtonian rivers (Emmett et al. 1991, Musick et al. 2000, WDFW and ODFW 2001). Eulachon take less time to mature and generally spawn earlier in southern portions of their range than do eulachon from more northerly rivers (Clarke et al. 2007).

Spawning is strongly influenced by water temperatures, so the timing of spawning depends upon the river system involved (Willson et al. 2006). In the Columbia River and further south, spawning occurs from late January to March, although river entry occurs as early as December (Hay and McCarter 2000) . Further north, the peak of eulachon runs in Washington State is from February through March while Alaskan runs occur in May and river entry may extend into June (Hay and McCarter 2000) . Females lay eggs over sand, course gravel or detritial substrate. Eggs attach to gravel or sand and incubate for 30 to 40 days after which larvae drift to estuaries and coastal marine waters (Wydoski and Whitney 1979) .

Eulachon generally die following spawning (Scott and Crossman 1973). The maximum known lifespan is 9 years of age, but 20 to 30% of individuals live to 4 years and most individuals survive to 3 years of age, although spawning has been noted as early as 2 years of age (Wydoski and Whitney 1979, Barrett et al. 1984, Hugg 1996, Hay and McCarter 2000, WDFW and ODFW 2001) . The age distribution of spawners varies between river and from year-to-year (Willson et al. 2006).

5.1.2 Population Dynamics

Microsatellite genetic work, in addition to other biological data including the number of vertebrae size at maturity, fecundity, river-specific spawning times, and population dynamics (Gustafson et al. 2010) appears to confirm the existence of significant differentiation among populations in the southern DPS of eulachon. NOAA Fisheries’ eulachon Biological Review Team separated the DPS into four subpopulations (Gustafson et al. 2010). These are the Klamath River (including the Mad River and Redwood Creek), the Columbia River (including all of its tributaries upstream to RM 180), the Fraser River, and the British Columbia coastal rivers (north of the Fraser River up to, and including, the Skeena River).

Abundance declines have occurred in the Fraser and other coastal British Columbia rivers (Hay and McCarter 2000, Moody 2008). Over a three-generation span of 10 years (1999 to 2009), the overall Fraser River eulachon population biomass has declined by nearly 97% (Gustafson et al. 2010). In 1999, the biomass estimates were 418 metric tons, and by 2010 had dropped to just 4 metric tons. Abundance information is lacking for many coastal British Columbia sub-area populations, but Gustafson et al. (2010) found that eulachon runs were universally larger in the past.

The Columbia River (including all of its tributaries upstream to RM 180) supports the largest known eulachon run. Although direct estimates of adult spawning stock abundance are limited, commercial fishery landing records begin in 1888 and continue as a nearly uninterrupted data set to 2010 (Gustafson et al. 2010). From about 1915 to 1992, historical commercial catch levels were typically more than 500 metric tons (500 metric tons equals approximately 12,728,100 fish at 11.55 fish per pound), occasionally exceeding 1,000 metric tons. In 1993, eulachon catch levels began to decline and averaged less than 5 metric tons from 2005 to 2008 (Gustafson et al. 2010).

From 2003 through 2013, the Fraser River eulachon population in Canada is estimated at 676,599 to 908,966 (median values) adults (COSEWIC 2011). Beginning in 2010, ODFW and WDFW began eulachon biomass surveys similar to those conducted on the Fraser River. Based on the three years of available data that have been collected and analyzed, WDFW calculated a median spawner estimate of 37 million eulachon in the Columbia River in 2011 (range 18,000,000 to 70,000,000 spawners), 34 million in 2012 (range 19,000,000 to 60,000,000 spawners), and 110,000,000 million spawners in 2013 (range 45,000,000 to 200,000,000).

The egg and larvae production estimates for the 2010-2011 sample-years calculated a minimum estimate of 300,000,000,000 (range 1,100,000,000,000 to 300,000,000,000, with a median estimate of 590,000,000,000) egg and larvae for the Columbia River Basin population. The egg and larvae production estimates for the 2011-2012 sample-year provided by WDFW calculated a minimum estimate of 330,000,000,000 (range 1,000,000,000,000 to 330,000,000,000, with a median estimate of 580,000,000,000) egg and larvae for the Columbia River Basin population. The egg and larvae production estimates for the 2012-2013 sample-year provided by WDFW calculated a minimum estimate of 710,000,000,000 (range 3,200,000,000,000,000 to 330,000,000,000, with a median estimate of 1,700,000,000,000) egg and larvae for the Columbia River Basin population.

There are no long-term eulachon monitoring programs in Northern California. Large eulachon spawning aggregations once occurred regularly in the Klamath River, but abundance has declined substantially (Fry Jr. 1979, Moyle et al. 1995, Larson and Belchik 1998, Hamilton et al. 2005). Recent reports from Yurok tribal fisheries biologists report capturing adult eulachon in presence/absence surveys (seine/dip nets) in the Klamath River over a four-year period [2011 (7 eulachon), 2012 (40 eulachon), 2013 (112 eulachon), and 2014 (±1000 eulachon)]. All egg/larvae capture via plankton net tows in the Klamath River during this same period were determined not to be eulachon.

5.1.3 Status

The southern DPS of eulachon was listed as threatened on March 18, 2010 (75 FR 13012). The primary factors responsible for the decline of eulachon are the destruction, modification, or curtailment of habitat and inadequacy of existing regulatory mechanisms. Under the Species at Risk Act, Canada designated the Fraser River population as endangered in May 2011 because of a 98% decline in spawning stock biomass over the previous 10 years (COSEWIC 2011). The eulachon Biological Review Team was concerned that four out of seven coastal British Columbia spawning groups may be at risk of extirpation as a result of phenomena associated with small populations and random genetic effects (Gustafson et al. 2010).

There are few direct estimates of eulachon abundance. Escapement counts and spawning stock biomass estimates are only available for a small number of systems, and catch statistics from commercial and tribal fisheries are available for others. However, inferring population status or even trends from yearly catch-statistic changes requires assumptions that are difficult to corroborate (e.g., assuming that harvest effort and efficiency are similar from year to year, assuming a consistent relationship among the harvested and total stock portion, and certain statistical assumptions, such as random sampling). However, the combination of catch records and anecdotal information indicates that there were large eulachon runs in the past, which have severely declined. As a result, eulachon numbers are at, or near, historically low levels throughout the range of the southern DPS.

Although landings can be biased by level of fishing effort, evidence of persistent low eulachon returns as well as landings in the Columbia River from 1993 to 2000 prompted the states of Oregon and Washington to adopt a Joint State Eulachon Management Plan (WDFW and ODFW 2001). All recreational and commercial fisheries for eulachon were closed in Washington and Oregon in 2011. However, in 2014, WDFW and ODFW opened a limited-duration recreational and commercial fishery for eulachon.

The Biological Review Team was concerned about risks to eulachon diversity because of data suggesting that Columbia River and Fraser River spawning stocks may be limited to a single age class combined with the species' semelparous life history (individuals spawn once and die). These characteristics likely increase the species' vulnerability to environmental catastrophes and perturbations and provide less of a buffer against year-class failure than species such as herring that spawn repeatedly and have variable ages at maturity (Gustafson et al. 2010).

Threats include human activities or natural events (e.g., fish harvest, volcanoes) that alter key physical, biological and/or chemical features and reduce a species' viability. Both natural and human-related threats are outlined and organized under the following five ESA listing factors: (1) destruction or modification of habitat; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) other natural or human factors.

5.1.4 Critical Habitat

Critical habitat has been designated for the southern DPS of eulachon (76 FR 65323). The designated areas are a combination of freshwater creeks and rivers and their associated estuaries, comprising approximately 539 km (335 mi) of habitat. The physical or biological features essential to the conservation of the DPS include:

(1) Freshwater spawning and incubation sites with water flow, quality and temperature conditions and substrate supporting spawning and incubation, and with migratory access for adults and juveniles. These features are essential to conservation because without them the species cannot successfully spawn and produce offspring.

(2) Freshwater and estuarine migration corridors associated with spawning and incubation sites that are free of obstruction and with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

(3) Nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. Eulachon prey on a wide variety of species including crustaceans such as copepods and euphausiids (Hay and McCarter 2000, WDFW and ODFW 2001), unidentified malacostracans (Sturdevant et al. 1999), cumaceans (Smith and Saalfeld 1955), mysids, barnacle larvae, and worm larvae (WDFW and ODFW 2001). These features are essential to conservation because they allow juvenile fish to survive, grow, and reach maturity, and they allow adult fish to survive and return to freshwater systems to spawn.

6 Sturgeon

Members of the family Acipenseridae share several life history traits. Sturgeons, or Acipenseriformes, are anadromous, spawning in freshwater and spending part of their lives at sea or in saline waters with some species migrating within or between river systems, or even undergoing coastal migrations. Four species of sturgeon are listed as threatened or endangered under the ESA: shortnose sturgeon, Atlantic sturgeon, green sturgeon, and Gulf sturgeon.

6.1 Shortnose Sturgeon

Shortnose sturgeon were listed as endangered throughout its range on March 11, 1967 (32 FR 4001) pursuant to the Endangered Species Preservation Act of 1966. Shortnose sturgeon remained on the list as endangered with enactment of the ESA in 1973.

Shortnose sturgeon occur along the Atlantic Coast of North America, from the Saint John River in Canada to the Saint Johns River in Florida. The Shortnose Sturgeon Recovery Plan (NMFS 1998a) describes 19 shortnose sturgeon populations that are managed separately in the wild. Two additional geographically separated populations occur behind dams in the Connecticut River (above the Holyoke Dam) and in Lake Marion on the Santee-Cooper River system in South Carolina (above the Wilson and Pinopolis Dams) (NMFS 1998a). While shortnose sturgeon spawning has been documented in several rivers across its range (including but not limited to: Kennebec River, ME, Connecticut River, Hudson River, Delaware River, Pee Dee River, SC, Savannah, Ogeechee, and Altamaha rivers, GA), status for many other rivers remain unknown (Shortnose Sturgeon Status Review Team 2010).

6.1.1 Life History

Sturgeon are a long-lived species, taking years to reach sexual maturity. Male shortnose sturgeon tend to sexually mature earlier than females, and sturgeon residing in more northern latitudes reach maturity later than those at southerly latitudes (Shortnose Sturgeon Status Review Team 2010). Sturgeon are broadcast spawners, with females laying adhesive eggs on hard bottom, rocky substrate at upstream, freshwater sites. When the males arrive at the spawning site, they broadcast sperm into the water column to fertilize the eggs. Despite their high fecundity, sturgeon have low recruitment.

Spawning periodicity varies by species and sex, but there can be anywhere from 1 to 5 years between spawning, as individuals need to rebuild gonadal material. There is difficulty in definitively assessing where and how reliably spawning occurs. Presence of eggs, age-1 juveniles and capture of "ripe" adults moving upstream (i.e., likely on a spawning run) serve as strong indicators, but due to their life history and the impacts sturgeon populations have taken, there are additional hurdles to successful spawning. Because sturgeon are iteroparous, and populations in some areas so depleted, eggs deposited at the spawning grounds may not be fertilized if males do not arrive at the spawning grounds that year.

Hatching occurs approximately 94-140 hrs after egg deposition, and larvae assume a bottom-dwelling existence (Smith et al. 1980). The yolksac larval stage is completed in about 8-12 days, during which time larvae move downstream to rearing grounds over a 6 – 12 day period (Kynard and Horgan 2002). Size of larvae at hatching and at the juvenile stage varies by species. During the daytime, larvae use benthic structure (e.g., gravel matrix) as refugia (Kynard and Horgan 2002). Juvenile sturgeon continue to move further downstream into brackish waters, and eventually become residents in estuarine waters for months or years.

Generally, sturgeon are benthic omnivores, feeding on benthic invertebrates that are abundant in the substrate in that area. Shortnose sturgeon forage over sandy bottom, and eat benthic invertebrates like amphipods (Shortnose Sturgeon Status Review Team 2010).

Juvenile shortnose generally move upstream during spring and summer and downstream for fall and winter; however, these movements usually occur above the salt- and freshwater interface (Shortnose Sturgeon Status Review Team 2010). During summer and winter, adult shortnose sturgeon inhabit freshwater reaches of rivers reaches influenced by tides. During summer, at the southern end of its range, shortnose sturgeon congregate in cool, deep, areas of rivers taking refuge from high temperatures (Kynard 1997). Because they rarely leave their natal rivers, Kieffer and Kynard (1993) considered shortnose sturgeon to be freshwater amphidromous (i.e. adults spawn in freshwater but regularly enter saltwater habitats during their life).

6.1.2 Population Dynamics

Currently, there is no range-wide population estimate for shortnose sturgeon, although many individual river systems have been studied and population estimates have been generated for several rivers (Shortnose Sturgeon Status Review Team 2010). Some rivers have been more intensely studied than others, allowing for multiple estimates. Rivers with the largest shortnose sturgeon population estimates are the Hudson (ranging up to 61,000), St. John (18,000), Kennebec (9,500), Delaware (12,000), and Altamaha (6,300) (Dadswell 1979, Bain et al. 2000a, Brundage and Herron 2003, Squiers 2003, DeVries 2006).

Shortnose sturgeon populations are at risk from incidental bycatch, dams, dredging and pollution (Shortnose Sturgeon Status Review Team 2010). Despite the life span of adult sturgeon, the viability of sturgeon populations is highly sensitive to juvenile mortality resulting in lower numbers of sub-adults recruiting into the adult breeding population (Secor et al. 2002). This relationship caused Secor et al. (2002) to conclude sturgeon populations can be grouped into two demographic categories: populations having reliable (albeit periodic) natural recruitment and those that do not. The shortnose sturgeon populations without reliable natural recruitment are at more risk. Secor et al. (2002) note that sturgeon species are particularly vulnerable to the loss of juveniles from their natal populations. Sturgeon populations cannot survive fishing related mortalities exceeding 5 to 13% of an adult spawning run and they are vulnerable to declines and local extinction if juveniles die from fishing related mortalities (Boreman 1997, Secor et al. 2000).

6.1.3 Status

The shortnose sturgeon is endangered, and much remains unknown about the population status in many rivers throughout its range. The threats that face shortnose sturgeon are likely to continue into the future. However, either due to recovery or increased sampling efficiency, it appears shortnose sturgeon populations are increasing in some rivers or remaining stable in others. The Altamaha River population estimate in 1998 was 2,800 and is now 6,300, the population in the Delaware River is unchanged from 1987 to 2003, the Ogeechee population has grown from roughly 250 in the early 90s to 350 in the late 2000s, Dovel (1979) estimated the Hudson population at 30,300 and Bain et al. (2000b) estimates the population at 61,000, the Kennebec has grown from 7,200 in 1977-1981 to 9,500 in 2003, and the last shortnose in the Penobscot had been seen in 1979 until some were caught in 2005 and now the population is thought to number over 1,000. The larger threat to shortnose sturgeon survival is the habitat fragmentation caused by extirpations throughout Florida, southern Georgia, all of North Carolina except for the Cape

Fear River, all of Virginia, and all of Maryland (Rogers and Weber 1995, Kynard 1997, Kahnle et al. 1998, NMFS 1998c, Collins et al. 2000, Skjeveland et al. 2000, Welsh et al. 2002, Oakley 2003). While it appears some populations may be increasing, none of these extirpated populations have been recolonized for various reasons.

6.1.4 Critical Habitat

No critical habitat has been designated for shortnose sturgeon.

6.2 Atlantic Sturgeon (General Overview)

We discuss the distribution, life history, population dynamics, status, and critical habitats of the five species (here we use the word "species" to apply to distinct population segments, DPSs) separately; however, because listed Atlantic sturgeon species are virtually indistinguishable in the wild and comprise the same biological species, we begin this section describing characteristics common across DPSs. We used information available in the 2007 Atlantic Sturgeon Status Review (ASSRT 2007), and the listing documents (77 FR 5880, 77 FR 5914) to summarize the status of the species.

The range of Atlantic sturgeon includes the St. John River in Canada, to St. Johns River in Florida. Five DPSs of Atlantic sturgeon were designated and listed under the ESA on February 6, 2012 (Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic) (77 FR 5880, 77 FR 5914).

6.2.1 Life History

Although the Atlantic sturgeon DPSs are genetically distinct, their life history characteristics are the same and are discussed together below.

As Acipensieriformes, Atlantic sturgeon are anadromous and iteroparus. Like shortnose sturgeon, male Atlantic sturgeon tend to sexually mature earlier than females, and sturgeon residing in more northern latitudes reach maturity later than those at southerly latitudes. Evidence of Atlantic sturgeon spawning has been found in many of the same rivers as shortnose sturgeon (see discussion above). Atlantic sturgeon eggs are between 2.5-3.0mm, and larvae are about 7mm long upon hatching. Generally, sturgeon are benthic omnivores, feeding on benthic invertebrates that are abundant in the substrate in that area. Atlantic sturgeon commonly eat polychaetes and isopods.

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As juveniles, Atlantic sturgeon migrate downstream from the spawning grounds into brackish water. Unlike shortnose sturgeon, subadult Atlantic sturgeon (76-92cm) may move out of the estuaries and into coastal waters where they can undergo long range migrations. At this stage in the coastal waters, individual subadult and adult Atlantic sturgeon originating from different DPSs will mix, but adults return to their natal river to spawn.

6.2.2 Population Dynamics

Subadult and adult Atlantic sturgeon spend time in oceanic waters during coastal migrations. Evaluating the status of the species depends on the status of the smaller extant populations because maintaining those populations maintains genetic heterogeneity and having a broad range prevents a single catastrophic event from causing their extinction. A description of each Atlantic sturgeon DPS, with details regarding the smaller, in-river populations is below.

6.2.3 Status

The status of each Atlantic sturgeon DPS will be discussed separately below.

6.2.4 Critical Habitat

No critical habitat has been designated for any Atlantic sturgeon DPS.

6.3 Atlantic Sturgeon (Gulf of Maine DPS)

The Gulf of Maine (GOM) DPS includes all Atlantic sturgeon that are spawned in the Gulf of Maine watersheds from the Maine/Canada border to Chatham, MA. The GOM DPS was listed as threatened (77 FR 5880). A 4(d) Rule to apply take prohibitions to the GOM DPS was proposed separately (76 FR 34023; June 10, 2011). The proposed rulemaking identified several activities that may take GOM DPS Atlantic sturgeon, including incidental bycatch in fisheries, habitat alteration, and "entrainment and impingement of all life stages of GOM DPS Atlantic sturgeon during the operation of water diversions, dredging projects, and power plants…" (76 FR 34023).

6.3.1 Life History

Although the Atlantic sturgeon DPSs are genetically distinct, their life history characteristics are the same; please see the description in Seciton 6.2.1, above.

6.3.2 Population Dynamics

In the early 1800s, there were estimated to be 10,240 adult Atlantic sturgeon in the Kennebec River (ASSRT 2007); currently, the existing spawning population is thought to be less than 300 adults annually. Spawning is known to occur in the Kennebec River, and it is suspected that the Penobscot River also supports spawning. Recent directed sampling has found eggs in the Kennebec, and ripe adults and age-1 fish have been captured (NMFS 16526 Report). Whether other river systems in the GOM DPS support spawning populations remains unknown. There is no current population estimate for the GOM DPS.

6.3.3 Status

Threats to GOM DPS Atlantic sturgeon include dredging, which can displace sturgeon, alter habitat, and allow saltwater to intrude further upstream, reducing freshwater spawning habitat, water quality degradation from run-off, and bycatch in commercial and recreational fisheries. Dams are also a threat to the GOM DPS, but recent dam removals in the region have begun to restore access to spawning habitat. The Edwards Dam on the Kennebec River was removed in 1999 (Natural Resources Council of Maine 2014). Construction has been underway to remove the Veazie and Great Works dams by the Penobscot River Restoration Trust since 2012 (Penobscot River Restoration Trust 2014).

The removal of dams on the Kennebec and Penobscot rivers is seen as a positive step towards restoring habitat, for the GOM DPS and for other anadromous species in the area. Recent research has detected the presence of adults, age-1 fish, and eggs in rivers where sturgeon were unknown to occur or had not been observed for many years. These observations suggest that abundance of the Gulf of Maine DPS of Atlantic sturgeon is sufficient such that recolonization to rivers historically suitable for spawning may be occurring. However, despite some positive signs, there is not enough information to establish a trend for this DPS. Still, in order to recover, the GOM DPS of Atlantic sturgeon can only withstand low levels of anthropogenic mortality because as a threatened species, they are at risk of becoming endangered in the foreseeable future.

6.3.4 Critical Habitat

No critical habitat has been designated for the Gulf of Maine DPS.

6.4 Atlantic Sturgeon (New York Bight DPS)

The New York Bight (NYB) DPS is comprised of all Atlantic sturgeon that are spawned in watersheds that drain into the coastal waters from Chatham, MA, to the Delaware-Maryland border on Fenwick Island. The NYB DPS is listed as endangered (77 FR 5880).

6.4.1 Life History

Although the Atlantic sturgeon DPSs are genetically distinct, their life history characteristics are the same; please see the description in Section 6.2.1, above.

6.4.2 Population Dynamics

The NYB DPS contains two known spawning population on the Delaware and Hudson rivers. The Hudson River is thought to support one of the more robust Atlantic sturgeon populations in its entire range (ASSRT 2007). In the late 1800s, an estimated 6,000-8,000 females contributed to the Hudson River stock; estimates from fisheries data between 1985 and 1995 estimate the population at 870 spawning adults in the Hudson River (600 males and 270 females) (Kahnle et al. 2007). Peterson et al. (2000) reported that there were approximately 4,300 age-1 and -2 Atlantic sturgeon in the Hudson River between 1985 and 1995.

Before 1890, the Delaware River is estimated to have supported around 180,000 adult female Atlantic sturgeon (ASSRT 2007). There have been attempts to generate a population estimate for Atlantic sturgeon on the Delaware River; estimates of juveniles have ranged from 5,600 to less than 1,000. A directed survey by the Delaware Division of Fish and Wildlife from conducted 1991-1998 captured more than 1,700 juveniles, with a high of 565 individuals in 1991, and 14 in 1998 (ASSRT 2007). More recent directed research has found Atlantic sturgeon eggs, mature adults, and juvenile fish present in the river, and it is believed that a remnant population of Delaware River Atlantic sturgeon exists (ASSRT 2007); NMFS 16507, 16431 reports).

There is evidence to support Atlantic sturgeon presence in other New England rivers through either historical records or the existence of past Atlantic sturgeon fisheries (e.g., the Merrimack River (NH/MA), Taunton River (MA/RI), Thames and Housatonic rivers (CT)). Sub-adult individuals have been captured in the estuaries of these rivers, and the habitat is thought to be important for feeding, but there is no evidence that spawning populations occur (ASSRT 2007). Although Atlantic sturgeon are captured in the estuary of the Connecticut River and in the Connecticut waters of Long Island Sound, it is believed that the native population has been extirpated (ASSRT 2007).

6.4.3 Status

Threats to the NYB DPS include habitat loss and water quality degradation through dredging and run-off, and incidental capture in fisheries. In addition, vessel strikes are of particular concern for Atlantic sturgeon in the Delaware River, as there have been numerous reports of recovered Atlantic sturgeon carcasses with injuries consistent with being struck with a boat propeller (i.e., the carcass was severed) (ASSRT 2007).

Although the Hudson River is believed to support one of the more robust populations, the status of Atlantic sturgeon in other rivers of the NYB DPS is either unknown or severely depleted from historic levels. The threats facing the NYB DPS are expected to continue into the future. A loss of any one of the riverine populations within this DPS would represent a loss in the number of reproducing individuals, a gap in the range of the DPS, and fragmentation of the species' habitat.

6.4.4 Critical Habitat
No critical habitat has been designated for the New York Bight DPS.

6.5 Atlantic Sturgeon (Chesapeake Bay DPS)
The Chesapeake Bay (CB) DPS includes Atlantic sturgeon that are spawned in the watersheds that drain into the Chesapeake Bay from Fenwick Island to Cape Henry, VA. Major rivers that are a part of the CB DPS include the York, James, Potomac, Susquehanna, and Rappahannock rivers.

6.5.1 Life History
Although the Atlantic sturgeon DPSs are genetically distinct, their life history characteristics are the same; please see the description in Section 6.2.1, above.

6.5.2 Population Dynamics
Pre-harvest (i.e., before 1890) levels of Atlantic sturgeon in the Chesapeake Bay and its tributaries are estimated to be ~20,000 adult females. The current spawning population in the James River is thought to be less than 300 individuals per year (ASSRT 2007). Recently, evidence of a spawning population on the York River was found when researchers captured mature, ripe adults (Hager et al. In Review). Status of spawning on other major tributaries in the CB DPS is unknown, although spawning once occurred on the Potomac, Susquehanna, and Rappahannock rivers.

6.5.3 Status
The CB DPS is listed as endangered (77 FR 5880). The CB DPS has been reduced to a fraction of its historical levels by overfishing. Although there is no longer a commercial fishery, the species still faces the threats described above throughout its range. Threats to the CB DPS are the same as those facing the NYB DPS (see section 6.4.3, above); Atlantic sturgeon mortality from vessel strikes has been documented on the James River (ASSRT 2007). Many of these threats are expected to continue into the future (e.g., ship strikes, dredging, dams, fisheries bycatch). Low population numbers of every river population in the CB DPS put them in danger of extinction; none of the populations are large or stable enough to provide with any level of certainty for continued existence of Atlantic sturgeon in this part of its range. The loss of any one riverine spawning population within the DPS will result in a decrease in genetic diversity, reduction in the number of reproducing individuals, a gap in the range of the DPS that is unlikely to be recolonized, and lower recruitment. NMFS concludes that the resiliency of the CB DPS to further perturbations is low.

6.5.4 Critical Habitat
No critical habitat has been designated for the Chesapeake Bay DPS.

6.6 Atlantic Sturgeon (Carolina DPS)

The Carolina DPS includes Atlantic sturgeon that originated from the Roanoke, Tar/Pamlico, Cape Fear, Winyah Bay, and Santee-Cooper rivers in North and South Carolina.

6.6.1 Life History

Although the Atlantic sturgeon DPSs are genetically distinct, their life history characteristics are the same; please see the description in Section 6.2.1, above.

6.6.2 Population Dynamics

Before commercial harvest began in 1890, it is estimated that there were 7,000-10,500 adult females in North Carolina, and 8,000 in South Carolina. Riverine spawning populations are thought to be at less than 3% of their historic levels (ASSRT 2007).

The spawning population in the Sampit River, part of the Winyah Bay system, is believed to have been eliminated; the status of other spawning populations in the Carolina DPS remain uncertain (ASSRT 2007). The Roanoke River has been confirmed to support a spawning population, as have the Tar-Pamlico, Cape Fear, Waccamaw, Great Pee Dee, Combahee, and Edisto rivers, with possible spawning occurring in the Neuse, Santee and Cooper Rivers (77 FR 5914).

6.6.3 Status

The Carolina DPS is listed as endangered (77 FR 5914). The Carolina DPS has been reduced to a fraction of its historical levels by past commercial harvest. Although there is no longer a commercial fishery, the species still faces threats throughout its range. Threats to the Carolina DPS include habitat loss due to dams, dredging, degraded water quality, and incidental capture in fisheries. Climate change is also expected to exacerbate water quantity and quality problems like elevated water temperatures and lower levels of dissolved oxygen (77 FR 5914). Many of these threats are expected to continue into the future (e.g., dredging, dams, fisheries bycatch), or even grow worse (e.g., climate change). Low population numbers of every river population in the Carolina DPS put them in danger of extinction; none of the populations are large or stable enough to provide with any level of certainty for continued existence of Atlantic sturgeon in this part of its range. The loss of any one riverine spawning population within the DPS will result in a decrease in genetic diversity, reduction in the number of reproducing individuals, a gap in the range of the DPS that is unlikely to be recolonized, and lower recruitment. NMFS concludes that the resiliency of the Carolina DPS to further perturbations is low.

6.6.4 Critical Habitat

No critical habitat has been designated for the Carolina DPS.

6.7 Atlantic Sturgeon (South Atlantic DPS)

The South Atlantic (SA) DPS includes Atlantic sturgeon originating from the ACE Basin (Ashepoo, Combahee, and Edisto rivers) in South Carolina, the Savannah, Ogeechee, Altamaha, and Satilla rivers in Georgia, and the St. Mary’s and St. Johns rivers in Florida.

6.7.1 Life History

Although the Atlantic sturgeon DPSs are genetically distinct, their life history characteristics are the same; please see the Section 6.2.1, above.

6.7.2 Population Dynamics

Prior to 1890, there were thought to be ~11,000 adult females in Georgia, and ~8,000 in South Carolina. The Altamaha River is thought to be the largest spawning population in the Southeast; Peterson et al. (2008) reported that approximately 324 (in 2004) and 386 (in 2005) adults per year returned. Other water systems suspected of still supporting a spawning population are the ACE Basin, the Savannah, Ogeechee, and Satilla rivers, and each is believed to have fewer than 300 adults annually (ASSRT 2007). The Ogeechee River subpopulation is considered to be particularly stressed as research has found that juvenile abundance is rare with high inter-annual variability, indicating spawning or recruitment failure. Spawning populations in the St. Mary’s and St. Johns rivers are believed to be eliminated (Florida Fish and Wildlife Conservation Commission 2001).

6.7.3 Status

The SA DPS is listed as endangered (77 FR 5914). Threats to the SA DPS are similar to those faced by the Carolina DPS; see Section 6.6.3, above. These threats will likely continue into the future. Like the other Atlantic sturgeon DPSs, the SA DPS was severely depleted by overfishing, and what little is known about the current population in several rivers indicates that the populations are at low levels or have been extirpated. The loss of any one riverine spawning population within the DPS will result in a decrease in genetic diversity, reduction in the number of reproducing individuals, a gap in the range of the DPS that is unlikely to be recolonized, and lower recruitment. NMFS concludes that the resiliency of the SA DPS to further perturbations is low.

6.7.4 Critical Habitat

No critical habitat has been designated for the South Atlantic DPS.

6.8 Green Sturgeon (Southern DPS)

Green sturgeon occur in coastal Pacific waters from San Francisco Bay to Canada. The Southern DPS of green sturgeon includes populations south of (and exclusive of) the Eel River (75 FR 30714).

6.8.1 Life History

As members of the family Acipenseridae, green sturgeon share similar reproductive strategies and life history patterns with other sturgeon species; see Section 6.1.1, above.

The Sacramento River is the location of the single, known spawning population for the green sturgeon Southern DPS (Adams et al. 2007). Size of larvae at hatching and at the juvenile stage varies by species (see discussion above). Generally, sturgeon are benthic omnivores, feeding on benthic invertebrates that are abundant in the substrate in that area. Little is known specifically about green sturgeon foraging habits; generally, adults feed upon invertebrates like shrimp, mollusks, amphipods and even small fish, while juveniles eat opossum shrimp and amphipods (Adams et al. 2002). Juvenile green sturgeon spend 1-3 years in freshwater, disperse widely in the ocean, and return to freshwater as adults to spawn (about age 15 for males, age 17 for females) (NMFS 2010a).

6.8.2 Population Dynamics

Trend data for green sturgeon is severely limited. Available information comes from two predominant sources, fisheries and tagging. Only three data sets were considered useful for the population time series analyses by NMFS's biological review team: the Klamath Yurok Tribal fishery catch, a San Pablo sport fishery tag returns, and Columbia River commercial landings (NMFS 2005a). Using San Pablo sport fishery tag recovery data, the California Department of Fish and Game produced a population time series estimate for the southern DPS. San Pablo data suggest that green sturgeon abundance may be increasing, but the data showed no significant trend. The data set is not particularly convincing, however, as it suffers from inconsistent effort and since it is unclear whether summer concentrations of green sturgeon provide a strong indicator of population performance (NMFS 2005a). Although there is not sufficient information available to estimate the current population size of southern green sturgeon, catch of juveniles during state and federal salvage operations in the Sacramento delta are low in comparison to catch levels before the mid-1980s.

6.8.3 Status

The Southern DPS is listed as threatened (71 FR 17757; April 7, 2006). On June 2, 2010, NMFS issued a 4(d) Rule for the Southern DPS, applying certain take prohibitions (75 FR 30714). The 5 Year Status Review for the Southern DPS was initiated in 2012 (77 FR 64959). Current threats to the Southern DPS include reduction in spawning habitat (mostly from impoundments), entrainment by water projects, temperature regulations through water releases from upstream dams, contaminants, incidental bycatch and poaching (NMFS 2010a). Given the small population size, the species' life history traits (e.g., slow to reach sexual maturity), and that the threats to the population are likely to continue into the future, we conclude that the Southern DPS is not resilient to further perturbations.

6.8.4 Critical Habitat

Green sturgeon critical habitat for the Southern DPS was designated on October 9, 2009 (74 FR 52300), including coastal U.S. marine waters within 60 fathoms deep from Monterey Bay, CA to Cape Flattery, WA, including the Strait of Juan de Fuca, and numerous coastal rivers and estuaries: see the Final Rule for a complete description (74 FR 52300). Food resources were identified as a primary constituent element.

6.9 Gulf Sturgeon

Gulf sturgeon historically occurred in coastal river systems from the Mississippi River to the Suwannee River, Florida, and in the Gulf of Mexico to the Florida Bay (USFWS and Gulf States Marine Fisheries Commission 1995). Currently, Gulf sturgeon are distributed from the Suwannee River to Lake Pontchartrain and the Pearl River system, Louisiana.

6.9.1 Life History

As members of the family Acipenseridae, Gulf sturgeon share similar reproductive strategies and life history patterns with other sturgeon species; see Section 6.1.1, above..

Evidence of Gulf sturgeon spawning has been found in the Suwannee, Pearl, Pascagoula, Escambia, Yellow, Choctawhatchee, or Apalachicola Rivers (Fox et al. 2000, Heise et al. 2004, USFWS and NMFS 2009). Size of larvae at hatching and at the juvenile stage varies by species (see discussion above). Generally, sturgeon are benthic omnivores, feeding on benthic invertebrates that are abundant in the substrate in that area. Gulf sturgeon eat isopods, amphipods, polychaete and oligochaete annelids, as well as crustaceans (Mason Jr. and Clugston 1993). Gulf sturgeon less than two years old reside in riverine and estuarine habitats throughout the year, but evidence shows that most sub-adult and adult Gulf sturgeon feed for 3-4 months while in the marine environment, and then do not feed for the next 8-9 months after they enter freshwater (Randall and Sulak 2012).

6.9.2 Population Dynamics

There are no range-wide population estimates for Gulf sturgeon, although particular river systems have been studied, including the Suwannee and Apalachicola rivers. The Suwannee River is considered to have the most robust population of Gulf sturgeon, with a population size estimated at 2,250-3,300 (87-211cm, 18kg fish) (USFWS and NMFS 2009). Zehfuss et al. (1999) estimated about 100 Gulf sturgeon (>45cm) at the Jim Woodruff Lock and Dam on the Apalachicola (which is likely an underestimate, based on high rates of tag loss); 293 Gulf sturgeon were captured from 1982-1991.

6.9.3 Status

Gulf sturgeon were listed as threatened on September 30, 1991 (56 FR 49653) and are managed jointly by USFWS and NMFS. Like other sturgeon species, Gulf sturgeon were historically overfished, which played a large role in the decline in its population. Although no directed fisheries are in operation today, Gulf sturgeon are still at risk from incidental bycatch in other state and federal fisheries. Habitat reduction from dams blocking access to spawning areas, dredging, groundwater extraction, poor water quality and contaminants all remain current threats, which will likely continue into the future.

According to the Gulf sturgeon 5 year review, NMFS considers the population stable, with seven riverine systems showing evidence of spawning, although variability in population size has been noted. This variability is attributed to Hurricanes Ivan (2004) and Katrina (2005) (USFWS and NMFS 2009). The 5-Year Review concluded that the threatened status for Gulf sturgeon was still appropriate. We conclude that Gulf sturgeon population is stable and somewhat resilient to further perturbation.

6.9.4 Critical Habitat

Critical habitat has been designated for Gulf sturgeon (68 FR 13370; March 19, 2003) in coastal rivers and estuarine areas of the Gulf of Mexico from Florida to Louisiana. Abundant food items were identified as a primary constituent element in Gulf sturgeon critical habitat.

7 Sawfish

Sawfish, like sharks, skates, and rays, belong to a group of fish called elasmobranchs, whose skeletons are made of cartilage. The proposed project may affect the ESA-listed smalltooth sawfish, described below.

7.1 Smalltooth Sawfish (U.S. DPS)

The smalltooth sawfish is a tropical marine and estuarine elasmobranch (e.g., sharks and rays) that uses its tooth-lined rostrum to forage on fish and benthic invertebrates. The United States DPS of smalltooth sawfish was listed as endangered on April 1, 2003 (68 FR 15674). Smalltooth sawfish can be found in Florida waters, primarily in the southern tip of the state, centered around Charlotte Harbor, Everglades National Park, and Florida Bay. On June 4, 2013, NMFS proposed a rule to list five species of sawfish (Pristis spp.) found outside U.S. waters (78 FR 33300), including the non-listed DPSs of smalltooth sawfish. We used information available in the 2009

Recovery Plan (NMFS 2009e), the 5-year Review (NMFS 2010c), and the proposed listing of other sawfish (78 FR 33300) to summarize the status of the species, as follows.

7.1.1 Life History

At birth, smalltooth sawfish are approximately 31 inches (80cm). For the first three years of life (until they reach about 2.5 m in length), juveniles reside in shallow, red mangrove estuaries with salinities between 18 and 24 ppt. Adults, which can grow to be 18 ft long, remain in warm coastal waters at shallow depths. Estimates of age at maturity range from 10 to 33 years. Gestation is approximately 5 months and females likely produce litters every second year. Litter sizes may be similar to that of the largetooth sawfish, which produces brood sizes of 1-13 individuals (mean: 7.3). Overall, much uncertainty still remains in estimating life history parameters for smalltooth sawfish since very little information exists on size classes other than juveniles.

7.1.2 Population Dynamics

Since actual abundance data are limited, researchers compiled capture and sightings data (collectively referred to as encounter data) in the National Sawfish Encounter Database. From 1998 to 2011, over 3,000 smalltooth sawfish encounters were reported and compiled in the database (Florida Museum of Natural History 2014). Although this data cannot be used to assess the population because of the opportunistic nature in which they are collected (i.e., encounter data are a series of random occurrences rather than an evenly distributed search over a defined period of time), researchers can use this database to assess the spatial and temporal distribution of smalltooth sawfish. We expect that as the population grows, the geographic range of encounters will also increase. Seitz and Poulakis (2002) and Poulakis and Seitz (2004) document recent (1990 to 2002) occurrences of sawfish along the southwest coast of Florida, and in Florida Bay and the Florida Keys, respectively. This information is confirmed by Wiley and Simpfendorfer (2010) who show the core range has expanded.

The majority of smalltooth sawfish encounters today are from the southwest coast of Florida between the Caloosahatchee River and Florida Bay. Outside of this core area, the smalltooth sawfish appears more common on the west coast of Florida and in the Florida Keys than on the east coast, and occurrences decrease the greater the distance from the core area (Simpfendorfer and Wiley 2004). The capture of a smalltooth sawfish off Georgia in 2002 is the first record north of Florida since 1963. New reports during 2004 extend the current range of the species to Panama City, offshore Louisiana (south of Timbalier Island in 100 ft of water), southern Texas, and the northern coast of Cuba. The Texas sighting was not confirmed to be a smalltooth sawfish and may have been a largetooth sawfish.

Despite the lack of scientific data on abundance, recent encounters with young-of-the-year, older juveniles, and sexually mature smalltooth sawfish indicate that the U.S. population is currently reproducing (Seitz and Poulakis 2002, Simpfendorfer 2003). The abundance of juveniles encountered, including very small individuals, suggests that the population remains viable (Simpfendorfer and Wiley 2004) and data analyzed from Everglades National Park as part of an established fisheries-dependent monitoring program (angler interviews) indicate an increase of between 2 and 5% per year in abundance within the park over the past decade (Carlson et al. 2007, Carlson and Osborne 2012). Also, the declining numbers of individuals with increasing size is consistent with the historic size composition data (Simpfendorfer and Wiley 2004).

The effective population size, the number of animals in the population that produce offspring was recently estimated to be between 250 and 350 individuals (Chapman et al. 2011). Given the small effective population size and the increasing number of neonates produced, inbreeding depression was suspected to be a concern for smalltooth sawfish. Given the degree of decline and range contraction that smalltooth sawfish have experienced over the last few generations, it was originally hypothesized that the remnant smalltooth sawfish population has experienced a genetic bottleneck. However, an analysis of tissue samples (fin clips) collected under the previous permit (number 13330) indicates inbreeding is rare (Chapman et al. 2011). Results of this study also suggest that the remnant smalltooth sawfish population will probably retain 90% of its current genetic diversity and there is no evidence of a genetic bottleneck accompanying last century's demographic bottleneck.

The status and trends and recent encounters in new areas beyond the core abundance area suggest that the population may be increasing. However, smalltooth sawfish encounters are still rare along much of their historical range and they are thought to be extirpated from areas of historical abundance such as the Indian River Lagoon and John's Pass (Snelson and Williams 1981, Simpfendorfer and Wiley 2004).

7.1.3 Status

It is believed that sawfish are at less than 5% of its population size than at the time of European settlement. Historically common in coastal waters from Texas to North Carolina, the range of the DPS has been contracted to southwestern Florida. Like other elasmobranchs, smalltooth sawfish are a k-selected species, characterized by a low rate of intrinsic population growth and able to maintain relatively small population sizes in stable environments, but vulnerable to excessive mortalities. The decline in sawfish abundance is attributed to bycatch in fisheries, entanglement in marine debris, and loss of juvenile habitat through destruction of mangroves and dredging and filling projects. These factors continue to be significant threats to smalltooth sawfish survival and recovery. Therefore, the species has little resilience to additional perturbations.

7.1.4 Critical Habitat

Two units of critical habitat were designated for smalltooth sawfish in 2009 (74 FR 45353): the Charlotte Harbor Estuary and the Ten Thousand Islands/Everglades. Primary constituent elements were not identified, although the final rule identified the red mangroves and shallow euryhaline habitats as essential to the conservation of smalltooth sawfish because both serve nursery area functions. Activities that may affect smalltooth sawfish critical habitat include dredging, filling, in-water construction, installation of water control structures, and hard clam aquaculture activities.

8 Rockfish

Rockfish are classified in the taxonomic family Sebastidae. Worldwide, there are about 130 species in the family. The proposed project may affect three ESA-listed species, discussed below.

8.1 Bocaccio (Puget Sound/Georgia Basin DPS)

Bocaccio is a rockfish species that occurs from the central Baja peninsula of Mexico north along the continental shelf and slope as far as Stepovac Bay, Alaska (Love et al. 2002). Genetic analyses suggest is composed of two distinct populations (Wishard et al. 1980, Matala et al. 2004). A southern population exists along the Pacific coasts of Mexican and California and is separated from a northern population by a region of apparent scarcity from northern California to southern Oregon (MacCall and He 2002b). It has been proposed that oceanographic features, such as current patterns restricting larval movement, are responsible for population discreteness (Matala et al. 2004, NMFS 2008d). Bocaccio of the Puget Sound/Georgia Basin were determined to be a DPS and listed as endangered in 2010. However, the presence of a third population has also been suggested (Queen Charlotte Island, Vancouver Island to Point Conception, California, and south of Point Conception) (Matala et al. 2004). For stock management purposes, the NMFS and Pacific Fisheries Management Council recognize these populations as separate stocks.

8.1.1 Life History

Preferred bocaccio habitat is largely dependent upon the life stage of an individual. Larvae and young juveniles tend to be found in deeper offshore regions (1-148 km offshore), but associated with the surface and occasionally with floating kelp mats (Hartmann 1987, Love et al. 2002, Emery et al. 2006). As individuals mature into older juveniles and adults, they transition into shallow waters and settle to the bottom, preferring algae-covered rocky, eelgrass, or sand habitats and aggregating into schools (Eschmeyer et al. 1983, Love et al. 1991). After a few weeks, fish move into slightly deeper waters of 18-30 m and occupy rocky reefs (Feder et al. 1974, Carr 1983, Eschmeyer et al. 1983, Johnson 2006, Love and Yoklavich 2008). As adults, bocaccio may be found in depths of 12-478 m, but tend to remain in shallow waters on the continental shelf (20-250 m), still associating mostly with reefs or other hard substrate, but may move over mud flats (Feder et al. 1974, Kramer and O'Connell 1995, Love et al. 2002, Love et al. 2005, Love and York 2005, Love et al. 2006). Artificial habitats, such as platform structures, also appear to be suitable habitat for bocaccio (Love and York 2006). Adults may occupy territories of 200-400 hectares, but can venture outside of this territory (Hartmann 1987). Adults tend to occupy deeper waters in the southern population compared to the northern population (Love et al. 2002). Adults are not as benthic as juveniles and may occur as much as 30 m above the bottom and move 100 m vertically during the course of a day as they move between different areas (Love et al. 2002, Starr et al. 2002). Prior to severe population reductions, bocaccio appeared to frequent the Tacoma Narrows in Washington State (DeLacy et al. 1964, Haw and Buckley 1971, Miller and Borton 1980).

Bocaccio are live-bearers with internal fertilization. Once females become mature (at 54-61 cm total length), they produce 20,000-2.3 million eggs annually, with the number increasing as females age and grow larger (Hart 1973, Echeverria 1987, Love et al. 2002). However, either sex has been known to attain sexual maturity as small as 35 cm or 3 years of age and, in recent years as populations have declined, average age at sexual maturity may have declined as well (Hart 1973, Echeverria 1987, Love et al. 2002, MacCall 2002b). Mating occurs between August and November, with larvae born between January and April (Lyubimova 1965, Moser 1967, Westrheim 1975, Wyllie Echeverria 1987, Love et al. 2002, MacCall and He 2002b).

Upon birth, bocaccio larvae measure 4-5 mm in length. These larvae move into pelagic waters as juveniles when they are 1.5-3 cm and remain in oceanic waters from 3.5-5.5 months after birth (usually until early June), where they grow at ~0.5-1 mm per day (Moser 1967, Matarese et al. 1989, Woodbury and Ralston 1991, Love et al. 2002, MacCall and He 2002b, MacCall 2003). However, growth can vary from year-to-year (Woodbury and Ralston 1991). Once individuals are 3-4 cm in length, they return to nearshore waters, where they settle into bottom habitats.

Females tend to grow faster than males, but fish may take 5 years to reach sexual maturity (MacCall 2003). Individuals continue to grow until they reach maximum sizes of 91 cm, or 9.6 kg, at an estimated maximum age of 50 years (Eschmeyer et al. 1983, Halstead et al. 1990, Ralston and Ianelli 1998, Love et al. 2002, Andrews et al. 2005, Piner et al. 2006). However, individuals tend to grow larger in more northerly regions (Dark et al. 1983).

Prey of bocaccio vary with fish age, with bocaccio larvae starting with larval krill, diatoms, and dinoflagellates (Love et al. 2002). Pelagic juveniles consume fish larvae, copepods, and krill, while older, nearshore juveniles and adults prey upon rockfishes, hake, sablefish, anchovies, lanternfish, and squid (Reilly et al. 1992, Love et al. 2002).

8.1.2 Population Dynamics

Although population estimates are not available for the northern population, the southern population has been estimated to number 1.6 million fish of 1 year of age or older in 2002 (MacCall 2002a). Of these, 1.0 million were estimated to occur south of Pt. Conception, where recruitment has been stronger. However, individuals north of Pt. Conception tend to be larger and, hence, more fecund. In 2002, the southern population was estimated to produce 720 billion eggs annually (243 billion south of Pt. Conception). North of Pt. Conception, bocaccio are most abundant in the Monterey Bay area, where prime habitat seems to be over the continental slope and, secondarily, over the shelf (Dark et al. 1983).

The rate of decline for rockfish in Puget Sound has been estimated at ~3% annually for the period 1965-2007. Various rebuilding estimates for bocaccio populations have predicted recovery, but require long periods (98-170 years) and assume no mortality from fishing (intentional harvests are closed, but bycatch still occurs) (MacCall and He 2002a, MacCall 2008, NMFS 2008d).

8.1.3 Status

The Puget Sound/Georgia Basin DPS of bocaccio was listed as endangered on April 28, 2010 (75 FR 22276). Bocaccio as a species has undergone severe decline in the past several decades, with the species currently estimated to be 3.6% of its abundance in 1970 (MacCall and He 2002b). In Puget Sound prior to World War II, commercial landings of rockfish species generally remained under 20,000 lbs, but sky-rocketed during the war to 375,000 lbs annually and fluctuated between 50,000 and 220,000 lbs until 1970, when landings increased linearly with fishing effort to a peak of 900,000 lbs by 1980 (Palsson et al. 2009). Levels fluctuated after this between 48,000 and 300,000 lbs for the next decade and clearly crashed in the 1990's, with landings below 30,000 lbs annually. At the cessat*i*on of commercial fishing in 2003, 2,600 lbs of rockfish were harvested. Similar trends are seen in recreational landings from Puget Sound (WDF 1975-1986).

Among rockfish of the Puget Sound, bocaccio appear to have undergone a particular decline (MacCall and He 2002b). This has likely because of the removal of the largest, most fecund individuals of the population due to overfishing and the frequent failure of recruitment classes, possibly because of unfavorable climactic/oceanographic conditions (MacCall and He 2002b).

Bocaccio resistance to depletion and recovery is also hindered by demographic features (Love et al. 1998a). Bocaccio are long-lived fishes, taking several years to reach sexual maturity and becoming more fecund with age (Dorn 2002). As harvesting targeted the largest individuals available, bocaccio have become less capable of recovering population numbers (Love et al.

1998b). Bocaccio reproduction appears to be characterized by frequent recruitment failures, punctuated by occasional high success years (Love et al. 1998b, MacCall and He 2002b). Recruitment success appears to be linked to oceanographic/climactic patterns and may be related to cyclic warm/cool ocean periods, with cool periods having greater success (Sakuma and Ralston 1995, MacCall 1996, Love et al. 1998b, Moser et al. 2000). Harvey et al. (2006) suggested that bocaccio may have recently diverted resources from reproduction, potentially resulting in additional impairment to recovery. Overall, bocaccio have the highest variability of recruitment of any rockfish studied to date, with recruitment exhibiting a random walk and high temporal variability (MacCall and He 2002b, Tolimieri and Levin 2005).

8.1.4 Critical Habitat

NMFS proposed critical habitat designation of approximately 1,185 mi^2 of marine habitat for bocaccio in Puget Sound, Washington, on August 6, 2013 (78 FR 47635). A final designation has not been made.

8.2 Yelloweye Rockfish (Puget Sound/Georgia Basin DPS)

Yelloweye rockfish occur from Baja California to the Aleutian Islands, but are most common from central California to Alaska (Love et al. 2002). This species likely composed of at least two populations and possibly more. Yamanaka et al. (2006) found that those individuals found within the Georgia Basin and Queen Charlotte Strait were genetically distinct from other samples from Oregon to Alaska.

8.2.1 Life History

As with other rockfishes, yelloweye habitat varies based upon life stage. Larvae maintain a pelagic existence but as juveniles, move into shallow high relief rocky or sponge garden habitats (Eschmeyer et al. 1983, Richards et al. 1985, Love et al. 1991). Juveniles may also associate with floating debris or pilings (Lamb and Edgell 1986). As adults, yelloweye rockfish move in to deeper habitats. Individuals have been found in waters as deep as 549 m, but are generally found in waters of less than 180 m (Eschmeyer et al. 1983, Love et al. 2002). However, adults continue to associate with rocky, high relief habitats, particularly with caves and crevices, pinnacles, and boulder fields (Carlson and Straty 1981, Richards 1986, Love et al. 1991, O'Connell and Carlisle 1993, Yoklavich et al. 2000). Yelloweye generally occur as individuals, with loose, residential aggregations infrequently found (Coombs 1979, DeMott 1983, Love et al. 2002). In the Puget Sound region, sport catch records from the 1970’s indicate that Sucia Island and other islands of the San Juans as well as Bellingham Bay had the highest concentrations of catches (Delacy et al. 1972, Miller and Borton 1980).

Yelloweye rockfish are live bearers with internal fertilization. Copulation occurs between September and April, with fertilization taking place later as latitude increases (Hitz 1962, DeLacy et al. 1964, Westrheim 1975, O'Connell 1987, Wyllie Echeverria 1987, Lea et al. 1999). Puget Sound yelloweye mate between winter and summer, giving birth from spring to late summer (Washington et al. 1978). Gestation lasts roughly 30 days (Eldridge et al. 2002). Although yelloweye rockfish were once believed to reproduce annually, evidence exists that indicate the potential for multiple births per year (MacGregor 1970, Washington et al. 1978). Females produce more eggs as they grow older and larger, with each individual producing roughly 300 eggs per year per gram of body weight (1.2-2.7 million eggs per year) (MacGregor 1970, Hart 1973). In addition, older females of several rockfish species may be capable of provisioning their offspring better than their younger counterparts, meaning that they may be more a more influential component in a given year's recruitment success (Sogard et al. 2008).

Larvae are born at 4-5 mm in length and maintain a pelagic existence for the first 2 months of life, before moving to nearshore habitats and settling into rocky reef habitat at about 25 mm in length (DeLacy et al. 1964, Matarese et al. 1989, Moser 1996a, Love et al. 2002). Yelloweye growth is thought to vary by latitudinal gradient, with individuals in more northerly regions growing faster and larger. Year class strength appears to be most strongly linked to survival of the larval stage (Laidig et al. 2007). In general, sexual maturity appears to be reached by 50% of individuals by 15-20 years of age and 40-50 cm in length (Yamanaka and Kronlund 1997). As with other rockfish, yelloweye can be long-lived (reported oldest age is 118 years) (Munk 2001). Maximum size has been reported as 910 cm, but assymptotic size in Alaskan waters for both males and females was estimated to be 690 cm and 659-676 mm along British Columbia (Clemens and Wilby 1961, Westrheim and Harling 1975, Rosenthal et al. 1982, Love et al. 2005, Yamanaka et al. 2006).

Individuals shift to deeper habitats as they age. Juveniles tend to begin life in shallow rocky reefs and graduate to deeper rocky habitats as adults. Once adult habitat is established, individuals tend to remain at a particular site (Love 1978, Coombs 1979, DeMott 1983).

As with other rockfish species, yelloweye rockfish prey upon different species and size classes throughout their development. Larval and juvenile rockfish prey upon phyto- and zooplankton (Lee and Sampson 2009). Adult yelloweyes eat other rockfish (including members of their own species), sand lance, gadids, flatfishes, shrimp, crabs, and gastropods (Love et al. 2002, Yamanaka et al. 2006).

8.2.2 Population Dynamics

Over the period of 1965-2007, it is estimated that rockfish species has declined by 3% per year. Yelloweye rockfish within the Puget Sound/Georgia Basin (in U.S. waters) are very likely most abundant within the San Juan Basin. Though there is no reliable population census (ROV or otherwise) within the basins of Puget Sound proper, the San Juan Basin has the most suitable rocky benthic habitat (Palsson et al. 2009) and historically was the area of greatest numbers of angler catches (Moulton and Miller 1987, Olander 1991). Productivity for yelloweye rockfish is influenced by long generation times that reflect intrinsically low annual reproductive success. Natural mortality rates have been estimated from 2 to 4.6 percent (Yamanaka and Kronlund 1997, Wallace 2007). Productivity may also be particularly impacted by Allee effects, which occur as adults are removed by fishing and the density and proximity of mature fish decreases. Adult yelloweye rockfish typically occupy relatively small ranges (Love et al. 2002) and it is unknown the extent they may move to find suitable mates.

8.2.3 Status

The Puget Sound/Georgia Basin DPS of yelloweye rockfish was listed as endangered on April 28, 2010 (75 FR 22276). It has been estimated that yelloweye rockfish have fallen 30% in abundance within 1/3 of a generation in the past few decades, an astonishing rate of decline. Yelloweye rockfish abundance has been variable in the Puget Sound region over the past 60 years, ranging from less than 1% to greater than 3% of samples, although Wallace (2001) documented large historical population in the Strait of Georgia. The latest samples have been historic lows in abundance. Perhaps more importantly, age classes appear to have been truncated to younger, smaller fish, severely hampering the ability of the species to recover from its primary cause of decline: overfishing (Berkeley et al. 2004).

In Puget Sound, prior to World War II, commercial landings of rockfish species generally remained under 20,000 lbs, but sky-rocketed during the war to 375,000 lbs annually and fluctuated between 50,000 and 220,000 lbs until 1970, when landings increased linearly with fishing effort to a peak of 900,000 lbs by 1980 (Palsson et al. 2009). Levels fluctuated after this between 48,000 and 300,000 lbs for the next decade and clearly crashed in the 1990's, with landings below 30,000 lbs annually. At the cessation of commercial fishing in 2003, 2,600 lbs of rockfish were harvested. Over the period of 1965-2007, it is estimated that rockfish species has declined by 3% per year.

8.2.4 Critical Habitat

NMFS proposed critical habitat designation of approximately 575 mi^2 of marine habitat for yelloweye rockrish in Puget Sound, Washington, on August 6, 2013 (78 FR 47635). A final designation has not been made.

8.3 Canary Rockfish (Puget Sound/Georgia Basin DPS)

Canary rockfish are found from the northern Baja peninsula north to the western Gulf of Alaska, and with the greatest abundance along British Columbia to central California (Miller and Lea 1972, Hart 1973, Cailliet et al. 2000, Love et al. 2002). It is unclear how many populations compose canary rockfish as a species. Genetic analyses have found that individuals south of Cape Blanco in southern Oregon lack an allele that individuals north of this point have (Wishard et al. 1980). The Puget Sound/Georgia Basin DPS includes all canary rockfish in the waters of Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of Victoria Sill. In addition, canary rockfish are managed as two stocks in Canadian waters (COSEWIC in press).

8.3.1 Life History

Canary rockfish occupy a variety of habitats based upon their life stage. Larvae and younger juveniles tend to occupy shallow waters at the beginning of their lives, but generally remain in the upper 100 m of the water column (Love et al. 2002).. Juveniles initially settle into tide pools and rocky reefs (Miller and Geibel 1973, Love et al. 1991, Cailliet et al. 2000, Love et al. 2002). Juveniles have also been observed in diurnal movements, occurring near sand-rock interfaces in groups by day and moving over sandy areas at night (Love et al. 2002). After as much as 3 years, juveniles move into deeper rocky reefs, forming loose schools, rarely on but generally near the bottom (Phillips 1960, Boehlert 1980, Lamb and Edgell 1986, Rosenthal et al. 1998, Starr 1998, Cailliet et al. 2000, Johnson et al. 2003, Methot and Stewart 2005, Tissot et al. 2007). Adults may be found in waters of up to 400 m, but tend to be most common in the 80-200 m range, or even shallower (Moser 1996b, Methot and Stewart 2005, Tissot et al. 2007). Mid shelf locations seem to have the highest concentrations of canary rockfish off Washington and Oregon (Weinberg 1994). Adults tend to occur in shallow areas in higher latitudes than their southern counterparts, although adults do appear to move into progressively deeper waters as they age (Vetter and Lynn 1997, Methot and Stewart 2005). It is believed that, within Puget Sound, canary rockfish were most common in the 1960's and 1970's in Tacoma Narrows, Hood Canal, San Juan Islands, Bellingham, and Appletree Cove (Delacy et al. 1972, Miller and Borton 1980).

A latitudinal gradient may be present by age class, with older and larger individuals preferably occupying more northerly habitat (Dark et al. 1983).

Individual canary rockfish can range widely (up to 700 km over several years), although patterns of residency have been observed (Gascon and Miller 1981, DeMott 1983, Casillas et al. 1998, Lea et al. 1999, Love et al. 2002). In addition, seasonal movements have been found, with individuals moving from 160-210 m depths in late winter to 100-170 m in late summer (COSEWIC in press).

Canary rockfish develop their young internally before giving birth to live young as larvae. During each annual spawning event, a female can produce 260,000 to 1.9 million eggs, depending upon her size and age (Guillemot et al. 1985, NMFS 2008d). Unlike some other rockfish, there does not appear to be a latitudinal or geographic gradient associated with number of eggs produced (Gunderson et al. 1980, Love et al. 2002). Birth takes place in Oregonian and Washingtonian waters between September through March, with a peak in December and January. The peak in British Columbian waters is slightly later (February) (Hart 1973, Westrheim and Harling 1975, Wyllie Echeverria 1987, Barss 1989).

When born, larvae are 3.6-4.0 mm in length and take from 1-4 months to develop into juveniles (Waldron 1968, Richardson and Laroche 1979, Stahl-Johnson 1985, Moser 1996a, Krigsman 2000, Love et al. 2002). As with other rockfish, females seem grow more quickly than do males, with females reaching sexual maturity at 7-9 years of age (35-45 cm in length) versus males at 7-12 years (~41 cm in length) off Oregon (Westrheim and Harling 1975, Boehlert and Kappenman 1980, Lenarz and Echeverria 1991, STAT 1999). Mean length at sexual maturity off Vancouver Island is 41 cm for females and 48 cm for males (Westrheim and Harling 1975). Canary rockfish are known to frequently reach 60-75 years of age and have been found to be as old as 84 years (Cailliet et al. 2000, Cailliet et al. 2001, Andrews et al. 2007). Maximum reported sizes are 76 cm and 4.5 kg (Boehlert 1980, IGFA 1991, Williams et al. 1999, Love et al. 2002, Methot and Stewart 2005).

Canary rockfish prey upon different species as they age. Larvae are planktivores, consuming invertebrate eggs, copepods, and nauplii (Moser and Boehlert 1991, Love et al. 2002). Juveniles feed upon zooplankton, including crustaceans, juvenile polychaetes barnacle cyprids, and euphasiid eggs and larvae (Gaines and Roughgarden 1987, Love et al. 1991). However, adults move into a carnivorous lifestyle as well as eating euphasiids and other crustaceans. Adults consume other fishes such as shortbelly rockfish, mytophids and stomiatiods (Cailliet et al. 2000, Love et al. 2002). However, oceanographic and climactic shifts can alter foraging such that canary rockfish feed on other available species (Lee and Sampson 2009).

8.3.2 Population Dynamics

The rate of decline for rockfish in Puget Sound has been estimated at ~3% annually for the period 1965-2007.

8.3.3 Status

The Puget Sound/Georgia Basin DPS of canary rockfish was listed as threatened on April 28, 2010 (75 FR 22276). Canary rockfish were once considered common in Puget Sound, but has declined at a faster rate than any other rockfish species in the region (Holmberg et al. 1967, NMFS 2008d). In Puget Sound, prior to World War II, commercial landings of rockfish species generally remained under 20,000 lbs, but sky-rocketed during the war to 375,000 lbs annually and fluctuated between 50,000 and 220,000 lbs until 1970, when landings increased linearly with fishing effort to a peak of 900,000 lbs by 1980(Palsson et al. 2009). Levels fluctuated after this between 48,000 and 300,000 lbs for the next decade and clearly crashed in the 1990's, with landings below 30,000 lbs annually. At the cessation of commercial fishing in 2003, 2,600 lbs of rockfish were harvested. Canary rockfish have been noted for being much less frequently caught in the Puget Sound and Georgia Basin region since 1965 (NMFS 2008d). The rate of decline for rockfish in Puget Sound has been estimated at ~3% annually for the period 1965-2007.

Declines have been noted in both numbers as well as frequencies. This likely due to the targeted removal of larger, older, and more fecund individuals by commercial fisheries, reducing the ability of canary rockfish to rebound from excessive mortality (NMFS 2008d). For example, recreational fishing data have not reported any individuals caught greater than 55 cm since 2000, whereas a variety of large size classes had formerly been caught. There are concerns that even now some populations have been lost entirely, primarily due to over harvesting, but also due to low dissolved oxygen levels in some areas of Puget Sound (NMFS 2008d).

8.3.4 Critical Habitat

NMFS proposed critical habitat designation of approximately 1,185 mi^2 of marine habitat for canary rockfish in Puget Sound, Washington, on August 6, 2013 (78 FR 47635). A final designation has not been made.

9 Abalone

Abalone are molluscs classified in the taxonomic family Haliotidae. Two ESA-listed species may be affected by the proposed action and are described below.

9.1 White Abalone

The white abalone is a large marine gastropod mollusk found in deep (20 – 60 m), rocky habitats interspersed with sand channels, from Point Conception, California to Punta Abreojos, Baja California, Mexico. The species was listed as endangered under the ESA on May 29, 2001 (66 FR 29046). We used information available in the status review report (Hobday and Tegner 2000) and the recovery plan (NMFS 2008c) to summarize the status of the species, as follows.

9.1.1 Life History

White abalone are "broadcast" spawners, releasing gametes in synchrony during the winter. Fertilization is reliant upon dense adult aggregations and high gamete density. Fertilized eggs sink and hatch into free-swimming larvae. After one or two weeks, larvae settle and becoming increasingly sedentary with age. They mature at 4 – 6 years of age and can live 35 – 40 years. Females release hundreds of thousands to millions of eggs each year. White abalone are herbivorous, feeding on attached or drifting algae.

9.1.2 Population Dynamics

Surveys conducted in 2002 and 2003 resulted in population estimates of 12,818 (± 3,582) and 7,365 (± 5,340) individuals on two banks in southern California. These estimates are larger than the estimate of total abundance (600 – 1,600 individuals) in the late 1990s. Though current abundance remains unknown, it is likely less than one percent of pre-exploitation population size

9.1.3 Status

Surveys conducted between 1972 and 1997 indicate that the density of white abalone declined by four orders of magnitude (99 percent). Furthermore, juvenile shells are rarely observed, indicating a lack of recruitment. The species is endangered as a result of overharvest by commercial and recreational fisheries. The Californian commercial fishery began in 1968 and peaked at 144,000 lbs (86,000 individuals) in 1972. By 1978, white abalone catch had declined dramatically, such that individuals were rarely landed (< 1000 lbs annually). The Californian recreational fishery peaked in 1975, at ~35,000 individuals. The commercial and recreational fisheries were closed in 1996. White abalone were also harvested in Baja California, Mexico, although catch numbers are not available. Its continued existence is threatened by illegal poaching and low recruitment (the current density of white abalone limits the success rate of fertilization and recruitment). Therefore, species' resilience to future perturbations is low.

9.1.4 Critical Habitat

Critical habitat has not been designated because it was determined to be "not prudent," due to concern that disclosure of white abalone whereabouts would increase the threat of poaching (66 FR 29048).

9.2 Black Abalone

Black abalone is a large marine gastropod mollusk found in shallow (< 6 m) rocky intertidal and subtidal habitats, from Point Arena, California to Bahia Tortugas and Isla Guadalupe, Baja California, Mexico. The species was listed as endangered under the ESA on January 14, 2009 (74 FR 1937). We used information available in the status review report (Butler et al. 2009) to summarize the status of the species, as follows.

9.2.1 Life History

Black abalone are "broadcast" spawners, releasing gametes in synchrony during the spring and summer. Fertilization is reliant upon dense adult aggregations, high gamete density. Within days, fertilized eggs sink and hatch into free-swimming larvae. After 4 – 10 days, larvae settle and becoming increasingly sedentary with age. They mature at ~3 years of age and can live for 30 years. Small females release a hundred thousand eggs each year, but larger individuals release millions of eggs annually. Black abalone are herbivorous, feeding on attached or drifting algal material.

9.2.2 Population Dynamics

Fisheries data indicate that black abalone populations have declined > 95% in recent decades, such that the species now exhibits a patchy distribution along the coasts of California and northern Baja California. The populations appear to be reproductively isolated by distance, emphasizing the importance of local spawning and recruitment.

9.2.3 Status

Long-term monitoring sites from most of the geographical range of black abalone in the United States indicate that black abalone have become locally extinct at 11 of the 32 study locations (34%), have declined between 90–99% in abundance at an additional 10 (31%) study locations, and have declined between 80–89% at 2 sites (Neuman et al. 2010). At 8 northern sites (25%), there have been no instances of declines, and average abundance has increased by 56% (Neuman et al. 2010). Thus, significant declines (>80%) have occurred at the majority (72%) of study sites, including all sites in southern California (Neuman et al. 2010). There is evidence of recent recruitment in northern Baja California. Black abalone are endangered as a result of overharvest and disease. The Californian commercial fishery peaked at 1,860 metric tons in 1879, reached 868 metric tons in 1973, and fell to <20 metric tons in 1993, when the commercial and recreational fisheries were closed. Between 1972 and 1981, over 3.5 million individuals were harvested. The Mexican commercial fishery peaked in 1990 with 28 metric tons and declined to < 0.5 metric tons by 2003. The severe declines were caused primarily by withering syndrome. Withering syndrome is a disease caused by bacteria that prevents assimilation of nutrients in the digestive system. The first appearance along mainland California occurred in 1988, when approximately 85% of the resident black abalone in Diablo Cove died as a result of the disease and warm-water effluent from a nuclear power facility. Previous overharvest, continued poaching, and withering syndrome have resulted in extremely low population densities, which further reduce the potential for fertilization and recruitment and limit the recovery potential of the species. Its resilience to future perturbations is extremely low.

9.2.4 Critical Habitat

On October 27, 2011, the NMFS designated critical habitat for black abalone as follows: rocky areas from mean high water to six meters water depth in the Farallon, Channel, and Año Nuevo islands; the California coastline from Del Mar Ecological Reserve south to Government Point (excluding some stretches, such as in Monterey Bay and between Cayucos and Montaña de Oros State Park); and between the Palos Verdes and Torrance border south to Los Angeles Harbor. These areas include primary constituent elements required by black abalone, such as: rocky substrates, food resources, juvenile settlement habitat, suitable water quality, and suitable nearshore circulation patterns.

10 Corals

Corals include a diverse range of animals that are taxonomically complex. Most corals are classified in the taxonomic Class Anthozoa. Most reef-building corals are further classified in the Order Scleractinia Thousands of species of reef-building corals occur worldwide. The proposed project may affect two ESA-listed coral species and 66 species proposed for ESA-listing, discussed below.

10.1 Elkhorn Coral

Elkhorn coral is a branching coral found in reef crest and fore reef environments (1 – 5 m) in Florida, Bahamas, and the Caribbean. It was listed as threatened under the ESA on May 9, 2006 (71 FR 26852); it was proposed as endangered on December 7, 2012 (77 FR 73219). We used information available in the status review report (*Acropora* Biological Review Team 2005) and the proposed listing (77 FR 73219) to summarize the status of the species, as follows.

10.1.1 Life History

Elkhorn corals reproduce sexually and asexually (i.e., fragmentation). Sexual reproduction is accomplished by releasing sperm and egg during spawning events, which last only a few nights during July, August, and/or September. After fertilization, planktonic planulae larvae form. In response to physical and biological settlement cues, larvae settle on exposed, hard surfaces. Larger colonies have higher fertility and fecundity rates. Colony maintenance is achieved mainly by asexual reproduction, whereas sexual reproduction and recruitment is required for colony growth. Nutrients are provided by symbiotic, photosynthesizing zooxanthellae, which require sunlight and relatively clear, well-circulated water. The species' optimal water temperatures range from 25 to 29°C; elevated temperature may result in bleaching (i.e., loss of zooxanthellae).

10.1.2 Population Dynamics

Once abundant throughout its range, elkhorn coral has experienced precipitous declines since the 1980s. In areas where quantitative data are available, the species has declined in abundance (coverage and colony numbers) by greater than 97 percent. Since 2006, some populations have declined by an additional 50 percent and experienced recruitment failure; however no populations have been extirpated, and the species retains its historical range.

10.1.3 Status

Elkhorn coral was once one of the most abundant and important Caribbean coral species, in terms of accretion of reef structure. Disease, temperature-induced bleaching, and physical damage from hurricanes led to severe declines in the 1980s. Current major threats include climate change (ocean warming and acidification), disease, sedimentation, and nutrient over-enrichment. Current levels of abundance and recruitment are extremely low, and the species continues to decline without any signs of recovery; however, there is no evidence of extirpation. Therefore, the species' resilience to future perturbations is limited.

10.1.4 Critical Habitat

On November 26, 2008, NMFS designated critical habitat for elkhorn coral. They designated marine habitat in four specific areas: Florida (1,329 square miles), Puerto Rico (1,383 square miles), St. John/St. Thomas (121 square miles), and St. Croix (126 square miles). These areas support the following physical or biological features that are essential to the conservation of the species: substrate of suitable quality and availability to support successful larval settlement and recruitment and reattachment and recruitment of fragments.

10.2 Staghorn Coral

Staghorn coral is a branching coral found in reef terraces and outer reef environments (5 – 15 m) in Florida, Bahamas, and the Caribbean. It was listed as threatened under the ESA on May 9, 2006 (71 FR 26852); it was proposed as endangered on December 7, 2012 (77 FR 73219). We used information available in the status review report (*Acropora* Biological Review Team 2005) and the proposed listing (77 FR 73219) to summarize the status of the species, as follows.

10.2.1 Life History

Staghorn corals reproduce sexually and asexually (i.e., fragmentation). Sexual reproduction is accomplished by releasing sperm and egg during spawning events, which last only a few nights during July, August, and/or September. After fertilization, planktonic planulae larvae form. In response to physical and biological settlement cues, larvae settle on exposed, hard surfaces. Larger colonies have higher fertility and fecundity rates. Colony maintenance is achieved mainly by asexual reproduction, whereas sexual reproduction and recruitment is required for colony growth. Nutrients for the coral are provided by symbiotic, photosynthesizing zooxanthellae, which require sunlight and relatively clear, well-circulated water. The species' optimal water temperatures range from 26 to 29°C; elevated temperature may result in bleaching (i.e., loss of zooxanthellae), and lower temperatures reduce growth rates.

10.2.2 Population Dynamics

Once abundant throughout its range, staghorn coral has experienced precipitous declines since the 1980s. In areas where quantitative data are available, the species has declined in abundance (coverage and colony numbers) by greater than 97 percent. Since 2006, some populations have declined by an additional 50 percent and experienced recruitment failure; however no populations have been extirpated, and the species retains its historical range.

10.2.3 Status

Staghorn coral was once one of the most abundant and important Caribbean coral species, in terms of accretion of reef structure. Disease, temperature-induced bleaching, and physical damage from hurricanes led to severe declines in the 1980s. Current major threats include climate change (ocean warming and acidification), disease, sedimentation, and nutrient over-enrichment. Current levels of abundance and recruitment are extremely low, and the species continues to decline without any signs of recovery; however, there is no evidence of extirpation. Therefore, the species' resilience to future perturbations is limited.

10.2.4 Critical Habitat

On November 26, 2008, NMFS designated critical habitat for staghorn coral. They designated marine habitat in four specific areas: Florida (1,329 square miles), Puerto Rico (1,383 square miles), St. John/St. Thomas (121 square miles), and St. Croix (126 square miles). These areas support the following physical or biological features that are essential to the conservation of the species: substrate of suitable quality and availability to support successful larval settlement and recruitment and reattachment and recruitment of fragments.

11 Johnson's Seagrass

Johnson's seagrass is a rare species with an extremely limited distribution. It is found on the east coast of Florida from Sebastian Inlet to central Biscayne Bay. On September 14, 1998, NMFS issued a final rule to list the species as threatened pursuant to the ESA (69 FR 49035). We used information available in the final rule and the 5-year review (NMFS 2007c) to summarize the status of the species, as follows.

11.1.1 Life History

The life history and maintenance of populations is exclusively dependent on asexual reproduction and clonal growth dynamics. No male flowers have ever been reported, and there is no evidence of sexual reproduction. Female flowers, however, are common; they are morphologically and physiologically capable of being fertilized if male pollen was available. Growth and the occupation of space, as well as the dispersal of the species, depend on the division of apical meristems. Populations disappear and reappear on both short- (months) and long-term (years) time scales (NMFS 2007c). Johnson's seagrass is able to colonize and thrive in environments where other seagrasses cannot, as a result of its potential for vegetative expansion, a perennial and intertidal growth habit, and a relatively high tolerance for fluctuating salinity and temperature (Kenworthy and Virnstein 1997).

11.1.2 Population Dynamics

The species distribution is characterized as patchy, disjunct, and temporally fluctuating. Surveys indicate, however, that the present geographic ranges of the southern and northern limits of the species have been stable for at least 10 years. It appears that the populations in the northern range of the species (Sebastian Inlet to Jupiter Inlet) are stable and capable of sustaining themselves despite stochastic events related to severe storms and fluctuating climatology. Although it is disjunctly distributed and patchy, there is some continuity in the southern distribution, at least during periods of relatively good environmental conditions, and no significant large-scale disturbances.

11.1.3 Status
Johnson's seagrass was listed as a threatened species in 1998 because of its limited reproductive potential and energy storage capacity restrict its ability to repopulate an area after anthropogenic or natural disturbances (69 FR 49035). At the time of listing, five threats were identified: dredging, prop scoring, storm surge, altered water quality, and siltation. Given its limited distribution and inability to quickly repopulate, the species' is expected to have little resilience to these perturbations. Despite the continuation, or increase, of these threats, however, abundance and distribution have remained constant over the past decade.

11.1.4 Critical Habitat
Critical habitat for Johnson's seagrass was designated on April 5, 2000 (65 FR 17786). Ten areas were designated: a portion of the Indian River Lagoon, north of the Sebastian Inlet Channel; a portion of the Indian River Lagoon, south of the Sebastian Inlet Channel; a portion of the Indian River Lagoon near the Fort Pierce Inlet; a portion of the Indian River Lagoon, north of the St. Lucie Inlet; a portion of Hobe Sound; a site on the south side of Jupiter Inlet; a site in central Lake Worth Lagoon; a site in Lake Worth Lagoon, Boynton Beach; a site in Lake Wyman, Boca Raton; and a portion of Biscayne Bay. These areas are characterized by one or more of the following criteria: (1) locations with populations that have persisted for 10 years; (2) locations with persistent flowering populations; (3) locations at the northern and southern range limits of the species; (4) locations with unique genetic diversity; and (5) locations with a documented high abundance of Johnson's seagrass compared to other areas in the species' range. Important physical and biological features of the critical habitat areas include adequate water quality, salinity levels, water transparency, and stable, unconsolidated sediments that are free from physical disturbance.

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Appendix C

Additional Species Specific Effects Analysis for Species Under Jurisdiction of NMFS

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Effects of Cooling Water Intake Structures on Threatened and Endangered Species under National Marine Fisheries Service Jurisdiction

Under the Endangered Species Act (ESA), "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

We analyze the effects of cooling water intake structures (CWIS) considering only the mandatory requirements of the Environmental Protection Agency's (EPA) regulation, without any of the U.S. Fish and Wildlife and National Marine Fisheries Services' (Services) species and habitat protection measures (except where noted). The effects analysis in the Opinion anticipates that where necessary State and Tribal Directors will incorporate the control measures, monitoring, and reporting recommendations provided by the Services through technical assistance facilitated by the exchange of information between the Directors and the Services into NPDES permits that contain 316(b) requirements. For federal permits issued by EPA, the Services will review and evaluate the effects of a facility's CWIS during consultation with EPA (where that consultation is required under section 7) for each individual permit. For permits issued by States and Tribes, the Services will receive all permit applications for review, will evaluate the effects of each facility's CWIS, identify measures when appropriate and, when necessary, work with EPA to implement its oversight procedures.

Appendix C provides an initial evaluation of the direct and indirect effects of the proposed action on species and critical habitat. The National Marine Fisheries Services (NMFS) performs our effects analysis using a series of steps.

1) We identify the physical, chemical, or biotic stressors that are likely to result from the operation of CWIS, as regulated under the Rule.
2) We determine whether and how many individuals are likely to be exposed to such stressors.
3) Then, we evaluate the probable responses of individuals to the stressors. If responses are likely to reduce the fitness (i.e., survival and/or reproduction) of one or more individual, we consider the magnitude of such losses on population viability.

The ultimate purpose of our assessment is to determine whether the proposed action is likely to reduce the species' likelihood of surviving and recovering in the wild (our "jeopardy" determination).

Our "destruction or adverse modification" determinations must be based on an action's effects on the conservation value of habitat that has been designated as critical to threatened or endangered species. If an area encompassed in a critical habitat designation is likely to be exposed to the direct or indirect consequences of the proposed action on the natural environment, we ask if primary constituent elements included in the designation (if there are any) or physical, chemical or biotic phenomena that give the designated area conservation value are likely to be appreciably diminished.

The biological evaluation (BE) provides a qualitative assessment of the stressors potentially arising from the proposed action and their possible direct or indirect effects on ESA-listed species and designated critical habitat. These stressors include; impingement, entrapment, entrainment, thermal discharges, chemical discharges, and altered flow regimes (EPA 2013).

Discharges are not regulated under Section 316(b); however, such discharges are an indirect effect of EPA's action. In the BE, EPA includes thermal and chemical discharges in their description of the direct and indirect effects of the action on ESA-listed species and designated critical habitat; therefore, we include them in our effects analyses.

The location of all facilities that may be within the action area of the rule is unknown. From a survey that EPA conducted, however, EPA knows the names and location of 575 electric generating facilities and 230 manufacturers that may be within action area of the rule. The survey was a census of electric generating facilities. For manufacturers, however, a weighted sample was collected. For the purpose of analyzing the rule, EPA estimated that 544 electric generating facilities and 521 manufacturing facilities, or a total of 1,065 facilities, will be subject to the rule (ABT 2014).

While EPA is confident that in its estimate that there are 1,065 total facilities with one or more CWISs, because of the sample of manufacturers, EPA does not know the location of roughly 315 of these facilities (ABT 2014). Consequently, in order to produce a better sense of manufacturers' locations for the purpose of the Biological Evaluation, EPA developed an upper-bound set of manufacturers. This set included all manufacturers that may potentially be within the Agency's action area of the rule, found by searching its permit database for facilities that hold a NPDES permit and share a North American Industry Classification code with manufacturing facilities that responded to the survey that they had a CWIS. This search identified the location of an additional 2,925 manufacturing facilities that may be within action area of the rule. EPA added the 2,925 additional manufacturing facilities to the 575 electric generating facilities and 230 manufacturers with known locations to estimate that a total of 3,730 facilities may potentially be within the action area of the rule. It is important to note that EPA is confident that only 1,065 of these 3,730 facilities have a CWIS (ABT 2014). The set of 3,730 facilities, which represents an upper bound estimate of the number off facilities that may possibly have cooling water intakes, allows the Services to identify the broadest set of species that may be affected by CWISs. Of the 3,730 facilities, 3,490 (94 percent) facilities overlap with the range of one or more ESA-listed species (EPA 2013) (Table 1). Overall, based on the set of 3,730 facilities, the EPA estimates 21,039 facility-species overlaps are theoretically possible, though many fewer are projected when one looks only at the 1,065 facilities EPA estimates will actually be subject to this rule.

Table 1. Species under the jurisdiction of NMFS that are protected under the ESA that may be affected by the issuance of regulations pursuant to section 3016(b) of the Clean Water Act.

Common name (Distinct population segment, evolutionarily significant unit, or subspecies)	Scientific name	Status	Critical Habitat
Cetaceans			
Blue whale	*Balaenoptera musculus*	Endangered	No
Bowhead whale	*Balaena mysticetes*	Endangered	No
Fin whale	*Balaenoptera physalus*	Endangered	No
Humpback whale	*Megaptera novaeangliae*	Endangered	No
Killer whale (Southern Resident)	*Orcinus orca*	Endangered	Yes
North Atlantic right whale	*Eubalaena glacialis*	Endangered	Yes
Sei whale	*Balaenoptera borealis*	Endangered	No
Sperm whale	*Physeter macrocephalus*	Endangered	No
Beluga whale (Cook Inlet)	*Delphinapterus leucas*	Endangered	Yes
False killer whale (Main Hawaiian insular)	*Pseudorca crassidens*	Endangered	No
Pinnipeds			
Guadalupe fur seal	*Arctocephalus townsendi*	Threatened	No
Hawaiian monk seal	*Monachus schauinslandi*	Endangered	Yes, Proposed
Steller sea lion (Western)	*Eumetopias jubatus*	Endangered	Yes
Bearded seal (Beringia)	*Erignathus barbatus nauticus*	Threatened	No
Ringed seal (Arctic)	*Phoca hispida hispida*	Threatened	No
Sea turtles			
Green sea turtle (Florida & Mexico's Pacific coast colonies)	*Chelonia mydas*	Endangered	No
Green sea turtle (all other areas)		Threatened	Yes
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered	Yes
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	No
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Yes
Loggerhead sea turtle (North Pacific Ocean)	*Caretta caretta*	Endangered	No
Loggerhead sea turtle (Northwest Atlantic Ocean)		Threatened	Proposed
Olive ridley sea turtle (Mexico's Pacific coast breeding colonies)	*Lepidochelys olivacea*	Endangered	No
Olive ridley sea turtle (all other areas)		Threatened	No
Sturgeons			
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered	No
Green sturgeon (southern)	*Acipenser medirostris*	Threatened	Yes
Gulf sturgeon	*Acipenser oxyrhynchus desotoi*	Threatened	No
Atlantic sturgeon (Gulf of Maine)	*Acipenser oxyrhynchus*	Threatened	No
Atlantic sturgeon (New York Bight)		Endangered	No
Atlantic sturgeon (Chesapeake Bay)		Endangered	No
Atlantic sturgeon (Carolina)		Endangered	No
Atlantic sturgeon (South Atlantic)		Endangered	No
Salmonids			
Atlantic salmon (Gulf of Maine)	*Salmo salar*	Endangered	Yes
Chinook salmon (CA Coastal)	*Oncorhynchus tschawytscha*	Threatened	Yes
Chinook salmon (Central Valley Spring-run)		Threatened	Yes
Chinook salmon (Lower Columbia River)		Threatened	Yes
Chinook salmon (Upper Columbia River Spring-run)		Endangered	Yes
Chinook salmon (Puget Sound)		Threatened	Yes
Chinook salmon (Sacramento River Winter-run)		Endangered	Yes
Chinook salmon (Snake River Fall-run)		Threatened	Yes
Chinook salmon (Snake River Spring/Summer-run)		Threatened	Yes
Chinook salmon (Upper Willamette River)		Threatened	Yes
Chum salmon (Columbia River)	*Oncorhynchus keta*	Threatened	Yes
Chum salmon (Hood Canal Summer-run)		Threatened	Yes
Coho salmon (Central CA Coast)	*Oncorhynchus kisutch*	Endangered	Yes
Coho salmon (Lower Columbia River)		Threatened	Proposed
Coho salmon (Southern Oregon & Northern California Coast)		Threatened	Yes
Coho salmon (Oregon Coast)			Yes
Sockeye salmon (Ozette Lake)	*Oncorhynchus nerka*	Threatened	Yes
Sockeye salmon (Snake River)		Endangered	Yes
Steelhead (Central California Coast)	*Oncorhynchus mykiss*	Threatened	Yes
Steelhead (California Central Valley)		Threatened	Yes
Steelhead (Lower Columbia River)		Threatened	Yes
Steelhead (Middle Columbia River)		Threatened	Yes
Steelhead (Northern California)		Threatened	Yes

Steelhead (Puget Sound)		Threatened	No
Steelhead (Snake River)		Threatened	Yes
Steelhead (South-Central California Coast)		Threatened	Yes
Steelhead (Southern California)		Threatened	Yes
Steelhead (Upper Columbia River)		Threatened	Yes
Steelhead (Upper Willamette River)		Threatened	Yes
Other fishes			
Pacific eulachon	*Thaleichthys pacificus*	Threatened	Yes
Bocaccio (Georgia Basin)	*Sebastes paucispinis*	Endangered	Proposed
Yelloweye rockfish (Georgia Basin)	*Sebastes pinniger*	Threatened	Proposed
Canary rockfish (Georgia Basin)	*Sebastes ruberrimus*	Threatened	Proposed
Smalltooth sawfish	*Pristis pectinata*	Endangered	Yes
Marine invertebrates			
Elkhorn coral	*Acropora palmata*	Threatened[1]	Yes
Staghorn coral	*Acropora cervicornis*	Threatened[1]	Yes
White abalone	*Haliotis sorenseni*	Endangered	
Black abalone	*Haliotis cracherodii*	Endangered	Yes
Marine plants			
Johnson's seagrass	*Halophilia johnsonii*	Threatened	Yes

Because EPA did not provide facility monitoring data or information on aggregate effects, we searched for information describing the effects of CWIS on listed species. We found the following, which represents the best available information: recent biological opinions, often on the Nuclear Regulatory Commission's (NRC) licensing of a CWIS facility; ESA section 10 permits or permit applications for incidental take at CWIS facilities; facility reports; government reports; peer-reviewed literature; and published design criteria for fish screens. We begin each species-group section with a discussion of the best available information. We describe the information and explain whether this information reflects the effects of typical CWIS, as regulated under the Rule. For example, when considering information from biological opinions, we note that such facilities have been the subject of a section 7 consultation and operate under an incidental take statement (ITS), which requires minimization of take, monitoring, and reporting under 50 CFR 402.14(i).

1 Cetaceans

To determine the effects of CWIS on cetaceans, the best information would ideally consist of daily impingement and entrainment monitoring data, quantifying the number of prey items killed at each CWIS facility that overlaps with the ranges of the species, plus daily environmental monitoring data from each facility to determine the effects of thermal and chemical discharges on cetaceans and their prey. In the BE, EPA explains that this information is not available. EPA concludes that data are insufficient to evaluate whether cetaceans have been adversely affected by existing CWIS and associated discharges (EPA 2013). We agree that data are limited but identified the following as the best available information. We were unable to locate information describing the effects of CWIS on Cook Inlet beluga whales, Southern Resident killer whales, or Main Hawaiian Island Insular false killer whales, but we identified government reports and peer-reviewed scientific literature detailing the importance of piscine prey for these species. A NOAA

[1] Proposed endangered

Technical Memorandum describes the potential biological impacts of the Kahe Point Ocean Thermal Energy Conversion Facility in Hawaii (Harrison 1987). In a letter dated May 17, 2012, from the NMFS Northeast Region to the NRC, NMFS concurred that the Pilgrim Nuclear Power Station, located in Plymouth, MA, was not likely to adversely affect sei, fin, humpback, or North Atlantic right whales and was not likely to adversely affect North Atlantic right whale critical habitat (NMFS 2012).

1.1 Stressors

Whales are too large to be impinged or entrained by CWIS, and we are not aware of any such occurrences. Thermal discharges, however, may affect individuals. In addition, cetaceans may be indirectly affected by the effects of CWIS facilities on their prey (e.g., fish, invertebrates, and/or zooplankton). Prey availability is likely to be reduced by impingement, entrainment, thermal discharges, and chemical discharges of CWIS facilities regulated under the Rule.

1.2 Exposure

In the BE, EPA estimates the number of facilities that overlap with cetacean species (Table 2). In addition, we used ArcGIS (a geographic information system) to map the list of facilities potentially regulated under the Rule (EPA 2013) to identify overlap with ranges of listed species and their designated critical habitat. As regulated under the Rule, CWIS facilities are likely to result in prey reductions. Prey reductions are likely to affect all individuals within a species or DPS, especially in the following species, which have small population sizes and restricted ranges: North Atlantic right whale, North Pacific right whale, Southern Resident killer whale, Cook Inlet beluga whale, and Main Hawaiian Island insular false killer whale). Prey reductions are likely to affect males and females of all age groups.

Table 2. Facilities overlapping with ESA-listed cetacean species as identified by EPA (EPA 2013). Our mapping results shown in parentheses.

Species	Overlapping facilities	Exposed individuals
North Atlantic Right Whale	77 (21)	396
North Pacific Right Whale	(15)	1,000
Humpback Whale	14 (66)	40,000
Fin Whale	(62)	12,000
Blue Whale	(66)	3,000
Sei Whale	(62)	500
Southern Resident Killer Whale	6 (5)	87
Cook Inlet Beluga Whale	(3)	345
Main Hawaiian Island Insular False Killer Whale	(1)	170

1.3 Response

Stressors that may affect cetacean species are indirect effects from thermal discharges and indirect effects to prey species which are discussed in general and then for each ESA-listed cetacean species below.

1.3.1 Thermal Discharges

Right whales have been recorded at sea surface temperatures of 0.0 to 21.8°C (Kenney 2007), humpback whales at sea surface temperatures up to 32°C (NMFS 1991), and fin whales at sea surface temperatures up to 28°C (NMFS 2010). Whales exhibit some tolerance for changing temperatures, as reflected by movements through varied water temperatures over periods of minutes to weeks (Kenney 2007). In response to thermal discharges, whales are likely to avoid the area of the plume. Depending on the temperature, duration, and size of the plume, such avoidance may result in changes to foraging or migration behavior. We do not have any information on whether such changes result in fitness reductions for individuals. We expect the risk to be higher in areas with multiple CWIS facilities, which would make plume avoidance more difficult. Therefore, the aggregate effects of thermal discharges from CWIS facilities are likely to adversely affect cetaceans, both directly and indirectly (through the reduction of prey).

1.3.2 Effects to Prey Species

Cetacean prey species are likely to be impinged or entrained by CWIS or adversely affected by the thermal and chemical discharges. Planktonic prey items are likely to be entrained; larger prey items, such as adult fish, are likely to be impinged. Entrainment and impingement of many individuals, at multiple facilities (i.e., aggregate effects), could reduce the amount of prey available to cetaceans. Thermal and chemical discharges have the potential to result in even greater reductions of prey because more individuals are likely to be exposed to the plume, which covers a larger area than the intake structure itself. Cetaceans are likely to respond to prey limitation by increasing foraging time and effort. Some individuals of ESA-listed species could experience fitness loss as a consequence of reduced prey availability, which often results in slower growth and maturity, less reproductive, and possible emaciation (Ward et al. 2009, Ford et al. 2010). Below, we consider the effects of reduced prey availability, as a result of impingement and entrainment authorized by the Rule, on the fitness of individuals and the viability of populations and species.

1.4 Southern Resident Killer Whale

Mapping the facilities that may be regulated under the Rule (EPA 2013) to the range of the species, we find five facilities that overlap with the Southern resident killer whale DPS (Table 2). As with all of the ESA-listed cetaceans, Southern resident killer whales are too large to be impinged or entrained by CWIS. However, they may be affected by thermal discharges and indirect effects to prey species.

Hormone analyses indicate that the Southern Resident killer whale is prey-limited (Ayres et al. 2012). However, a more thorough review of all available info on prey limitation is available in Hilborn et al. (2012). Their review is not this clear cut and they had concerns about some of the info presented regarding the hormone analysis. The population has a highly specialized diet, which is primarily comprised of Chinook salmon (80 percent of total diet) plus steelhead trout and chum, sockeye, and coho salmon in lesser amounts (Hanson et al. 2010). The whales prefer the larger and fattier but less abundant Chinook salmon, as opposed to the more abundant species, such as pink and sockeye salmon (Ford and Ellis 2006). Canadian and U.S. Chinook salmon populations occur within the range of the Southern Resident killer whale, including nine ESA-listed Chinook salmon ESUs. In inland marine waters, during the summer months, Southern Resident killer whales prey upon Fraser River Chinook salmon (31 to 94 percent of their diet). Fraser River stocks are the most abundant Chinook salmon populations that migrate through the area starting in June; however, they are rare in May. In May, the whales rely more heavily on Chinook salmon from the North Puget Sound, South Puget Sound, and the Central Valley (47 percent of their diet; Hanson et al. 2010). Though Southern Resident killer whales likely consume Chinook and other salmonid species during the fall, winter, and spring and in outer coastal waters, the source populations of these salmon remains unknown (Hanson et al. 2010).

In the salmonid section below, we describe the effects of CWIS on salmon based on the best available information provided by EPA (EPA 2013). As described in the BE and follow up conversations, EPA used data obtained from the Pittsburgh Power Station in Pittsburgh, CA, and Contra Costa Power Station in Antioch, CA (now called Gateway Generating Station), to estimate an annual impingement and entrainment mortality rate of 609 Chinook salmon in total for all facilities per year. Information regarding the life stage (i.e., eggs, fry, parr, smolt, juveniles or adults) of these mortalities was not provided. We consider this to be a minimum estimate because these facilities incorporated multiple control measures to minimize the impingement and entrainment of salmonids (e.g., seasonal operation reductions to avoid peak larval/egg present, reduced intake velocity, operation of a cooler, and reduced intake volumes); whereas the Rule only requires facilities to implement one of the seven Best Technology Available (BTA) Standards for Impingement Mortality.

EPA estimates that 126 CWIS facilities overlap with Chinook salmon (EPA 2013). Multiplying this number by the minimum impingement and entrainment mortality rate (609 salmon/year/facility), we estimate a minimum total impingement and entrainment mortality of 76,734 Chinook salmon per year. Thermal and chemical discharges (as described in the salmonid section below) are likely to result in higher levels of mortality of Chinook salmon, as a result of CWIS regulated under the Rule. We do not have information regarding the life stage of Chinook salmon mortalities. In Washington, Oregon, Idaho, and California, pre-fishing abundance of Chinook salmon is estimated at 960,788 (NMFS 2008). Hilborn et al. (2012) and Ward et al. (2013) have more recently estimated adult abundance using several different Chinook abundance indices at approximately 1.2 million salmon (Ward et al. 2013) .

The DPS consists of one small population consisting of 87 whales (Carretta et al. 2013), which is almost half of its likely previous size (140 to as many as 400 whales; Carretta et al. 2013; Krahn et al. 2004). Prey limitation may have led to a 20 percent decline in the population's abundance from 1995 to 2001(Ayres et al. 2012). Because of this population's small size, it is susceptible to demographic stochasticity. This population has a variable growth rate (28-year mean=0.3% ± 3.2% s.d), and risk of quasi extinction that ranges from 1 percent to as high as 66 percent over a 100-year horizon, depending on the population's survival rate and the probability and magnitude of catastrophic events (Krahn et al. 2004, Carretta et al. 2013). The effective population size (i.e., the number of breeders under ideal genetic conditions) of 26 whales is very small, and this in combination with the absence of gene flow from other populations may elevate the risk of inbreeding and other issues associated with low genetic diversity (Ford et al. 2011). The influences of demographic stochasticity and potential genetic issues in combination with other sources of random variation combine to amplify the probability of extinction, known as the extinction vortex (Gilpin and Soule 1986, Melbourne and Hastings 2008).

In summary, Southern resident killer whales are not expected to be directly affected by CWIS; they may be indirectly affected due to impacts to prey species, primarily Chinook salmon.

1.5 Cook Inlet Beluga Whale

Mapping the facilities that may be regulated under the Rule (EPA 2013) to the range of the species, we find three facilities that overlap with the Cook Inlet beluga whale DPS (Table 2). As with all of the ESA-listed cetaceans, Cook Inlet beluga whales are too large to be impinged or entrained by CWIS. However, they may be affected by thermal discharges and indirect effects to prey species.

Cook Inlet beluga whales are opportunistic feeders for which eulachon and salmon form the bulk of the prey when they are seasonally abundant (Hobbs et al. 2008). In the northwestern Cook Inlet, eulachon spawning migration occurs in May (several hundred thousand fish) and June (several million fish; Calkins 1989). The fat content of eulachon (up to 15 percent of total body weight; Payne et al. 1999) is significant source of energy for beluga whales, especially for pregnant and lactating females (Calkins 1989). Native hunters in Cook Inlet have stated that beluga whale blubber is thicker after the whales have fed on eulachon (1 ft) as compared to the early spring prior to eulachon runs (2 to 3 inches; Huntington, 2000).(Hobbs et al. 2008). In the northwestern Cook Inlet, eulachon spawning migration occur in May (several hundred thousand fish) and June (several million fish; Calkins 1989). The fat content of eulachon (up to 15 percent of total body weight) (Payne et al. 1999) is significant source of energy for beluga whales, especially for pregnant and lactating females (Calkins 1989). Native hunters in Cook Inlet have stated that beluga whale blubber is thicker after the whales have fed on eulachon (1 ft) as compared to the early spring prior to eulachon runs (2 to 3 inches) (Huntington 2000).

Alaska Department of Fish and Game has conducted limited research on eulachon but substantial research on salmon in the Cook Inlet watershed. They report that biomass estimates for eulachon in Cook Inlet streams are unavailable, but eulachon biomass in the central Gulf of Alaska has increased since the early 1980's (CIBWRP 2010). Eulachon are anadromous fish(Willette 2010). Eulachon are anadromous that spawn and hatch in fresh water streams, then quickly move into salt water to grow and mature in the ocean (Barlett 2012). Eulachon escapement is estimated at several million fish (Calkins 1989) and was the fourth most abundance species found in surveys conducted in northern Cook Inlet in June, July, and September of 1993 (Moulton 1997). Based on the assumption that the CWIS locations overlap with eulachon spawning areas, then during spawning and egg/larval migration to the ocean, some mortality of eulachon is expected.

In the summer, as eulachon runs diminish, belugas rely heavily on five species of salmon. Like eulachon, salmon are another source of lipid-rich prey for the beluga whale and represent the greatest percent frequency of occurrence of the prey species found in Cook Inlet beluga whale stomachs (Hobbs et al. 2008). Eulachon and salmon may be vital for beluga sustenance throughout the year (Abookire and Piatt 2005, Litzow et al. 2006). Eating such fatty prey and building up fat reserves throughout spring and summer allows beluga whales to sustain themselves during periods of reduced prey availability (e.g., winter) or other adverse impacts by using the energy stored in their blubber to meet metabolic needs. Mature females have additional energy requirements. The known presence of pregnant females in late March, April, and June (Mahoney and Shelden 2000, Vos and Shelden 2005) suggests breeding may be occurring in late spring into early summer. Calves depend on their mother's milk as their sole source of nutrition for at least a year (Burns and Seaman 1986), and lactation lasts up to 23 months. Thus, eulachon and salmon are critical prey for Cook Inlet beluga whales.

Descriptions of fish abundance and distribution for the Cook Inlet area are generally lacking (Goetz et al. 2007), and summertime prey availability is difficult to quantify. Since 1970, sockeye and coho salmon abundances have generally increased in Cook Inlet while chum salmon abundances have decreased (Willette 2010). Salmon catches in northern Cook Inlet have generally declined due largely to declining fishing effort (Willette 2010). Shields and Dupuis (2013) report a total harvest of 3.1 million salmon (5 species).

Small reductions in salmon populations are not likely to reduce the fitness of any individual. Several animals exhibited a thin blubber layer in the late summer (Hobbs et al. 2008). We found one example of an emaciated Cook Inlet beluga whale, a pregnant female whose death may have been caused by her poor body condition (thin, with vertebrae showing through the skin; Vos and Shelden 2005). We could not find any information linking these whales to reduced prey availability. Similarly, we did not find any information linking the low growth rate of the DPS to prey limitation or nutritional stress. Samples of harvested and stranded beluga whales have shown consistent summer blubber thicknesses, a possible indication that the species is not prey limited. Weighing both sides of the admittedly limited data, we tentatively conclude that prey reductions as a result of CWIS are not likely to reduce the fitness of Cook Inlet beluga whales.

In summary, Cook Inlet beluga whales are not expected to be directly affected by CWIS; they may be indirectly affected due to impacts to prey species, primarily eulachon and secondarily Chinook salmon.

1.6 Main Hawaiian Island Insular False Killer Whale

Mapping the facilities that may be regulated under the Rule (EPA 2013) to the range of the species, we find one facility that overlaps with the Main Hawaiian Island insular false killer whale DPS (Table 2). As with all of the ESA-listed cetaceans, Main Hawaiian Island insular false killer whales are too large to be impinged or entrained by CWIS. However, they may be affected by thermal discharges and indirect effects to prey species.

The Main Hawaiian Island insular false killer whale has been observed feeding on a wide variety of large pelagic fish, including tunas, swordfish, and mahimahi. These fishes are not likely to be impinged by CWIS; however their eggs or larvae may be entrained. To evaluate the indirect effects of CWIS on Main Hawaiian Island insular false killer whales, we consider the information provided by Harrison (1987), which describes the possible environmental effects of the construction and operation of a proposed Ocean Thermal Energy Conversion facility at Kahe Point in Hawaii. This information is applicable to this consultation because an existing conventional power plant currently operates at this site and is regulated under the Rule (EPA 2013). The Kahe Power Plant withdraws ambient surface water (25°C) to cool its six generating units and discharges the effluent at 31 to 32°C. Kahe Point appears to be an important location for large fish densities and high concentrations of eggs and larvae (Harrison 1987). Based on the limited information available we are not able to conduct site specific analysis. Entrainment mortality of prey is also likely and may result in a greater impact on local fish populations than impingement (Harrison 1987). Reduced prey biomass is a medium level threat to Main Hawaiian Island insular false killer whales, whose range overlaps with five facilities (Oleson et al. 2010).

In summary, Main Hawaiian Island insular false killer whales are expected to be directly and indirectly affected by CWIS.

1.7 North Atlantic Right Whale

The BE indicated that 77 CWIS overlap the range of the North Atlantic right whale DPS. NMFS mapping suggested that 21 CWIS that may be regulated under the Rule (EPA 2013) overlap with the range of the species (Table 2). As with all of the ESA-listed cetaceans, North Atlantic right whales are too large to be impinged or entrained by CWIS. However, they may be affected by thermal discharges and indirect effects to prey species.

The best available information on CWIS effects on the North Atlantic right whale is provided in the May 17, 2012 concurrence letter, from the NMFS Northeast Region to the NRC (NMFS 2012), regarding the Pilgrim Nuclear Power Station, which uses a single pass CWIS that would be regulated under the Rule. The cooling system uses two pipes with an intake capacity of 224 MGD. The intake structure consists of wing walls, a skimmer wall, vertical bar racks, and vertical traveling screens to remove aquatic organisms and small debris. The intake approach velocity just before the screens is 1 ft/sec (ENSR Corporation 2000). EPA issued the current National Pollutant Discharge Elimination Permit (NPDES) permit in 1991; the permit expired in 1996 but has been administratively extended for the past 18 years. It is unknown whether impingement and entrainment of prey species would be reduced under the Rule, or whether EPA would determine that the facility meets the proposed impingement and entrainment best technology available standards. The Pilgrim Nuclear Power Plant was the subject of an informal section 7 consultation on the NRC renewal of its 20-year operating license. In preparation, NRC prepared an environmental impact statement and a biological assessment. The facility conducts impingement monitoring three times per week and entrainment sampling 6 to 12 times per month; as a condition of their NRC license, the facility must report impingement or entrainment of listed species to NRC. Cetacean prey species have been impinged or entrained at the facility. The facility appears to be typical of facilities regulated under the Rule, with the exception of impingement monitoring, entrainment sampling, and reporting, which is required by the NRC, but is not required by EPA in the Rule. The following information is based upon the data described in the NMFS concurrence letter as well as results in published government reports and peer-reviewed scientific papers.

Right whales forage on high-density concentrations of copepods, including *Calanus finmarchicus*, *Pseudocalanus spp*., and *Centropages spp*. (Baumgartner et al. 2007, Pace and Merrick 2008). Because of their small size, copepods are likely to be entrained in CWIS; they may also be adversely affected by thermal and chemical discharges. Despite its required entrainment monitoring, NRC was not able to provide data on the number of copepods entrained at the Pilgrim Nuclear Power Station. Overall zooplankton entrainment mortality rates at the facility average 5 percent, with an additional loss of 8.3 percent mortality after exposure to chlorine (Bridges and Anderson 1984). A study of freshwater entrainment reveals that calanoid copepods are the most sensitive to entrainment, with discharge mortalities nearly 10 percent higher than intake mortalities, which ranged from four to 35 percent (Evans et al. 1986). Using an entrainment mimic unit, Bamber and Seaby (2004) report that while the majority of adult copepods (*Acartia tonsa*) survive entrainment (overall 20 percent mortality under standard operating conditions), individuals die as a result of pressure (11 percent mortality), unusually high temperatures (increases of 7.6 to 11.5˚C resulted in 12 percent mortality), and chlorine (23 percent mortality). Carpenter et al. (1974) estimate that about 70 percent of copepods entering the CWIS of a facility on Long Island Sound are not returned to the Sound in the effluent. In summary, 4 to70 percent of copepods exposed to entrainment, thermal, and chemical discharges are likely to die as a result of the exposure. Therefore, we consider how such levels of copepod mortality affect the concentrations of prey available to whales.

As explained in NMFS's concurrence letter, a two-year study was conducted to evaluate the effect of the Pilgrim Nuclear Power Station on zooplankton concentrations (ENSR Corporation 2000). Monthly water samples were taken at intake, discharge, and offshore (i.e., control) locations. Copepods were found in moderate abundance in all samples, and there were no statistically significant differences among mean densities of copepods (ENSR 2000, ENSR Corporation 2000). This study is corroborated by a similar study performed at the Seabrook Nuclear Power Station, located in Seabrook, NH, where CWIS have not reduced zooplankton densities in more than 20 years of operation. As a result of 70 percent copepod mortality rates, Carpenter et al. (1974) estimate a 0.1 percent reduction in annual copepod production in the area immediately surrounding the Long Island Sound facility. Two additional studies indicate that there have been no changes in the zooplankton community and no evidence for decline in copepods in Cape Cod Bay (Stamieszkin et al. 2010, Werme et al. 2011), despite the operation of the Pilgrim facility. Based on these data, NMFS concluded that while the entrainment of copepods at the Pilgrim Nuclear Power Station is likely to reduce the amount of prey available to right whales, such reductions are likely to be insignificant and undetectable from natural variability.

While a single facility may not adversely affect North Atlantic right whales, we must consider the aggregate effects of multiple facilities. In the BE, EPA identifies 77 facilities with CWIS within the habitat of the North Atlantic right whale (i.e., "facility overlap," EPA 2013). Mapping the list of 3,730 facilities, which represent an upper bound estimate of the number of facilities that may possibly have cooling water intakes (ABT 2014), we identify 21 facilities that overlap with the range of the North Atlantic right whale. Extrapolating the estimated 0.1 percent reduction in annual copepod production as a result of losses at one facility (Carpenter et al. 1974), we estimate that CWIS facilities within the range of the species are likely to reduce annual copepod production by 2.1 to 7.7 percent.

North Atlantic right whales require an estimated prey concentration of 7.57 to 2,394 kcal/m^3 (Kenney et al. 1986). Therefore, individuals must seek out and exploit extremely dense patches of copepods. Whales are likely to respond to small reductions in prey available by increasing the time and effort spent foraging. This is not beyond their normal behavior. North Atlantic right whales have been shown to expend more energy to forage at depths, where copepods are more abundant, of higher caloric content, and less able to avoid capture (Baumgartner et al. 2003). Ingestion rates appear to exceed estimated daily metabolic requirements for most of the 26 North Atlantic right whales studied in the Bay of Fundy; however, there are large uncertainties in estimating metabolic rates and requirements (Baumgartner and Mate 2003). Baumgartner and Mate (2003) conclude that all individuals meet the daily metabolic requirements for survival because no emaciated individuals were observed; however, the data do not allow the authors to determine whether there is sufficient prey availability to support reproduction for the population.

Given these data, we do not expect small reductions in copepod concentrations to reduce the survival of any right whales; however, it is unknown whether reproductive potential may be reduced. Given the small magnitude of reduction in prey availability (2.1 to 7.7 percent), however, we would expect reductions in reproductive potential to be small. Therefore, we conclude that reductions in fitness as a result of CWIS facilities regulated under the Rule are possible, but are likely to be small. We do not expect population level effects as a result of these small reductions in fitness.

In summary, North Atlantic right whales are not expected to be directly affected by CWIS; they may be indirectly affected due to impacts to prey species.

1.8 North Pacific Right Whale

The BE did not identify any CWIS overlap with the range of the North Pacific right whale DPS. NMFS mapping suggested that 15 CWIS that may be regulated under the Rule (EPA 2013) overlap with the range of the species (Table 2). As with all of the ESA-listed cetaceans, North Pacific right whales are too large to be impinged or entrained by CWIS. However, they may be affected by thermal discharges and indirect effects to prey species.

Like North Atlantic right whales, individuals require exceptionally high densities of prey for survival and reproduction (Baumgartner et al. 2003, Baumgartner and Mate 2003, Baumgartner et al. 2011). North Pacific right whales forage on copepods in shelf, slope and oceanic areas within the Bering Sea and Gulf of Alaska (Shelden et al. 2005). Though not described in the BE, we used the associated list of CWIS facilities that may be regulated under the Rule to identify 15 CWIS facilities that overlap with the range of the North Pacific right whale DPS. These facilities are likely to reduce copepod concentrations, as a result of entrainment and thermal and chemical discharges, as described above.

As compared to North Atlantic right whales, however, these whales appear to have a greater pelagic distribution, possibly related to a wider distribution of larger copepods across shelf, slope and oceanic regions of the southeastern Bering Sea and the Gulf of Alaska. Therefore, prey reductions, and resulting reductions in reproductive rates, are expected to be even smaller than described for the North Atlantic right whale. Thus, we do not expect the issuance and implementation of the Rule to result appreciable reductions in fitness for individual North Pacific right whales.

In summary, North Pacific right whales are not expected to be directly or indirectly affected by CWIS.

1.9 Humpback and Fin Whales

The BE indicated that 14 CWIS overlap the range of the humpback whale but did not identify any CWIS that overlap the range of fin whales. NMFS mapping suggested that 66 and 62 CWIS that may be regulated under the Rule (EPA 2013) overlap with the range of humpback and fin whales, respectively (Table 2). As with all of the ESA-listed cetaceans, humpback and fin whales are too large to be impinged or entrained by CWIS. However, they may be affected by indirect effects to prey species.

Humpback and fin whales feed on krill and small schooling fish, primarily Atlantic herring, mackerel, and sand lance; humpback whales may also feed on capelin, Pollock, and haddock. These prey species are likely to be impinged as juveniles or adults and entrained as eggs or larval fishes. To evaluate the indirect effects of CWIS on humpback and fin whales, we use the impingement and entrainment data gathered at the Pilgrim Nuclear Power Station (Table **3**).

Table 3**. Impingement and entrainment rates of cetacean prey at the Pilgrim Nuclear Power Station (Normandeau Associates 2011).**

	Impingement study years	Mean annual impingement	Entrainment study year	Mean annual entrainment	Population size or recruitment estimate

Atlantic herring	1990-2004	2,069		0.01% spawning biomass	3.3 billion age-one fish
Atlantic mackerel	1980-2010	7	2010	316 age-one fish	566 million age-one fish
Sand lance	NA	NA	2010	3,854 larvae	500,000 metric tons
Pollock	1980-2010	65	1989-1998	26,044 eggs 47-364 larvae	196,000 metric tons
Haddock	2007	15	1989-1998	0-89,926 eggs 0-178,892 larvae	120,000 metric tons

As described in the letter of concurrence, the impingement and entrainment rates of cetacean prey items are small relative to annual recruitment or population estimates. Humpback and fin whales are foraging generalists and are not likely to be prey limited, as their populations are somewhat large and growing. Based on these data, NMFS concluded that the Pilgrim Nuclear Power Station is not likely to adversely affect humpback and fin whales. We must consider the aggregate effects of multiple facilities. In the BE, EPA estimates that 14 facilities overlap with the range of the humpback whale (EPA does not include fin whales). Mapping the list of 3,730 facilities, which represent an upper bound estimate of the number of facilities that may possibly have cooling water intakes, we identify 66 and 62 facilities that overlap with the ranges of the humpback and fin whale, respectively. Extrapolating from the Pilgrim facility data to 66 facilities, we expect CWIS regulated under the Rule to result in the impingement of approximately 126,554 herring, 462 mackerel, 4,290 pollock, and 990 haddock. Extrapolating from the Pilgrim facility data to 66 facilities, we expect CWIS regulated under the Rule to result in the entrainment of 0.66 percent of herring spawning biomass, 20,856 mackeral age-one equivalents, 254,354 sand lance larvae, over 1.7 million pollock eggs and up to 24,024 pollock larvae, and up to 5.9 million haddock eggs and up to 11.8 million haddock larvae. As described above, we do not know whether the Rule will reduce the impingement or entrainment of cetacean prey species because of the variable efficacy among the seven alternatives for the BTA Standards for Impingement Mortality and because the Rule does not establish an entrainment best technology available standard but instead relies on Director discretion. Therefore, we evaluate the effects of current levels of impingement and entrainment on cetacean prey.

Humpback and fin whales depend on large, dense prey aggregations to build up energy stores prior to travel to less productive waters; this is especially important for females, who expend considerable energy nursing calves (Brodie 1975, Dolphin 1987). Humpback whales, for example, spend approximately 80 percent of daylight hours between the months of July and September foraging (Dolphin 1987). Fin whales may require higher concentrations of prey than humpback whales (Piatt and Methven 1992), but both species need large amounts of prey. Kenney et al. (1997) estimated that cetaceans on the Northeast Shelf consume approximately 1.3 million tons of fish and 244,000 tons of zooplankton. Faced with reductions in prey availability, humpback and fin whales are likely to exert more time and effort into feeding or to shift their distribution (Weinrich 1998). Examples of emaciated sei and humpback whales exist (Clapham and Mayo 1987) but are generally associated with entanglement. The reproductive rates of humpback and sei whales do not appear to be limited by prey availability.

In summary, humpback and fin whales are not expected to be directly or indirectly affected by CWIS.

1.10 Sei and Blue Whales

The BE does not indicated any overlap of CWIS with sei and blue whale ranges. NMFS mapping suggested that 62 and 66 CWIS that may be regulated under the Rule (EPA 2013) overlap with the range of sei and blue whales, respectively (Table 2). As with all of the ESA-listed cetaceans, sei and blue whales are too large to be impinged or entrained by CWIS. However, they may be affected indirectly by direct effects to prey species.

The effects of CWIS on planktonic prey concentrations are likely to diminish with distance from the facility. Sei whales eat copepods, and blue whales eat krill, but these cetaceans mainly forage in areas off the continental shelf and other offshore waters. Therefore, CWIS are likely to have minor effects on the availability of their prey. We do not expect any fitness reductions to sei or blue whales as a result of CWIS regulated under the Rule.

In summary, sei and blue whales are not expected to be directly or indirectly affected by CWIS.

1.11 Critical Habitat

Designated critical habitat overlaps with CWIS likely to be regulated under the Rule for two cetacean species: Southern Resident killer whales and Cook Inlet beluga whales. Designated critical habitat for the Southern Resident killer whale DPS includes: the Summer Core Area in Haro Strait and waters around the San Juan Islands; Puget Sound; and the Strait of Juan de Fuca (71 FR 69054). Fish are the major dietary component of the DPS, with salmon the clearly preferred prey, consumed in large amounts. The designated critical habitat includes the biological feature of prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth. As described above and below (for salmonids), CWIS, as regulated under the Rule, are likely to reduce prey availability through impingement, entrainment, and thermal discharges. Though EPA determined that no facilities overlap with Southern Resident killer whale critical habitat, our mapping revealed overlap with seven facilities within a one kilometer diameter (and one facility directly overlapping). We believe that the thermal, chemical and indirect effects of CWIS may occur within one kilometer of the CWIS.

Designated critical habitat for the Cook Inlet beluga whale includes 7,800 km^2 of marine and estuarine area in Cook Inlet, Alaska. There are two specified areas: Cook Inlet northeast of a line from the mouth of Threemile Creek to Point Possession (bounded by the Municipality of Anchorage, the Matanuska-Susitna Borough, and the Kenai Peninsula borough); and the area south of the former area, including nearshore areas along the west side of the Inlet and

Kachemak Bay on the east side of the lower inlet (76 FR 20180). Fish are the primary prey species of the Cook Inlet beluga whale, especially salmon and Pacific eulachon, which have very high fat content and occur in large concentrations at or near the mouths of tributary streams. The designated critical habitat includes the biological feature of primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole. As described above and below (for salmonids), CWIS may reduce prey availability. Though EPA determined that no facilities overlap with Cook Inlet beluga whale critical habitat, our mapping revealed overlap with one facility within a one kilometer diameter.

2 Pinnipeds

The Rule establishes Best Technology Available Standards for Impingement And Entrainment. While one alternative of the Best Technology Available Standards for Impingement Mortality (i.e., offshore velocity cap) is defined to exclude marine mammals, it is one of seven alternatives, and we have no way of determining the proportion of facilities that may select this alternative.

To determine the effects of CWIS on pinnipeds, the best information would consist of daily impingement and entrainment monitoring data, quantifying the number of prey items killed at each CWIS facility that overlaps with the ranges of the species, plus daily environmental monitoring data from each facility to determine the effects of thermal and chemical discharges on pinnipeds and their prey. In the BE, EPA states that this information is not available and that EPA does not have sufficient data to evaluate whether these species have been affected by existing CWIS and associated discharges. EPA concludes that ESA-listed pinniped species, due to their large size, high mobility, and broad habitat ranges, would not be directly affected by entrainment or impingement in CWIS regulated under the Rule; however, pinnipeds are likely to be indirect affected by reduced prey availability as a result of impingement or entrainment of prey items in CWIS (EPA 2013). EPA explains that their proposed action may affect the general aquatic habitat, which may change fish community composition (including forage fish and prey species upon which mammals may depend for a high quality diet).

We agree that data are limited, but we do not agree that pinnipeds are not likely to be directly affected by CWIS regulated under the Rule because many pinnipeds have been entrapped in CWIS. The best available information includes NMFS's 1999 Letter of Authorization under the Marine Mammal Protection Act to the Seabrook Station nuclear power plant (64 FR 28114) and 2008 Marine Mammal Protection Act permit applications from 11 power generating stations in California (73 FR 9299).

In 1999, NMFS issued a Letter of Authorization to the Seabrook Station in New Hampshire (64 FR 28114). This letter describes the impacts of the CWIS on seals in the area. From 1993 to 1998, 56 habor, gray, harp, and hooded seals were entrapped and died in the holding bays at the terminus of the intake tunnels (Table 4). NMFS determined that the taking of up to 20 harbor seals and four of any combination of gray, harp, and hooded seals, annually would have no more than a negligible impact on these stocks of marine mammals (64 FR 28114).

In 2008, NMFS received Marine Mammal Protection Act permit applications from 11 power generating stations in California (73 FR 9299). These permit applications contain biological monitoring data, which describe and quantify the effects of the CWIS on pinnipeds (MBC Applied Environmental Sciences 2001). Such data are available because these 11 facilities monitored and reported on the annual number of pinnipeds entrapped in their CWIS and the number of pinnipeds found dead in their CWIS (Table 4). Many facilities reported that pinnipeds were found decomposed and may have died before becoming entrapped within the CWIS. The entrapped pinnipeds include: California sea lions, harbor seals, and one northern elephant seal.

Table 4. Entrapped pinnipeds at facilities with CWIS (64 FR 28114) (MBC Applied Environmental Sciences 2001).

Facility	Years (N)	Total pinnipeds	Min-max annual pinnipeds	Mean (SD) annual pinnipeds	Total dead	Mean (SD) annual dead	Proportion dead pinnipeds
Seabrook	1993 – 1998 (6)	56	2-17	9.3(5.5)	56	9.3(5.5)	1.00
San Onofre	1978-2000 (23)	385	0-64	17(15)	217	9.9(18.8)	0.56
Diablo Canyon	1995-2000 (6)	0	0	0	0	0	
El Segundo	1979-2000 (22)	15	NA	0.7(NA)	10	NA	0.67
Scattergood	1989-2000 (12)	40	0-8	3.3(3.0)	35	4.4(2.2)	0.88
Encina	1978-2000 (23)	4	0-2	0.2(0.5)	3	1.0(0.0)	0.75
Huntington Beach	1977-2000 (24)	13	0-3	0.5(0.9)	9	1.5(0.6)	0.70
Ormond Beach	1977-2000 (24)	75	0-8	3.2(3.0)	41	3.2(1.6)	0.55
Redondo Beach	1976-2000 (25)	37	0-7	1.5 (1.9)	19*	1.9(1.2)	0.51
Moss Landing	1992-1999 (8)	8	0-3	1.0(1.1)	8**	1.6(0.9)	1.00
Mandalay	1977-2000 (24)	1	0-1	(NA)	1	(NA)	1.00
Long Beach	1977-2000 (24)	0	0	0	0	0	
TOTAL	**(221)**	**634**	**0-64**	**2.9 (7.2)**	**399**	**5.3 (6.4)**	**0.63**

**We considered four "fate unknown" pinnipeds as dead.*
***We considered eight seriously injured pinnipeds as dead.*

Table 4 summarizes the data reported from the 12 CWIS facilities (64 FR 28114) (MBC Applied Environmental Sciences 2001). The number of pinnipeds entrapped annually at each facility ranges from 0 to 64; the annual number of deaths at each facility ranges from 0 to 37 pinnipeds (data not shown). The proportion of entrapped pinnipeds that are found dead annually ranges from zero to 100 percent. Over all facilities during all years, a total of 634 pinnipeds were entrapped, an average of 2.9 per year. Over all facilities during all years, a total of 399 pinnipeds were found dead in the CWIS. Over all facilities, during all years, the average proportion of entrapped pinnipeds that were found dead was 63 percent. For each facility, we calculated the mean and standard deviation of the annual number of pinniped entrapments for all monitoring years. For each facility, we calculated the mean and standard deviation of the annual number of pinnipeds found dead for all monitoring years in which pinnipeds were entrapped. For each facility, we also calculated the mean proportion of entrapped pinnipeds that were found dead. We recognize the large variation among facilities (e.g., annual take ranges from 0 to 64) and attribute these to differences in facility locations, CWIS characteristics, and implementation of control measures (e.g., more or less monitoring).

These 12 facilities have implemented control measures to minimize adverse effects on pinnipeds. The Seabrook Station's three CWIS consist of a velocity cap and vertical bars, spaced 16 inches apart, covering the intake openings; twice daily monitoring and reporting (within 30 days of take and annually) are required (64 FR 28114). The 11 facilities in California also have velocity caps and large organism excluder bars, spaced 18 inches apart; the facilities utilize marine mammal rescue cages to remove the pinnipeds from the CWIS, and unhealthy or injured pinnipeds are transferred to a marine mammal rehabilitation center. If not removed and rehabilitated, we would expect entrapped individuals to die as a result of injuries or starvation. It is our understanding that these facilities are the only CWIS facilities likely to be regulated under the Rule that have applied for a Marine Mammal Protection Act permit, which is required of any facility that entraps or otherwise harms or harasses marine mammals. These facilities are not representative of facilities regulated under the Rule, which does not require large organism excluder bars and velocity caps as well as monitoring, removal of entrapped individuals, and monitoring and reporting. Instead, the Rule requires the owner or operator of an existing facility to comply with one of seven alternatives under the Best Technology Available Standards for Impingement Mortality. One of these alternatives is an "offshore velocity cap," which is defined in the Rule as "a velocity cap located a minimum of 800 feet from the shoreline and outside of the littoral zone. A velocity cap is an open intake designed to change the direction of water withdraw from vertical to horizontal, thereby creating horizontal velocity patterns that result in avoidance of the intake by fish and other aquatic organisms. For purposes of this subpart, the velocity cap must use bar screens or otherwise exclude marine mammals, sea turtles, and other large aquatic organisms.

2.1 Stressors

Pinnipeds may be directly affected by CWIS by entrapment. In addition, indirect effects could occur because pinniped prey (e.g., fish and invertebrates) are likely to be impinged, entrained or otherwise affected by flow reduction and thermal and chemical discharges.

2.2 Exposure

In the BE, EPA estimates the number of facilities that overlap with listed pinniped species (Table 5). In addition, we used ArcGIS to map the list of facilities potentially regulated under the Rule (EPA 2013) to identify overlap with ranges of listed species and their designated critical habitat (Table 5). As observed at the 12 facilities described above, pinnipeds of all ages and both sexes may be exposed to entrapment or the indirect effects to their prey species.

Table 5. Facilities overlapping with the Steller sea lion and Hawaiian monk seal as identified by EPA (EPA 2013). NMFS mapping results shown in parentheses.

Species	Overlapping facilities	Expected exposure
Steller sea lion (Western DPS)	16 (3)	~50,000
Hawaiian monk seal	(5)	~1,000

2.3 Response

Stressors that may affect ESA-listed pinniped species are entrapment and thermal discharges; indirect effects to prey species may also affect ESA-listed pinnipeds. General responses to these stressors are discussed below followed by subsequent species specific discussions.

2.3.1 Entrapment

The 12 facilities described above do not overlap with ESA-listed pinnipeds, and we do not have any information from facilities that overlap with ESA-listed pinnipeds in Hawaii and Alaska. Pinnipeds are likely to encounter CWIS because they forage at nearshore and offshore locations, where CWIS may be located. Pinnipeds are opportunistic predators that are attracted to CWIS, which concentrate and impinge prey (MBC Applied Environmental Sciences 2001). Pinnipeds are also curious and bold, often leading to fishery interactions, entanglements, and use of man-made structures. Steller sea lions and Hawaiian monk seals exhibit these same behavioral characteristics that have likely led to the entrapment of California sea lions, harbor seals, northern elephant seals, gray seals, harp seals, and hooded seals. Therefore, where CWIS facilities and listed pinnipeds overlap, entrapment is likely.

The species entrapped in the 12 facilities are not listed under the ESA and may be more abundant than listed species. Estimated abundances of these species are as follows (64 FR 28114, MBC Applied Environmental Sciences 2001):

- North Atlantic harbor seals: minimum 30,990
- Gray seal regional population: minimum 2,010
- Harp seal: minimum 4.8 million
- Hooded seal: minimum 400,000
- California sea lions: approximately 200,000
- California harbor seals (local): approximately 30,000

The western Steller sea lion DPS has an estimated abundance of approximately 50,000 individuals. The total abundance of Hawaiian monk seals is approximately 1,212 seals (Carretta et al. 2013). The abundances of listed species that potentially could be affected by CWIS (1,000 – 50,000) are similar in magnitude to the abundances of species previously entrapped in CWIS (2,010 – 4.8 million).

2.3.2 Indirect Effects

Pinnipeds are foraging generalists, preying on a variety of fish and invertebrates. Impingement and entrainment of prey is likely to result in the death of hundreds of millions or billions of individuals at a single facility (EPA 2011). Flow reduction, thermal discharges, and chemical discharges are likely to kill individuals of prey species. Such impacts are likely to affect aquatic habitats and alter fish community composition (EPA 2013). Therefore, CWIS are likely to result in prey reduction, which may result in fitness reductions for individuals.

2.4 Hawaiian Monk Seal

The BE did not identify any CWIS overlap with the range of the Hawaiian monk seal. NMFS mapping suggested that five CWIS that may be regulated under the Rule (EPA 2013) overlap with the range of the species (Table 5). Hawaiian monk seals would be directly exposed to entrapment and thermal discharges and indirectly to potential effects on prey species.

Prior to the 1990s, monk seals were rarely observed in the main Hawaiian Islands (Baker and Johanos 2004); however, this population has since grown to 152 individuals (Baker et al. 2011). Seals have been observed at Kahe Point, which hosts large fish densities and high concentrations of eggs and larvae and is also the site of the Kahe Generating Station. We were not able to find information in our literature search indicating monk seal entrapment, or the lack thereof, at this or other CWIS facilities in Hawaii. However, we contacted a Hawaiian monk seal researcher who was not aware of any occurrences of monk seal entrapment (C. Littnan, NMFS PIFSC, pers. comm. to K. Petersen, NMFS, May 5, 2014).

At the Kahe Generating Station, 165 species of fishes and 55 invertebrate species have been impinged (Harrison 1987). Extrapolated estimates of impingement range from 18,976 to 125,279 individuals (161 to 1,237 kg) annually (Harrison 1987). Extrapolating to five facilities in Hawaii, we expect an impingement rate of 94,880 to 626,395 individuals (805 to 6,185 kg) per year. Entrainment may result in a larger impact on local fish populations than impingement (Harrison 1987). Total reef fish biomass in the main Hawaiian Islands is approximately 16,600,000 kg (Sprague et al. 2013). The main Hawaiian Islands population of monk seals consumes an estimated 1,300 kg/day, which is a maximum of 0.009 percent of the estimated available prey biomass (Sprague et al. 2013). Therefore, we do not expect the loss of 0.0003 percent of the estimated available prey biomass to result in fitness reductions for any individual.

The Hawaiian monk seal is an endangered species that continues to decline in abundance. The species is steadily declining at a rate of four percent per year (Carretta et al. 2013), which makes the small (N = 152) but growing (6.5 percent annually) subpopulation in the main Hawaiian Islands essential to the survival and recovery of the species (Baker et al. 2011).

In summary, Hawaiian monk seals may be directly and indirectly affected by CWIS.

2.5 Western DPS of Steller Sea Lion

EPA identified 16 CWIS that overlap the range of the Western DPS of Steller sea lions. NMFS mapping suggested that three CWIS that may be regulated under the Rule (EPA 2013) overlap with the range of the species (Table 5). The Western DPS of Steller sea lions would be directly exposed to entrapment and thermal discharges and indirectly to potential effects on prey species.

We were not able to any find information on Steller sea lion entrapment or the lack thereof at CWIS facilities. Therefore, we rely on the data from the 12 facilities described above. Pinniped entrapment rates vary from 0 to 64 individuals per facility per year, with an average of three individuals per facility per year. Extrapolating to the range of the Steller sea lion (Western DPS), where 3 - 16 facilities may be regulated under the Rule, we find an annual entrapment rate of 0 to 192 individuals, with an average of 9 (for three facilities) and 0 to 1,024, with an average of 48 (for 16 facilities). It is possible that EPA included both DPSs when determining overlap of the species; therefore, we consider our estimate of three facilities to be more accurate. Because of the low abundance of the species, actual entrapment rates are likely to be at the lower end of the range (0 to 3 individuals/facility/year), such that 0 to 9 individuals may be entrapped in CWIS annually.

Steller sea lions forage on a wide variety of invertebrates and fish, including: capelin, cod, herring, mackerel, pollock, rockfish, salmon, and eulachon. Seasonally available, energy-rich prey, such as herring, eulachon and salmon, are important to Steller sea lions (Sigler et al. 2004). As described above for cetaceans, impingement, entrainment, and other adverse environmental effects of CWIS are likely to result in prey reductions. We could not find information on the impingement and entrainment rates of Pacific herring. Using the data described for the Cook Inlet beluga whale, we estimate a minimum impingement and entrainment mortality rate of 9,135 salmon/year (3 facilities x 5 salmon species x 609 salmon/year) and 74,757 to 187,578 eulachon/year. In comparison, Alaska fisheries reported a preliminary harvest of 272 million salmon (476,000 metric tons or 524,700 tons) in 2013 (Sustainable Fisheries Partnership 2014), and eulachon escapement is estimated at several million fish (Calkins 1989). Therefore, salmon and eulachon losses as a result of CWIS are likely to reduce prey availability by less than one percent and 2 to 6 percent, respectively. We expect herring losses as a result of CWIS to fall within a similar range. Sigler et al. (2009) estimate that 500 to 1700 tons of prey are needed near a terrestrial location where 500 Steller sea lions haul out. Converting individuals to tons, we estimate that three CWIS facilities would take a minimum of 17 tons of salmon and 6 to 15 tons of eulachon annually. These estimates are small compared to fishery losses (e.g., up to 100 tons of eulachon are harvested annually; Shields and Dupuis 2013).

Prey reduction has led to nutritional stress in Steller sea lions of the Western DPS, which exhibit reduced body size, reduced productivity, and high mortality of pups and juveniles (Trites and Donnelly 2003). The dramatic decline in population size may have been caused by reduced abundance of high quality prey, including herring and eulachon (Trites and Donnelly 2003), due to a regime shift in ocean climate (i.e., the Pacific Decadal Oscillation; Trites et al. 2007; Guenette et al. 2006). However, Steller sea lions have a broad range and move between areas as prey become available (Sinclair and Zeppelin 2002, Sigler et al. 2009), resulting in a much larger prey base. Adults can likely meet their daily energy needs eating exclusively low energy prey (Sigler et al. 2009). Furthermore, Steller sea lions exhibit a flexible foraging strategy, allowing them to take advantage of seasonal prey aggregations that presumably are easier to capture due to high prey density and choose prey with higher energy content (Sinclair and Zeppelin 2002).

This strategy buffers Steller sea lions against seasonally varying energetic requirements as a result of pregnancy, lactation and fasting during the breeding period (Winship et al. 2002). Sigler et al. (2009) conclude that a flexible foraging strategy and diverse diet allows Steller sea lions to compensate for less nutritious prey.

In summary, CWIS are likely directly and indirectly affect Steller sea lions.

2.6 Critical Habitat

Steller sea lion (Western DPS) critical habitat does not overlap with facilities that are likely to be regulated under the Rule. Hawaiian monk seal proposed critical habitat is likely to overlap with five CWIS regulated under the Rule. The proposed designation for the Hawaiian monk seal includes six areas in the main Hawaiian Islands, including: terrestrial and marine habitat from 5 miles inland from the shoreline extending seaward to the 500-meter depth contour around: Kaula Island, Niihau, Kauai, Oahu, Maui Nui (including Kahoolawe, Lanai, Maui, and Molokai), and Hawaii. Food limitation is identified in the recovery plan as a critical threat to the Hawaiian monk seal; therefore, prey quantity and quality within the marine foraging habitat is an essential component in the recovery and conservation of the species. The proposed critical habitat includes the biological feature of marine areas with adequate prey quantity and quality. As described above, CWIS as regulated under the Rule are likely to reduce the availability of prey. The effects of energy projects are further considered in the Draft Economic Analysis of Critical Habitat Designation for the Hawaiian Monk Seal (ECONorthwest 2011), as follows:

> "NMFS has determined that energy projects may alter ecosystem dynamics and affect the proposed critical habitat. In general, the anticipated energy projects pose a potential threat to the essential features of critical habitat for the Hawaiian monk seal in several ways, similar to those associated with other in-water and coastal construction projects. Energy projects may have additional effects, but little is known about these projects and how their effects differ from those of other types of projects. Depending on their location and scope, future energy projects may impact the essential features of the proposed Hawaiian monk seal critical habitat in these ways: 1) in-water construction may reduce the numbers of available prey, by reducing available prey habitat or by reducing the quality of prey habitat; 2) inwater construction may reduce the amount or value of available shallow, sheltered marine habitat adjacent to preferred pupping areas utilized by moms and pups; and 3) activities associated with construction and related activities may increase the potential for anthropogenic disturbance, thus making monk seals avoid or abandon preferred haul-out areas or pupping areas. While it is clear that the structures and activities associated with these projects may have an impact on the essential features of the proposed critical habitat, variation in project design, anticipated energy production, and environmental conditions at a specific location will all play a role in defining the scope of these impacts. Uncertainties regarding the variation between projects, designs, locations, and

structure make it difficult to define the potential impacts, or to determine the specific, potential project modifications that might be necessary to avoid the impacts. Consequently, NMFS has determined that it most likely will address the nature of the potential threat on a project-specific basis."

The indirect effects of CWIS are likely to overlap with proposed critical habitat and reduce prey availability at those sites. However, the losses are not expected to substantially reduce the estimated available prey biomass. Therefore, as regulated under the Rule, CWIS are not likely to appreciably reduce the conservation value of the proposed critical habitat of Hawaiian monk seals.

3 Sea Turtles

The Rule establishes Best Technology Available standards for impingement and entrainment. While one alternative of the Best Technology Available Standards for Impingement Mortality (i.e., offshore velocity cap) is defined to exclude sea turtles, it is one of seven alternatives, and we have no way of determining the proportion of facilities that may select this alternative.

To determine the effects of CWIS on sea turtles, the best information would consist of an evaluation of all daily impingement and entrainment monitoring data, quantifying the number of prey items killed at each CWIS facility that overlaps with the ranges of the species, plus daily environmental monitoring data from each facility to determine the effects of thermal and chemical discharges on pinnipeds and their prey. Using this information, EPA could estimate the aggregate effects of CWIS on sea turtles. As described in the BE, EPA was unable to locate and evaluate this information; however, EPA provided annual take data from 13 power generating stations. Seven facilities were the subject of ESA section 7 consultations and six applied for incidental take permits. We identified similar data in another consultation that was not included in the BE on the Port Everglades facility. We used the data available in the following biological opinions to describe the effects of CWIS on sea turtles:

- Operation of the Cooling Water Intake System at the Brunswick Steam Electric Plant, Carolina Power and Light Company, 2000 (NRC) (NMFS 2000a)
- Greenhouse Gas Permit to Florida Power & Light for proposed improvements at the Port Everglades Next Generation Clean Energy Center, 2013 (EPA) (NMFS 2013b)
- Cooling Water Intake System at the Crystal River Energy Complex [Florida], 2002 (NRC) (NMFS 2002)
- Continued Operation of the St. Lucie Nuclear Power Plant's Circulating Seawater Cooling System, Jensen Beach, Hutchinson Island, Florida, 2001 (NRC) (NMFS 2001)
- Reinitiation of a Consultation in accordance with Section 7(a) of the ESA regarding Continued Operation of the Salem and Hope Creek Nuclear Generating Stations on the Eastern Shore of the Delaware River in New Jersey, 1993 (NRC) (NMFS 1992)

- Reinitiation - Continued Operation of Oyster Creek Nuclear Generating Station [New Jersey] pursuant to a License issued by the NRC in April 2009, 2011 (NRC) (NMFS 2011)
- Formal Consultation on the Continued Operation of the Diablo Canyon Nuclear Power Plant and San Onofre Nuclear Generating Station [California], 2006 (NRC) (NMFS 2006b)

These biological opinions resulted from section 7(a)(2) consultations. In most instances, NRC was the action agency; EPA consulted on the issuance of a Greenhouse Gas Permit. The consultation on the issuance of ESA section 10 permits to seven power plants in California has yet to be completed (the permits have yet to be issued). These biological opinions evaluate biological monitoring data, describing and quantifying the effects of CWIS on sea turtles. Such data are available because this small subset of facilities (N = 14) monitored and reported on the annual number of sea turtles entrapped in their CWIS and the number of sea turtles that died as a result of entrapment; some facilities gathered information on the non-lethal effects as well. For specific details on each facility, please refer to the original biological opinions.

Eight of the 14 facilities worked with NMFS to receive take exemption through ITSs. These facilities implemented control measures to minimize adverse effects on ESA-listed species and designated critical habitat, including: large organism excluder bars and sea turtle response programs. The reasonable and prudent measures generally require trained staff at the facility to contact turtle recovery experts at NMFS or rehabilitation centers, remove/release/transfer the turtle, and complete a report for each incident of entrapment. These facilities are also required to conduct biological monitoring (inspections of the intake structure for entrapped sea turtles) at least daily and up to 24 hours per day. The facilities sent annual reports to the action agency and/or NMFS.

Six of the 14 facilities are working with NMFS to receive section 10 incidental take permits. These facilities are located in California, where State regulations require large organism excluder bars spaced nine inches apart. These facilities provided 25 years of data on sea turtle entrapment in their incidental take permit applications.

This subset of 14 facilities does not represent a random sample of the possible 3,730 facilities that represent an upper bound estimate of the number of facilities that may possibly have cooling water intakes (ABT 2014). Most of the facilities potentially authorized under the Rule have not been the subject of section 7(a)(2) consultation and have not worked with the Services to receive an ITS or ESA section 10 permit. The Rule does not require Directors to establish permit requirements to protect sea turtles from entrapment, and Directors are not likely to require such measures (EPA 2013). As described in the BE, the subset of 14 facilities do not provide an unbiased sample, suitable for extrapolation to all facilities regulated under the Rule (EPA 2013). Still, the information from the relevant biological opinions represents the best available data and, though not a representative sample of the regulated universe, provides insight into the minimum adverse effects on sea turtles and critical habitat to be expected.

Table 6 summarizes the data analyzed in the biological opinions on the 14 facilities. The annual entrapment at each facility ranges from 0 to 949 turtles. Over all facilities during all years, a total of 15,595 turtles were entrapped, an average of 46 turtles per facility per year (standard deviation = 165). The annual number of deaths at each facility ranges from 0 to 28 turtles. Over all facilities during all years, a total of 385 entrapped turtles died. At individual facilities, the proportion of entrapped turtles that die ranges from 0 to 100 percent annually and 0 to 67 percent over all years. On average, 23 percent of entrapped turtles die annually at each facility (standard deviation = 0.33).

3.1 Stressors

In the BE, EPA identified numerous stressors that are produced as a result of CWIS. These include entrapment and indirect effects from thermal discharges, chemical discharges and of prey reduction.

3.2 Exposure

Large variation among the 14 facilities (e.g., annual take ranges from 0 to 949 turtles) is a result of the differences in facility locations, CWIS characteristics, and control measures. We expect at least this much variation in the 3,370 facilities that may be regulated under the Rule, attributed to differences in facility locations, CWIS characteristics, and control measures or lack thereof. The 14 facilities are required to minimize incidental take of sea turtles by implementing protective measures, such as excluder bars; even so, these facilities entrap 0 to 949 sea turtles annually. Infrequent monitoring increases the likelihood of death by drowning, starvation, predation, stress-related injuries and illnesses, or diminished overall condition. A large proportion (75 - 100 percent) of entrapped sea turtles are injured (see Response section, under injury). Without proper removal and handling, even minor injuries are likely to result in death. Prolonged entrapment is likely to interrupt or delay normal migrating, foraging, nesting, and mating behaviors.

Table 6. Sea turtle entrapment at 14 cooling water intake structures (data from biological opinions, see above).

Facility	Years (N)	Total turtle take	Annual turtle take	Total dead turtles	Annual dead turtles	Annual proportion dead turtles
Brunswick*	1986-1999 (14)	203	Unknown	31	Unknown	Unknown
Brunswick	2003-2012 (10)	104	4 – 23	24	0 – 9	0 – 0.39
Crystal River	2002-2011 (10)	87	3 – 21	9	0 – 2	0 – 0.25
Port Everglades	1991-2012 (22)	32	0 – 4	12	0 – 3	0 – 0.75
St. Lucie*	1976-1982 (7)	851	Unknown	76	Unknown	Unknown
St. Lucie	1983-2011 (29)	14,103	122 – 949	176	0 – 28	0 – 0.11
Salem	1978-2010 (33)	71	0 – 24	26	0 – 6	0 – 1.00
Oyster Creek	1992-2011	77	0 – 11	23	0 – 4	0 – 1.00

	(20)					
San Onofre	2083-2012 (30)	40	0 – 7	4	0 – 1	0 – 0.50
Diablo Canyon	1988-2012 (25)	11	0 – 2	0	0	0
El Segundo	1982-2006 (24)	3	0 – 1	1	0 – 1	0 – 1.00
Scattergood	1982-2006 (24)	6	0 – 2	0	0	0
Encino	1982-2006 (24)	3	0 – 1	2	0 – 1	0 – 1.00
Huntington Beach	1982-2006 (24)	0	0 – 0	0	0	0
Ormond Beach	1982-2006 (24)	1	0 – 1	0	0 – 1	0
Redondo Beach	1982-2006 (24)	3	0 – 1	1	0 – 1	0 – 1.00
TOTAL	**(344)**	**15,595**	**129-1,047**	**385**	**0 – 57**	**0 – 1.00**

**Annual data not available.*

When analyzing the data from the 14 facilities, we did not analyze the data by species, but instead combined all turtle data because facility location and individual CWIS characteristics determine which sea turtles may be exposed. For example, in some locations, we might expect a facility to entrap primarily loggerheads sea turtles, whereas in another location, we may expect the entrapment of Kemp's ridley sea turtles. Similarly, we did not analyze the data by turtle size or age because the facility location and CWIS characteristics likely play a large role in determining whether adult, juvenile, or hatchling turtles are entrapped. Gender data was not available from the majority of facilities; however, when it was available, the sex ratio varied from 1:1 to 6:1 favoring females. The skew likely reflects nesting females, which migrate to inshore waters when returning to their natal beaches. These nesting females are the most valuable individuals in terms of a species' survival and recovery. For our exposure analyses, we will assume that up to 85 percent of exposed turtles are female.

In the BE, EPA estimates the number of facilities that overlap with the range of each species (Table 7). In addition, we used ArcGIS to map the list of facilities potentially regulated under the Rule (EPA 2013) to identify overlap with ranges of listed species. There is a large discrepancy between EPA's and our estimates of the number of facilities overlapping with sea turtle ranges. We used the same list of 3,730 facilities provided by EPA that represent an upper bound estimate of the number of facilities that may possibly have cooling water intake structures (ABT 2014). EPA estimated that more of these facilities would fall within the range of sea turtles. It is possible that our mapping of turtle ranges was more precise than that used by EPA. Therefore, we consider our estimate to be more likely. Even so, the high range of the estimates is large and in some cases exceeds the total abundance of the species (e.g., leatherback, Kemp's ridley, and hawksbill sea turtles). The reason for this is because of the large number of sea turtles taken one year at the St. Lucie Nuclear Power Plant Facility (N = 949). EPA did not provide us data on the location or characteristics of CWIS; therefore, we cannot determine how each facility is likely to impact sea turtles. However, it is unlikely that all facilities overlap with sea turtle nesting beaches. Therefore, the maximum mortality estimate (based on entrapment of 949 sea turtles at each facility) is unlikely but can be considered the absolute maximum mortality we expect from all CWIS as regulated under the Rule. Mean entrapment based on the information available is 46 sea turtles per year. This average is based on facilities that implement control measures to minimize take (i.e., entrapment).

Table 7. Estimated exposure and minimum estimated annual mortality of sea turtles as a result of entrapment based on limited, non-site specific information.

Species	Overlapping facilities	Total mortality *	Female mortality
Loggerhead	61 (260)	2,806 – 57,889	2,386 – 49,206
Green	59 (192)	2,714 – 55,991	2,307 – 47,593
Leatherback	62 (164)	2,852 – 58,838	2,425 – 50,013
Kemp's	42 (164)	1,932 – 39,858	1,643 – 33,880
Hawksbill	36 (124)	1,656 – 34,164	1,408 – 29,040
Olive ridley	14 (23)	644 – 13,286	548 – 11,294
TOTAL	**14 – 62 (23 – 260)**	**12,604 – 260,026**	**10,717 – 221,026**

** Total mortality estimated by multiplying the number of facilities overlapping with species' ranges (EPA estimates in parentheses) by 46 – 949 (average and maximum annual mortality per facility due to entrapment at 14 facilities that minimize take). We estimated female mortality by multiplying total mortality by 85 percent and rounding to the next whole number.*

3.3 Response

Stressors that may affect sea turtles are entrapment, and indirect effects from thermal and chemical discharges and to prey species which are discussed in general and then for each ESA-listed sea turtle species below.

3.3.1 Entrapment

As described in the BE, power plants are known to entrap all six species of sea turtles found in U.S. waters (Norem 2005), with more than 730 occurrences of overlap between species ranges and CWIS (EPA 2013). Incidences of mortality have been reported at facilities in California, Texas, Florida, South Carolina, North Carolina, and New Jersey (National Research Council 1990, Plotkin 1995). These facilities span a wide range of intake flows (fewer than 30 million to more than 1,400 million gallons per day average intake flow), suggesting that sea turtle mortality or injury is not limited to large intakes. According to EPA, high-quality data on sea turtle impingement or entrainment is available from only one source, the St. Lucie Nuclear Power Plant, at Hutchinson Island, FL (EPA 2013). Therefore, most instances of entrapment, and resulting injury or mortality, are likely to go undetected and unreported. In the BE, EPA concludes that the cumulative impact of entrapment of sea turtles is unclear because sufficient data do not exist to estimate baseline sea turtle mortality due to entrapment at regional or national scales. Since all entrapment constitute incidental take (i.e., via entrapment or harassment), we conclude that the majority of incidental take has not been exempted by the

Services through an ITS or an ESA section 10 permit and that EPA has not structured its Rule to provide this information in the future.

The entrapment of sea turtles is caused by a voluntary or involuntary approach to the CWIS. Sea turtles may voluntarily approach the CWIS out of curiosity, in pursuit of prey, or in search of shelter. Some facilities appear to attract sea turtles, possibly because their CWIS concentrate prey (on screens or at returns) or heat surrounding waters. Smaller turtles or those with compromised swimming ability which cannot overcome the intake velocity may be involuntarily drawn toward the CWIS. Once inside the CWIS, the turtle may become entrapped, entangled, disoriented, submerged, or otherwise encumbered and unable to escape. Below we summarize the potential responses that sea turtles may exhibit as a result of exposure to entrapment. All responses are dependent upon several factors, including:

- Turtle species, size, and condition (health or reproductive status)
- Swimming efficiency, relative to intake velocity
- CWIS location, characteristics, and control measures
- Water temperature and other environmental characteristics
- Biological and environmental monitoring
- Response, experience, and knowledge of facility staff
- Mortality
- In reviewing the eight biological opinions described above, we have identified many sources of mortality as a result of entrapment in a CWIS:
- Drowning due to forced, prolonged submergence in the intake structure
- Drowning as a result of entanglement in barrier nets, screens, or other control measures
- Drowning as a result of entanglement in debris on improperly maintained trash bars
- Death as a result of injuries sustained in intake pipes or canal
- Starvation or otherwise debilitation of condition due to long periods of entrapment
- Exposure to predators
- Death as a result of drowning, entanglement, injury and stress sustained during capture
- Death due to previous injury or illness compounded by stress and exhaustion caused by entrapment
- Unknown causes

Drowning is a common cause of death for entrapped sea turtles. In natural situations, turtles may remain submerged for several hours; however stress decreases the amount of time a turtle can remain submerged and not drown (National Research Council 1990). For example, trawl times for shrimpers in the Southeast are limited by regulation to 55 minutes in the summer months and 75 minutes in the winter months, due to the fact that there is a strong positive correlation between tow time (i.e., forced submergence) and incidence of sea turtle death(Henwood and Stuntz 1987). A forcibly submerged sea turtle may suffer from a "wet" or "dry" drowning. During a wet drowning, water enters the lungs, causing damage to the organs and asphyxiation.

In a dry drowning, a reflex spasm seals lungs off from air and water (National Research Council 1990). Typically before drowning, a turtle becomes comatose or unconscious. During a forcible submergence, a turtle maintains a high level of energy consumption and rapidly depletes its oxygen store, resulting in potentially harmful conditions (Magnuson et al. 1990). One such condition is metabolic acidosis, when blood lactate levels get too high as a result of the submergence. Other conditions that may result from forced submergence include an increase in carbon dioxide in the blood and increases in epinephrine and other hormones associated with stress. The severity of the metabolic stress response is related to the size of the turtle, water temperature, and biological and behavioral differences among species. For example, Kemp's ridleys cannot survive underwater as long as other species and have been found to drown faster in trawl nets (Magnuson et al. 1990). Larger sea turtles are capable of longer voluntary dives and thus may be more able to survive a forced submergence for a longer period of time (Gregory et al. 1996). Additionally, Gregory et al. (1996) note that routine metabolic rates of turtles are higher during the warmer months, so the impacts of stress may be magnified. It is likely that entrapped sea turtles are already stressed; these conditions may increase the turtles' susceptibility to drowning.

Death as a result of entrapment clearly eliminates an individual's survival, but it also eliminates the individual's reproductive contribution to the population. Because sea turtles found in near-shore environments may be females returning to their natal beaches to nest, such deaths are likely to have devastating impacts on populations and species.

Injury

Injury, as a result of entrapment, is also a cause for concern. Sustained injuries may result in death after a turtle has been released. Injuries may prevent reproduction, reducing an individual's fitness to zero. Or injuries may prevent or reduce the normal development, growth, and behaviors of sea turtles. We have identified many sources of injury as a result of entrapment:

- Physiological changes, as a result of forced submergence in the intake structure
- Entanglement in barrier nets, screens, or other control measures
- Entanglement in heavy debris load of improperly maintained trash bars
- Abrasion or pinching resulting from entrapment in intake pipes, canal, or well
- Emaciation or otherwise debilitation of condition due to long periods of entrapment
- Exposure to predators
- Stress and injuries sustained during capture
- Exacerbation of previous injury or illness compounded by stress and exhaustion caused by entrapment
- Unknown causes

Many of the causes of injury are likely to result in death if severe or prolonged. One example is the physiological impacts of submergence. In addition to the stress-inducing effects of submergence, described above, sea turtles may also exhibit dynamic endocrine responses to submergence. Plasma hormone responses to the capture and restraint of male green turtles result in the abandonment of breeding behavior; female green turtles also exhibit a limited adrenocortical stress response during capture and restraint (Jessop et al. 2002). The submergence of loggerhead sea turtles produces severe metabolic and respiratory acidosis; though the acid-base imbalance is reduced during successive submergences, changes in blood pH, dissolved CO_2, and lactate are significant (Stabenau and Vietti 1999).

In our review of relevant biological opinions, some facilities indicated that entrapped sea turtles were released without injury; however, we generally found that the majority of impinged or entrained sea turtles exhibited injury. For example, at St. Lucie, which EPA identified as the only high-quality data source, approximately 85 percent of turtles show evidence of injury as a result of entrainment (Norem 2005). Our analyses indicate that 75 percent of all impinged or entrained sea turtles at Port Everglades were injured or killed. The Northeast Region reports that nearly all of the sea turtles recovered from the Oyster Creek facility have evidence of injury from sustained contact with the trash bars. The injuries included abrasions, bruises, scrapes, and even puncture wounds, likely caused by the tines of the trash rake. It is important to note that the large incidence of injury occurs despite frequent monitoring and conscientious turtle response programs, as implemented at the 14 facilities.

It is easy to estimate the fitness costs of mortality (100 percent); it is more difficult to estimate the fitness costs of injury. Injuries that are likely to result in latent mortality or prevent reproduction will reduce fitness 100 percent. Other injuries may temporarily prevent or delay reproduction; and yet others may delay growth or development. Some injuries may not have any fitness costs whatsoever; however, even minor injuries may result in major costs to fitness if the turtle is not released.

Reduced Foraging

As a result of impingement or entrainment, some sea turtles may be unable to locate and capture prey. For example, green sea turtles may not have access to their normal food sources, which include sea grasses and algae. Foraging specialists, such as the leatherback or hawksbill sea turtles, may not encounter adequate amounts of prey within the CWIS. This reduced prey availability could delay growth and development, prolong inter-nesting periods, or result in reduced condition. All responses are expected to reduce an individual’s overall fitness. The severity would increase proportionately to the length of entrapment. Because the Rule does not require facilities to monitor or remove turtles from CWIS, we expect prolonged entrapment, and thus greater fitness costs, to occur at the majority of facilities regulated by the Rule.

Delayed or Interrupted Migration or Reproduction

As described above, entrapment is likely to cause stress to sea turtles. The release of stress hormones may result in reduced or delayed reproduction (Jessop et al. 2002). We are also concerned with the physical disruption of the turtle’s behavior. Turtles may be entrapped while attempting to migrate, forage, nest, or mate. Their entrapment in a CWIS interrupts or delays these activities. Leatherbacks are probably more sensitive to interruption of migration than the other species of sea turtle because their spring migrations seem to be closely synchronized with the presence of prey species. The ridley turtles nest in large arribadas that are time- and location-sensitive. The availability of mates may also be time sensitive (Pearse and Avise 2001). The loss of nesting opportunities has been documented at the St. Lucie facility, where an entrapped female sea turtle was forced to nest on the canal bank. Several of the resulting hatchlings died, despite the frequent monitoring. The delay or interruption of normal behaviors is likely to result in negative fitness consequences.

Indirect Effects

In the preceding paragraphs, we described how sea turtles are likely to respond to the direct effects of CWIS, which include entrapment of sea turtles or exposure of sea turtles to thermal or chemical discharges. Here, we consider the impingement or entrainment of sea turtle prey, or the exposure of sea turtles and their prey to thermal or chemical discharges. In our review of relevant biological opinions, we found that each CWIS impinged or entrained a large number of potential sea turtle prey items annually. For example, at the Oyster Creek facility, the equivalent of 59,000 adult hard clams and 10,400 blue crabs are lost to impingement and entrainment each year. EPA estimates that CWIS, as regulated under the Rule, will impinge or entrain over a trillion aquatic organisms in waters of the U.S. each year, with most impacts to early life stages of fish and shellfish (EPA 2011). Such losses reduce prey availability for all sea turtle species. Thermal and chemical discharges may also reduce the availability of prey. Cold and heat shock mortalities of fish have been documented at the Oyster Creek facility, for example. The chlorine discharge may also have an effect on sea turtle prey. Thus, CWIS are likely to reduce prey availability to sea turtles, potentially resulting in fitness losses.

Thermal Discharges

In the BE, EPA identifies thermal discharges as likely stressor resulting from the operation of regulated CWIS. For example, the Oyster Creek facility has a daily maximum “end-of-pipe” temperature of 41.1°C, though the maximum temperature recorded was 38°C. Environmental temperatures above 40°C can result in stress for green sea turtles (Spotila et al. 1997). Excessive heat exposure (hyperthermia) is a known stress to sea turtles, but it is a rare phenomenon when sea turtles are in the ocean (Milton and Lutz 2003). As such, limited information is available on the impacts of hyperthermia on sea turtles.

While sea turtles may not be killed by the elevated temperatures, thermal plumes may affect normal distribution and foraging patterns. For example, green sea turtles have been found to aggregate in the warm water effluent discharged from the San Diego Gas and Electric Company's power generating facility. This is the only area on the west coast of the United States where the green sea turtles are known to aggregate (Stinson 1984).

Thermal effluent discharges may attract sea turtles or allow them to stay in an area longer than usual. Sea turtles may remain in areas late enough into the fall to become cold stunned when they finally begin their southern migration. Cold stunning occurs when water temperatures drop quickly and turtles become incapacitated, losing their ability to swim or dive (Spotila et al.

1997). Stranding reports from the NMFS Southwest Region document the cold stunning of olive ridley turtles from Los Angeles County and north to San Francisco County (NMFS 2006a).

Cold stunning is likely to have fitness reductions on sea turtles. Other thermal effects are likely to reduce the fitness of turtles by altering their normal reproductive behaviors. We do not have data on the thermal discharges of all facilities, but it is likely that thermal discharges will reduce the fitness of sea turtles.

Chemical Discharges

In the BE, EPA identifies chemical discharges as a likely stressor resulting from the operation of regulated CWIS. Our review of relevant biological opinions revealed two potential concerns: sponge balls and chlorine.

The St. Lucie facility releases sponge balls (maximum = 3/day) as a byproduct of the condenser cleaning system. The sponge balls are made of vulcanized natural rubber and could be mistaken for prey items by turtles. The effects of ingestion are unknown but are likely to include poisoning, choking, or blockages.

Other facilities use low level, intermittent chlorination to control biofouling in their CWIS. Though not specified in the Rule, we found maximum daily concentration of chlorine discharge values of 0.2 mg/L or a maximum daily chlorine usage of 41.7 kg/day, at one facility, and a maximum total residual oxidant concentration of 200 ppb, at another facility. For the former, the anticipated total residual chlorine level at the point of discharge is significantly higher than EPA's ambient water quality criteria and higher than chlorine levels known to be protective of aquatic life (maximum = 0.019 mg/L).

Chemical contaminants have been found in the tissues of sea turtles from certain geographical areas. While the effects of chemical contaminants on turtles are relatively unclear, they may have an effect on sea turtle reproduction and survival. Chemical contaminants may also affect the immune system, making sea turtles more susceptible to disease and other stresses. There is no information available on the effects of chlorination on sea turtles.

It is assumed that the chlorination is quickly diluted within the water body; however, this assumption has not been tested, and the effects on turtles remain unclear. Therefore, we must allow that chemical discharges may result in adverse effects to sea turtles.

3.4 Leatherback Sea Turtles

The global population of adult females has declined over 70 percent in less than one generation, from an estimated 115,000 adult females in 1980 to 34,500 adult females in 1995 (Pritchard 1982, Spotila et al. 1996). However, the most recent population size estimate for the North Atlantic alone is a range of 34,000-94,000 adult leatherbacks (NMFS USFWS 2013). Our analysis based on available information, without site specific data suggests that substantial numbers of leatherback sea turtles could die each year, as a result of entrapment in CWIS.

Leatherback sea turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters, where they forage, primarily on jellyfish and tunicates. These gelatinous prey are relatively nutrient-poor, such that leatherbacks must consume large quantities to support their body weight. Jellyfish are impinged and entrained in CWIS in very large quantities, to the point of leading to the shutdown of power plants (Masilamoni et al. 2000). Such losses reduce the availability of jellyfish prey for leatherback sea turtles.

Leatherbacks are constrained to a tight metabolic budget (Wallace and Jones 2008) and must meet a reproductive energy threshold before returning to nesting beaches to reproduce (Benson et al. 2007, Benson et al. 2011); if they do not, their remigration intervals (the time between breeding seasons) increases, without a corresponding increase in clutch size the next season (Hays 2000, Price et al. 2004, Wallace et al. 2006). Females lay up to seven clutches per year, with more than 65 eggs per clutch (Reina et al. 2002, Wallace et al. 2007). The loss of a single breeding season would result in a cost of 455 eggs per individual. Due to the great variance in hatchling success and the unknown lifetime reproductive success of leatherbacks, we are unable to accurately estimate the loss of reproductive potential in terms of offspring that survive to reproduce; however, the loss of a breeding season is likely to diminish lifetime reproductive success and reduced fitness. The loss of jellyfish prey, as a result of impingement and entrainment in CWIS, is likely to reduce the reproductive potential of many leatherback sea turtles, causing a decline in annual population productivity.

In summary, leatherback sea turtles are expected to be directly and indirectly affected by CWIS.

3.5 Loggerhead Sea Turtles

The North Pacific Ocean DPS has a small nesting population of a few thousand females that produces 7,000 to 8,000 nests annually. The female population size of the Northwest Atlantic DPS is estimated at 20,000 to 40,000 females.

Loggerhead sea turtles are susceptible to cold stunning (Witherington and Ehrhart 1989), such that thermal discharges could result effects to loggerhead sea turtles. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish and vegetation at or near the surface (Dodd 1988). Sub-adult and adult loggerheads prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom, coastal habitats. These species and/or their larval stages are likely to be impinged and entrained by CWIS. Therefore, we expect that CWIS are likely to result in additional losses, beyond the minimum entrapment of 2,386 females annually.

The North Pacific DPS has a small population size that is not resilient to further perturbation. Though the Northwest Atlantic DPS has a relatively large abundance, however it continues to face significant threats from fishing bycatch throughout their range in the Atlantic Ocean and Gulf of Mexico. The Northwest DPS appears to be declining largely driven by fishery bycatch throughout the Pacific Ocean (76 FR 58943).

In summary, loggerhead sea turtles will be directly and indirectly affected by CWIS.

3.6 Green Sea Turtles

Along the central and southeast coast of Florida, an estimated 200 to 1,100 females nest each year (Meylan et al. 1994, Weishampel et al. 2003).

Green sea turtles are susceptible to cold stunning (Witherington and Ehrhart 1989). As described above, green sea turtles aggregate in the warm water effluent of CWIS (Stinson 1984). These waters provide a warm water refuge as surrounding water temperatures decrease. If the turtles leave the warm water plume to begin their migration, cold stunning is likely to occur. Turtles that do not leave the warm water plume are unable to migrate and reproduce at natal nesting beaches. Furthermore, increases in water temperatures to 30°C increase the induction and severity of lesions associated with herpes virus infection (Haines and Kleese 1977), which reduces fitness in green sea turtles. Therefore, thermal effluent is likely to lead to reductions in survival and reproduction.

Entrapment of females CWIS, are likely to reduce the survival and recovery of the green sea turtle, Florida breeding colony. For all other areas, entrapment is likely to result in the loss of green turtles. Additional losses, as a result of thermal discharges, are likely to further reduce the viability of green sea turtle populations. Apparent increases in abundance in recent years are optimistic but must be viewed cautiously, as the datasets represent a fraction of a green sea turtle generation, which is up to 50 years. Green sea turtles exist at a fraction of their historical abundance, which combined with the high variance in abundance, reduces their resilience to population collapse (Dai et al. 2012, Scheffer et al. 2012).

In summary, green sea turtles will be directly and indirectly affected by CWIS.

3.7 Hawksbill Sea Turtles

Globally, 22,004 to 29,035 females nest annually. The loss of at least 1,408 females annually, as a result of entrapment in CWIS (Table 7), represents a minimum of 5 to 6 percent annual loss to the species. Thermal and chemical discharges are likely result in additional losses, further reducing the viability of hawksbill sea turtle populations. Long-term data on the hawksbill sea turtle indicate declines at nesting sites over the past 20 to 100 years. The species' resilience to further perturbations is low.

In summary, hawksbill sea turtles will be directly and indirectly affected by CWIS.

3.8 Kemp's Ridley Sea Turtles

The best estimate of Kemp's ridley abundance is 8,000 nesting females. The loss of sea turtles of both sexes as a result of entrapment in CWIS is likely based on the information available.

Kemp's ridleys sea turtles are susceptible to cold stunning (Meylan and Sadove 1986), such that thermal discharges are likely to result in additional losses. Kemp's ridleys forage on swimming crabs, fish, jellyfish, mollusks, and tunicates, all of which are likely to be impinged or entrained in CWIS. Therefore, we expect that CWIS are likely to result in additional losses of sea turtles.

Among all sea turtle species, the Kemp's ridley has declined to the lowest population level. Though it has increased in abundance in recent years, the species' limited range and small population size make it vulnerable to population collapses as a result of demographic and environmental stochasticity vortex (Gilpin and Soule 1986, Melbourne and Hastings 2008).

In summary, individual Kemp's ridley sea turtles will be directly and indirectly affected by CWIS.

3.9 Olive Ridley Sea Turtles

The total estimate of olive ridley sea turtles exceeds 1.39 million individuals. The minimum loss of 644 sea turtles annually represents 0.05 percent of the total abundance, and the maximum loss of 13,286 represents one percent of the total abundance. Nesting estimates appear to be increasing or stable.

In summary, olive ridley sea turtles will be directly and indirectly affected by CWIS.

3.10 Critical Habitat

We have determined that CWIS are likely to overlap with designated and proposed critical habitat of sea turtles. There are no CWIS on the islands where designated critical habitat occurs for green and hawksbill sea turtles; however, we determined that the effects of CWIS (within 1 km of the CWIS) are likely to overlap with leatherback designated critical habitat and Northwest Atlantic loggerhead proposed critical habitat.

Leatherback designated critical habitat includes a 43,798 km^2 area stretching along the California coast from Point Arena to Point Arguello and a 64,760 km^2 area stretching from Cape Flattery, Washington to Cape Blanco, Oregon (77 FR 4170). The designated habitat includes marine waters from the ocean surface down to a maximum depth of 80 m. The designation includes one primary constituent element, which is essential for the conservation of leatherbacks in marine waters off the U.S. West Coast: the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (e.g., *Chrysaora*, *Aurelia*, *Phacellophora*, and *Cyanea*), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks. Three facilities are likely to overlap with leatherback critical habitat. As described above, the indirect effects of CWIS could reduce the prey availability for leatherback sea turtles.

Northwest Atlantic loggerhead proposed critical habitat includes nearshore reproductive habitat, winter area, breeding areas, and migratory corridors (78 FR 43005). The proposed critical habitat includes physical and biological features that are essential to the recovery of the DPS, including: waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents; and sufficient prey availability and quality, such as benthic invertebrates, including crabs (spider, rock, lady, hermit, blue, horseshoe), mollusks, echinoderms and sea pens. Four facilities are likely to overlap with the proposed critical habitat. We have described above how CWIS are likely to reduce the prey availability for all sea turtle species. In addition, large withdrawals of water are likely to alter currents, disrupt wave patterns, or attract predators.

4 Salmonids

In the BE, EPA describes the likely adverse effects of CWIS on ESA-listed Atlantic and Pacific salmonids, and steelhead trout (i.e., salmonids). To estimate the extent of these effects, EPA evaluated the NPDES permits of eight facilities (Abt 2012). Three of these facilities overlapped with salmonid ranges: Portland General Electric Beaver Generating Facility in Clatskanie, OR; Port Townsend Paper Corporation in Townsend, WA; and Columbia Generating Station in Benton Co., WA. As described in their report, none of the NPDES permits had special conditions or requirements to protect ESA-listed species or to minimize impingement and entrainment of ESA-listed species.

As described in the BE and follow up conversations, EPA used data obtained from the Pittsburgh Power Station in Pittsburgh, CA, and Contra Costa Power Station in Antioch, CA (now called Gateway Generating Station), to calculate the annual loss of salmon per facility, as a result of impingement and entrainment. These facilities observed impingement and entrainment mortality of the following species: Atlantic salmon, Chinook salmon, Coho salmon, and steelhead trout. Quantitative data were only available for Chinook salmon. To estimate annual impingement and entrainment mortality per facility:

> "EPA calculated an average annual loss rate for each facility reporting losses. These facility-specific raw loss rates were corrected to account for any technology installed to reduce [impingement mortality and entrainment] between the sampling year and present, and summed to estimate reported annual losses. In no cases were [ESA-listed] species observed in [impingement mortality and entrainment] studies in more than three facilities, and in no case were these observations more recent than 1992" (EPA 2013).

Hanson et al. (1977) provide an overview of the entrapment and impingement of fishes by power plant cooling water intakes. The authors evaluate various measures for minimizing impingement and impingement mortality of fishes. They explain that several power plants have documented impingement mortalities approaching or exceeding one million fish annually. Their entrainment estimates (Hanson et al. 1977) include the Connecticut Yankee Power Plant (179 million fish larvae and juveniles annually) and the Oyster Creek Power Plant (150 million eggs and 100 million larvae). The variance among control measures and individual CWIS makes it difficult to predict the magnitude losses and their impact on aquatic resources (Hanson et al. 1977).

4.1 Stressors

CWIS have the potential to result in the following stressors for salmonids: impingement; entrainment; thermal discharges; chemical discharges; flow alteration; and indirect effects as a result of reduced prey availability or increased predation.

4.2 Exposure

Salmonids of multiple life stages and both sexes are likely to be exposed to the adverse effects of CWIS. Thermal and chemical discharges, flow alteration, and indirect effects are likely to reduce the fitness of a large proportion of salmonid populations. In addition, some salmonids are likely to be impinged or entrained in CWIS. We used ArcGIS to map the list of facilities potentially regulated under the Rule (EPA 2013) to identify overlap with ranges of listed species(Table 8).

Table 8. Estimated number of CWIS that overlap the range of salmonid species (EPA estimated number of facilities in parentheses).

Species	Overlapping facilities
Atlantic salmon	21 (147)
Chinook	71 (126)
Chum salmon	28 (81)
Coho salmon	37 (109)
Sockeye salmon	(77)
Steelhead trout	129 (190)

4.3 Response

Stressors that may affect ESA-listed salmon species are impingement, entrainment, thermal discharges, chemical discharges, and flow alterations; indirect effects to prey species may also affect ESA-listed pinnipeds. General responses to these stressors are discussed below followed by subsequent species specific discussions.

4.3.1 Impingement

Without screens and bypass systems, impingement (and resulting mortality) is more likely. Automatically cleaned screens with low approach velocity (less than 0.4 ft/s), small screen face openings (3/32" circular or square, or 1.75 mm continuous slots or rectangular openings) and bypass systems designed for fish swimming ability and behavioral traits, typically avoid most juvenile salmonid fish impingement or entrainment, and should be used anywhere juvenile salmonids could be present. With inadequate screen submergence, the water velocity directly between the water surface and the top of the screen can exceed the juvenile salmon swimming ability, potentially capturing fish above the screens until they fatigue or become prey. Even with a closed-cycle recirculating system, screens, and reduced intake velocity, the Columbia Generating Station is likely to impinge salmonids.

Sublethal effects are also a concern because they are likely to reduce fitness. Hanson et al. (1977) describes the relationship between water velocity and impingement time on physiological stress and survival. In general, the degree of oxygen stress observed in juvenile salmon increased with both increasing water velocity and increasing impingement time. For example, oxygen stress and a loss of equilibrium were evident in fish impinged 15 min at a water velocity of 61 cm/sec. Reduced activity was evident in fishes 48 hour after impingement of 9 minutes or longer at a velocity of 61 cm/sec. Survival decreased as the duration of impingement and water velocity increased. Prentice and Ossiander (1974) reported internal hemorrhaging in impinged salmonids and found the minimal velocity at which hemorrhaging occurred was approximately 46 cm/sec. At 61 cm/sec hemorrhaging occurred in approximately 10 percent of the fish tested after a 30-

second impingement, increasing to 33 percent after impingement for 60 seconds. Bell (1974) observed internal hemorrhaging, eye loss, and bent gill opercula in fish as a result of impingement. Impingement may also result in fish being partially descaled. Loss of scales destroys the integrity of the protective body covering causing disruption of essential osmotic differentiation between fish body fluids and their environment and increasing susceptibility to disease and parasitism. The injury rate resulting from scale loss was inversely proportional to fish size (i.e., small fish are affected greatly by scale loss). They reported that delayed mortality following partial descaling was a significant problem; studying salmon less than 30 cm in length, death occurred 3-18 hours after 30-50 percent scale loss. In addition, fish behavior after scale loss was observed to change markedly. One hour after descaling, juvenile salmon were noticeably less active and less alert to visual stimuli than were controls. Loss of equilibrium occurred approximately 3 hours after descaling, followed by a decrease in respiration and activity. In general, death occurred approximately 4 hours after descaling. The time sequence varied with the severity of scale loss. Loss of body weight followed descaling in marine species, presumably as the result of osmotic removal of water and body fluid through the injured skin surface and the gills. Delayed mortality resulting from scale loss may arise from an osmotic imbalance and an increased susceptibility to infection and disease. In addition, physiological stress due to scale loss may substantially decrease the ability of a fish to avoid predators.

Mortality resulting from mechanical abrasion may increase in areas characterized by high silt and debris loading. High debris densities and algal mats have been reported to trap and impinge fish on intake screens. Accumulation of debris on trash racks and intake screens not only serves to entrap and entangle fish, resulting in increased mechanical damage, but also effectively alters the hydraulic flow field and approach velocities associated with each intake structure. High concentrations of suspended sediment abrade the eyes, gills, and epidermal tissue of impinged fish. From the literature it appears that mechanical damage may be a significant factor in survival of entrapped and impinged organisms.

4.3.2 Entrainment

Salmonids that are entrained within a CWIS could be exposed to pressure and high temperatures, which kill them. Very young organisms, usually at the egg or larvae stage, are most susceptible to death by entrainment (EPA 2011).

The intake, condenser cooling, and heated water discharge systems of a thermal power plant could have an adverse effect on reproduction, depending on the proximity to important spawning areas and the life history pattern of the species (Craddock 1976). Gravid females and their eggs could be damaged by the intake system or by entrainment in discharge waters; spawning time could be altered. Eggs and larvae passed through a condenser cooling system would almost surely be damaged or killed (Craddock 1976). Salmon fingerlings, especially chum salmon, are vulnerable to entrainment because they migrate in dense schools near shore, where intakes may be located (Craddock 1976).

4.3.3 Flow Alteration

Female salmonids lay eggs in a “redd,” covered by gravel or cobble. The depth of a redd is partially dependent on water velocity. Survival of eggs depends on intragravel flow rates. Upon hatching, alevins move deeper into the gravel. As fry, they emerge from the gravel and orient themselves into the water current. As described in the BE, CWIS alter patterns of flow within receiving waters by withdrawing a substantial amount of water and by changing flow velocities and turbulence. Such withdrawals and changes are likely to disrupt the gravel deposits and intragravel flow rates, reducing the viability of eggs and fry.

4.3.4 Indirect Effects

Fish may be attracted to CWIS. For example, at the Columbia Generating Station, the support and riprap around the intake structure provides shelter for fish species that consume other fish, including salmonid fry (NRC 2011). Predators selectively prey on thermally shocked salmonids (Coutant 1973) and are likely to prey on salmonids stressed by impingement, flow alteration, and chemical discharges as well. Juvenile salmonids feed on zooplankton and larvae, which are entrained by CWIS.

Thermal Discharges

Thermal discharges from CWIS could result in damage or death to fishes from temperatures higher or lower than their normal temperature range (Craddock 1976). As temperatures rise, an animals’ respiration rate increases along with the heartbeat rate, which consequently increases the demand for oxygen. At higher temperatures the hemoglobin of the blood has reduced carrying capacity for oxygen. The combination of increased demand for oxygen and decreased efficiency for obtaining it causes a severe stress on the organism. This may eventually cause death or one or more of the many sublethal effects (Craddock 1976). Sublethal effects to exposure to increased temperatures, especially for juvenile fish, include increased susceptibility to predation (Sylvester 1972, Coutant 1973).

Other sublethal effects of entrainment in CWIS include physical shock and abrasion, the effects of chemicals used as biocides, and the effects of temperature increases and pressure changes that cause gas embolisms. Gas embolism may either kill the fish directly or render it susceptible to predation (Craddock 1976). A review of the literature revealed that increased temperature was an important factor in most fish diseases (Ordal and Pacha 1963). Studies with juvenile salmon and trout demonstrated that increased water temperatures intensified the effects of vibrio disease, kidney disease, furunculosis, and columnaris. Columnaris disease has been found to be exceptionally virulent during periods of high temperature. Elevated temperatures can increase predation rate on juveniles, which cannot swim effectively at high temperatures and low dissolved oxygen concentrations. They can result in inadequate food supplies. Elevated temperatures also increase the toxicity of chemical substances and the susceptibility to diseases. Prolonged exposure to elevated temperatures results in a stress response that further reduces body condition, survival rates, and reproductive success. Miara et al. (2013) report that elevated temperatures have altered, and are likely to continue altering, the migration of Atlantic salmon.

Chemical Discharges
Chlorination is often used as a biocide for antifouling of CWIS, with residual chlorine concentrations of 0.05 to 0.5 mg/L (Brungs 1973). For coho salmon, the maximum nonlethal concentration of residual chlorine is 0.05 mg/L. At concentrations of 0.083 mg/L for seven days, 50 percent of coho salmon survive (TL50); at concentrations greater than 0.13, 100 percent of cohol salmon die within 1 to 2 days (Brungs 1973). Brungs (1973) recommends limiting chlorination to 30 min/day with a maximum concentration of 0.01 mg/L. Durations and concentrations above such levels are likely to result in the mortality of salmonids.

Return of fish to non-source waters
The Rule allows the Director to approve the return of fish to non-source waters. Salmon return to their natal streams to spawn. The return of salmon to non-source waters is likely to interrupt their spawning migration. It is likely to result in the loss of reproductive potential, either through lack of spawning or fertilization. Introgression, gene flow among isolated gene pools, may also occur. The removal and introduction of other species to salmon habitat is likely to result in changes in predation, prey availability, and competition for salmon. It is also likely to result in the introduction of novel diseases and aquatic invasive species to salmonids.

4.4 Population and Species Level Effects

Anadromous salmonid populations have experienced dramatic declines in abundance during the past several decades as a result of various human-induced and natural factors, resulting in their threatened and endangered status. In recent years, some populations may not be able to withstand substantial losses fry, parr, or smolt salmon as a result of impingement and entrainment, or other adverse impacts from CWISs.

Numerous DPSs have shown encouraging increases in population size. Other populations within salmonid ESUs and DPSs have been extirpated, indicating that populations are susceptible to collapse. The adverse environmental impacts of thermal discharges, chemical discharges, flow alteration, introduction of aquatic invasive species, and the spread of disease have the potential to contribute to the decline of salmon and steelhead.

In summary, salmonids will be directly and indirectly affected by CWIS.

4.5 Critical Habitat

Critical habitat has been designated or proposed for most listed “salmonid” species and DPSs, including: Atlantic salmon, coho salmon, Chinook salmon, chum salmon, sockeye salmon, and steelhead trout. We summarize information on these critical habitats under the Status of the Species section, and detailed information is provided in the listings (64 FR 24049, 65 FR 7764, 70 FR 52488, 70 FR 52630, 73 FR 7816, 76 FR 65324, and 78 FR 2725). Because there are so many listed DPSs, we will not describe the physical and biological features essential to the conservation of each DPS. Instead, we provide a summary of all features, which are similar across all taxa:

- Sites for spawning, rearing, and migration;

- Food, areas with juvenile and adult forage items, foraging habitat;
- Substrate;
- Space, areas free from obstruction;
- Safe passage conditions;
- Water quality, quantity, temperature, and velocity; and
- Cover/shelter, riparian vegetation.

CWIS have the potential to alter flow regimes (including velocity and turbidity), increase water temperatures, reduce water quality (through the introduction of chlorine), reduce prey availability, and obstruct movement of salmon. In the BE, EPA estimates: 55 facilities will overlap with Chinook salmon critical habitat; 44 facilities will overlap with steelhead trout critical habitat; 13 facilities will overlap with chum salmon critical habitat; and three facilities overlap with coho salmon critical habitat. Using ArcGIS, we estimate that 13 facilities overlap with Atlantic salmon critical habitat; 54 facilities overlap with Chinook salmon critical habitat (within 1 km of the facility); 15 facilities overlap with chum salmon critical habitat (within 1 km of the facility); 85 facilities overlap with steelhead trout critical habitat (within 1 km of the facility); and 3 facilities overlap with coho salmon critical habitat (within 1 km of the facility).

5 Pacific Eulachon, Southern DPS

In the BE, EPA does not estimate how many Pacific eulachon (southern DPS) are likely to be impinged and entrained at a single facility annually; however, they provide estimates of the impingement and entrainment mortality of other smelt species in different genera (EPA 2013). EPA estimates the annual impingement and entrainment mortality rate for delta smelt at 62,526/year and longfin smelt 24,919/year (EPA 2013).

We were unable to find additional information on the effects of CWIS on Pacific eulachon (southern DPS). However, we found annual impingement and entrainment estimates of rainbow smelt at the Bay Shore Power Plant: 536,265,835 larvae entrained (10.9 percent of river population of larval rainbow smelt), 4,365,674 juvenile entrained, and 11,472 individuals impinged (Ager et al. 2008). This facility is located near Oregon, Ohio; cooling water is obtained from the Maumee River and Maumee Bay via an open intake channel. The design intake capacity is 810 mgd, and the design through screen velocity is 2.58 ft/sec. The facility has nine travelling screens (3/8 in openings) with bar racks. This facility is likely to be regulated under the Rule.

5.1 Stressors

Pacific eulachon (southern DPS) are likely to be adversely affected by the following stressors: impingement, entrainment, thermal discharges, chemical discharges, indirect effects, and the stressors associated with releasing fish at non-source water bodies.

5.2 Exposure

Mapping the facilities that may be regulated under the Rule (EPA 2013) to the range of the species, we find that 123 CWIS facilities overlap with Pacific eulachon (Southern DPS).

Eulachon are likely to be exposed to the adverse effects of CWIS as larvae, juvenile, and adults.

5.3 Response

Stressors that may affect the ESA-listed Southern DPS of Pacific eulachon are entrapment and thermal discharges; indirect effects to prey species may also affect ESA-listed Pacific eulachon.

5.3.1 Impingement and Entrainment

Impingement survival appears to be linked to season, temperature, and screen type. McLaren and Tuttle Jr. (2000) estimated impingement survival rates of 1.5 to 94.9 percent for rainbow smelt. Because the Rule does not require facilities to use screens, and because the Rule does not require screens to be designed to minimize eulachon mortality, low survival rates (i.e., high mortality rates) are expected. Entrainment results in "heavy losses" for smelt larvae (Craddock 1976), and the high temperatures associated with entrainment are likely to result in 100 percent mortality (McLaren and Tuttle Jr. 2000).

5.3.2 Thermal Discharge

Pacific eulachon exhibit a preference for a narrow range of water temperature, entering the Columbia River and its tributaries at temperatures of 4 to 10°C. They are sensitive to changes in water temperature, which affects prey availability, spawning, and rearing success. In addition, some marine species do not spawn when exposed to higher than normal temperatures (Craddock 1976). Temperature treated female eulachon of the Columbia River retained their eggs where the control group spawned normally (Blahm and McConnell 1971). In a series of experiments, Blahm and McConnell (1971) exposed to elevated water temperatures. They found:

- 100 percent of fish died after 8 days of exposure to 11°C water
- 50 percent of fish died after 1 hour of exposure to 18°C water
- 100 percent of fish died after 1 hour of exposure to 24°C water

5.3.3 Chemical Discharge

We expect Pacific eulachon responses to chemical discharges to be similar as those described for salmonids.

5.3.4 Indirect Effects

Larval and post larval eulachon prey upon phytoplankton, copepods, copepod eggs, mysids, barnacle larvae, worm larvae, and other eulachon larvae until they reach adult size (WDFW and ODFW 2001). The primary prey of adult eulachon are copepods and euphausiids, malacostracans and cumaceans (Smith and Saalfeld 1955, Barraclough 1964, Drake and Wilson 1991, Sturdevant et al. 1999, Hay and McCarter 2000). The prey of eulachon are likely to be entrained in CWIS.

5.3.5 Flow Alteration

Eulachon eggs adhere to the river bottom in areas of gravel and course sand. Flow alteration and turbidity, as a result of CWIS, is likely to interfere with the settlement and adherence of eggs to the river bottom. In addition, flow alteration may interfere with the downstream transport of larvae to estuarine and marine habitat.

5.3.6 Return of Fish to Non-Source Waters

The Rule allows the Director to approve the return of fish to non-source waters. Eulachon return to their natal streams to spawn. Most adults die after spawning. The return of Pacific eulachon to non-source waters is likely to interrupt their spawning migration. It is likely to result in the loss of reproductive potential, either through lack of spawning or fertilization. Introgression, gene flow among isolated gene pools, may also occur. The removal and introduction of other species to eulachon habitat is likely to result in changes in predation, prey availability, and competition for eulachon. It is also likely to result in the introduction of novel diseases and aquatic invasive species to the DPS.

5.4 Population and Species Level Effects

Impingement and entrainment has the potential to effect more than three million eulachon and various life stages. Also of concern are potential losses due to thermal and chemical discharges, flow alteration, and the release of impinged fish into non-source waters. These adverse environmental impacts have the potential to affect large numbers of fish. Spawning is strongly influenced by water temperatures, and increased temperatures as a result of CWIS may interfere with spawning in areas near CWIS discharges. Females lay eggs over sand, course gravel or detritial substrate and incubate for 30 to 40 days, after which larvae drift to estuaries and coastal marine waters. Flow alteration is likely to interfere with the attachment and incubation of eggs and the movement of larvae.

In summary, Pacific eulachon (Southern DPS) will be directly and indirectly affected by CWIS.

5.5 Critical Habitat

No CWIS overlap directly with Pacific eulachon (southern DPS) critical habitat, however 11 facilities are located with 11 km of Pacific eulachon (southern DPS) critical habitat. Pacific eulachon (southern DPS) critical habitat consists of 16 specific areas in California, Oregon, and Washington. The designated areas are a combination of freshwater creeks and rivers and their associated estuaries, comprising approximately 539 km of habitat (76 FR 65323). The designation identifies three categories of physical or biological features essential to the conservation of the southern DPS:

> (1) Freshwater spawning and incubation sites with water flow, quality and temperature conditions and substrate supporting spawning and incubation, and with migratory access for adults and juveniles. These features are essential to conservation because without them the species cannot successfully spawn and produce offspring.

(2) Freshwater and estuarine migration corridors associated with spawning and incubation sites that are free of obstruction and with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

(3) Nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. Eulachon prey on a wide variety of crustacean species. These features are essential to conservation because they allow juvenile fish to survive, grow, and reach maturity, and they allow adult fish to survive and return to freshwater systems to spawn.

6 Sturgeon

As described in the BE, EPA was unable to locate data on all facilities, their CWIS, and the likely effects of those structures on ESA-listed species or designated critical habitat. It is difficult for us to predict such parameters because the Rule does not establish impingement and entrainment standards required of all facilities. For example, we have determined that closed-cycle recirculating systems at some facilities (e.g., Vogtle Electric Generating Plant in Georgia) are not likely to adversely affect ESA-listed sturgeon; however, owners or operators may choose to implement less protective alternatives, such as the Director-determined systems of technology. We cannot predict which of the alternatives an owner or operator may select or how that selection is likely to affect impingement or entrainment. Without such data, we cannot accurately quantify the effect of the action on sturgeon or their designated critical habitat. Instead, we estimate the likely effects of the action, as supported by the best available data, found in the BE, biological opinions, and scientific literature.

6.1 Stressors

CWIS are likely to cause impingement or entrainment, thermal discharges, chemical discharges, and the indirect effect of prey and habitat reduction

6.2 Exposure

To best estimate the possible take, we gathered information on all of the 7(a)(2) consultations that have considered take of sturgeon or their critical habitat. NMFS (2013c) anticipates three CWIS will kill 562 shortnose sturgeon and 414 Atlantic sturgeon (92 percent New York Bay, 6 percent Gulf of Mexico, 2 percent Chesapeake Bay) in the next 23 years. Data from 1972 to 1998 for the other four CWIS on Hudson River power plants killed 212 shortnose sturgeon over those 27 years (NMFS 2000b). NMFS anticipates no mortality of shortnose or Atlantic sturgeon from CWIS associated with the Yadkin-Pee Dee project (NMFS 2013a). NMFS (2000a) estimated no mortality of shortnose or Atlantic sturgeon from CWIS in the Cape Fear River, North Carolina. No take of Atlantic or shortnose sturgeon was projected from the four CWIS at the Vogtle Electric Generating Plant. There were no projects considering Gulf or green sturgeon or their critical habitat and only two of the above projects considered Atlantic sturgeon, which were not listed until 2012. Other CWIS in the Delaware River (NRC 1979) have also been shown to impinge and entrain shortnose sturgeon (and possibly Atlantic sturgeon, though they were not listed at the time monitoring took place), however without long-term monitoring and an estimate of the annual shortnose sturgeon impingement and entrainment, we cannot use these individual points in this analysis.

Based on the above information from 13 CWIS, the average anticipated annual mortality of shortnose sturgeon is approximately 2.49 per facility that overlaps with shortnose sturgeon range. Shortnose sturgeon range from Maine to Florida, but only one shortnose sturgeon has been captured in Virginia recently, so CWIS in Virginia will not be considered. And based on information from eight CWIS (the assessments on the other five structures were before Atlantic sturgeon were listed), the average anticipated annual mortality of Atlantic sturgeon is approximately 2.26 per facility that overlaps with Atlantic sturgeon range.

The data above are annual take estimates from 13 CWIS of a total of at least 557 CWIS that overlap with shortnose, Atlantic, Gulf, and green sturgeon nursery habitat. While this is the best available information for this exposure analysis, this represents meaningful data from just 2.25 percent of the CWIS that may affect listed sturgeon species and their critical habitat, highlighting the need for increased oversight associated with 316(b) permits. Furthermore, there are apparently no consultations for the effects of CWIS on Gulf or green sturgeon, despite indications that green sturgeon are very vulnerable to impingement and entrainment of all U.S. sturgeon species (Poletto et al. 2014). Additionally, the seven CWIS with documented take are on the Hudson River. On the one hand, these facilities proactively applied for a Conservation Plan and take permit, in the process, minimizing and mitigating their effects to listed species to the maximum extent practicable as required under ESA section 10(a)(2)(B)(ii), likely reducing the amount of impingement and entrainment more so than the other approximately 544 CWIS affecting sturgeon. On the other hand, the impingement and entrainment documented in these consultations comes from the Hudson River, which has the largest populations of both shortnose and Atlantic sturgeon along the coast, increasing the probability of sturgeon becoming impinged or entrained. NMFS believes that because these impingement and entrainment estimates represent the maximum amount of mitigation in the largest population of both shortnose and Atlantic sturgeon that it is reasonable to use those numbers to estimate the probable level of take for facilities that are not meeting the strict criteria established under ESA section 10(a)(2)(B)(ii) but are also operating in rivers with smaller Atlantic and shortnose populations.

Because there is no impingement or entrainment data for Gulf sturgeon or green sturgeon, we are forced to use the only information available. Shortnose sturgeon are impinged and entrained at approximately 2.49 fish per facility and Atlantic sturgeon are impinged and entrained at approximately 2.26 fish per facility. To estimate green sturgeon impingement and entrainment rates, it is appropriate to use at least 2.49 fish per facility because they are entrained at a higher rate than other Acipenserids (Poletto et al. 2014). But to estimate Gulf sturgeon, a sub-species of Atlantic sturgeon, it is appropriate to use 2.26 fish per facility (Table 9).

Because EPA did not provide estimates of Atlantic sturgeon take by DPS, we will calculate the likely proportion of the total take that will affect each DPS. Because this is a national programmatic and sturgeon from a particular DPS are generally concentrated more around their natal rivers, and furthermore, most CWIS are located upstream in freshwater portions of rivers, it's likely that the DPSs most exposed to impingement and entrainment are the largest DPSs. Because there are no population estimates, we must estimate the likely proportions. Furthermore, even if we knew exact ratios of each DPS along the coast, due to changes in movement patterns and just by chance, there will be variability around those proportions, making it necessary to identify maximum ranges of each DPS that could be killed to ensure the identified level of take is not exceeded.

The BE estimated the number of CWIS that overlap with some species' ranges but did not for other species. For instance, the BE estimates the number of CWIS in shortnose sturgeon and Gulf sturgeon habitat, but not for Atlantic sturgeon or green sturgeon. Because of this, NMFS had to map the location of all CWIS and overlay species range data where it was available. In our assessment, we determined 481, 484, 41, and 31 facilities overlapped with shortnose, Atlantic, Gulf, and green sturgeon habitat (Table 9). While none of these numbers are the same as were provided in the BE, NMFS is confident these facilities overlap with listed sturgeon habitat.

Table 9. Estimated annual impingement and entrainment mortality of sturgeon by facility and for all facilities affecting each species and/or DPS.

Species	Overlapping facilities	Annual mortality/facility	Total annual mortality
Shortnose	481	2.49	1,198
Atlantic*	484	2.26	1,094
Gulf of Maine DPS			329
NYB DPS			493
Chesapeake Bay DPS			383
Carolina DPS			274
South Atlantic DPS			438
Gulf	41	2.26	93
Green, Southern DPS	31	2.49	78

** Total numbers of Atlantic sturgeon captured or killed will not exceed the identified totals, however the DPS make-up of that total take may fluctuate seasonally and annually.*

6.3 Response

CWIS are likely to cause impingement or entrainment, thermal discharges, chemical discharges, and the indirect effect of prey and habitat reduction.

6.3.1 Impingement and Entrainment

Impingement occurs when organisms are trapped against cooling water intake screens, racks, or removal equipment by the force of moving water. Generally, fish are impinged when their swimming speed is overtaken by the intake velocity. Such speeds are determined by the individual's size and age, body condition, level of fatigue, ability to remain a head-first orientation into current, and surrounding environmental conditions, such as water temperature (Mayfield and Cech 2004, Cech Jr. and Doroshov 2005, Kynard et al. 2005, Allen et al. 2006a, Deslauriers and Kieffer 2012, Poletto et al. 2014). Kynard et al. (2005) found that yearling or older shortnose sturgeon (≥ 28 cm) are likely to avoid impingement, when intake velocities are 1 ft/sec or less in laboratory conditions (e.g., fish are healthy and free of heat stress, pollution, and/or disease). This study did not account for fatigue, which results in impingement of juvenile shortnose sturgeon at swimming speeds of 0.7 ft/sec or 22.3 cm/sec (Deslauriers and Kieffer 2012).

Entrainment is when fish, larvae, or eggs are sucked into the CWIS when eggs are small enough to pass by the screen or there is no screen in place. Sturgeon eggs are demersal; they sink and adhere to the bottom of the river. They are unlikely to be entrained by CWIS. Upon hatching, the larvae in yolk-sac and post-yolk-sac stages remain on the bottom of the river. Sturgeon larvae are intolerant of salinity (Dovel and Berggren 1983, Kahnle et al. 1998, Bain et al. 2000, Allen et al. 2009), . They occur only in freshwater, in the deepest waters (Taubert and Dadswell 1980, Bath et al. 1981, Kieffer and Kynard 1993, Allen et al. 2009)(Sweka et al. 2007, Randall and Sulak 2012). Larvae grow rapidly and by the time they begin down-stream migrations, they are too large to be entrained by CWIS (Sulak and Clugston 1999, Kynard and Parker 2004, Allen et al. 2006b). While there have been studies of impingement at 13 CWIS, there have only been entrainment studies at two Indian Point CWIS on the Hudson River out of 577 CWIS in sturgeon occupied waters. In addition to only monitoring 0.35 percent of the CWIS in shortnose, Atlantic, Gulf, and green sturgeon habitat, the lone study was conducted between 1981 and 1987, starting over 30 years ago. In that study, no sturgeon larvae were collected during intense entrainment monitoring (i.e., nearly 24 hours per day, four to seven days per week, during the spawning season, in the spring; Woodland and Secor 2007). This was during a period of likely recovery for shortnose sturgeon, as the population estimates increased during this time through 2000. However, this was during a series of recruitment failures for Atlantic sturgeon and therefore it is likely there were fewer Atlantic sturgeon eggs available to be collected. Therefore, we conclude that the entrainment of sturgeon eggs or larvae is unlikely.

Currently facilities are not required to install trash bars, travelling screens, or fish removal systems; however, if installed, the following expectations apply. We expect large fish to either swim away or become impinged on trash bars (if present); we expect small fish to pass through trash bars (if present) and possibly become impinged on the screens, if present (NMFS 2000b). The velocity in front of travelling screens, including the Ristroph screens installed at the Indian Point facility, averages 1.0 ft/sec or less (Fletcher 1990). Kynard et al. (2005) suggests that shortnose sturgeon older than one year (≥ 28 cm) should be able to avoid impingement by the travelling screen; however, all fish impinged at Indian Point ranged in size from 32 to 71 cm (i.e., large enough to theoretically avoid impingement). Poletto et al. (2014), Allen et al. (2006), and Amaral et al. (2002) also identify top speeds to avoid being impinged of at least 20 cm/sec and up to 55 cm/sec. It is possible that the young sturgeon naturally drift with the current to move downstream, so when confronted with intake velocities, they don't attempt to swim off until it's too late (Dadswell et al. 1984, Gilbert 1989, NMFS 1998a, Kynard and Horgan 2002) . In addition, larger fish may become fatigued, stressed, or disoriented while trying to avoid the screens or trash bars. Even if through-rack velocity is not high enough to preclude fish from exiting the area, they may have difficulty finding a way out, especially if there is debris in front of the trash bars. Fletcher (1990) found that striped bass spent an average of 9.73 hours between the trash racks and screens prior to removal. Therefore, it is likely that entrapped fish first become stressed, tired or disoriented, and then become impinged on the screens or captured in the traveling buckets.

Impingement may kill organisms immediately or result in latent mortality as a result of exhaustion, suffocation, injury, or exposure to air when screens are rotated for cleaning. At Indian Point, previous data indicated mortality rates of 78 percent for shortnose sturgeon and 59 percent for Atlantic sturgeon. However, the installation of modified Ristroph screens may reduce fish impingement mortality to rates of 9 to 62 percent (Fletcher 1990). NMFS generally assumes 100 percent mortality for the following reasons:

- The above studies do not use sturgeon;
- Species considered in the monitoring and testing studies are not morphologically similar to sturgeon and are considerably smaller than sturgeon;
- No studies compare the impingement mortality or likelihood of injury of sturgeon versus other species;
- Post-impingement survival has never been studied; and
- Sturgeon impinged on the trash bars are likely to die because there is no opportunity for fish removal.

6.3.2 Thermal Discharges

Thermal discharges have the potential to cause lethal or sublethal effects, positive effects, to create barriers, and indirect effects by affecting food resources. To evaluate the effects of thermal discharges as a result of CWIS, a thermal plume study was conducted at the Indian Point facility.

The extent and shape of the thermal plume varies greatly, primarily in response to tidal currents (Swanson et al. 2011b). Generally, the warmest water remains close to the surface, and plume temperatures tend to decrease with depth; however, occasionally the thermal plume extends deeply rather than across the surface. The maximum observed temperature of thermal discharges is approximately 46°C (Hester and Doyle 2011). Waters deeper than 5 m are not likely to exceed 32°C. Shortnose, Atlantic, Gulf, and green sturgeon occupy the mainstems of large rivers and avoid shallow off-channel habitat. We do not expect temperature-related mortality because sturgeon can avoid the surface waters, and occasional deep hot spots, that may exceed tolerable temperatures.

Niklitschek (2001), Mayfield and Cech (2004), Chapman and Carr (1995), and (Niklitschek and Secor 2005) (2005) have identified temperature ranges that allow for optimal growth of shortnose, Atlantic, Gulf, and green sturgeon. Shortnose sturgeon will utilize water as warm as 26 to 30°C (Dadswell et al. 1984, Kynard 1997, Niklitschek 2001) . Atlantic sturgeon will use waters up to approximately 32°C (annual permit reports to NMFS Office of Protected Resources). While there is limited information on lethal limits of Gulf sturgeon temperature tolerance, as a sub-species of Atlantic sturgeon, adapted to the warmer waters of the Gulf of Mexico, it is likely they can tolerate temperatures very similar to Atlantic sturgeon or maybe slightly higher. Green sturgeon though are more sensitive to high temperatures, sometimes encountering lethal temperatures as low as 25°C (Mayfield and Cech 2004) (Cech Jr. et al. 2000, Allen et al. 2006a). The 48 hour 50 percent mortality rate for shortnose sturgeon was between 28 and 30°C, with instantaneous lethal thermal maxima for young-of-the-year shortnose sturgeon between 34.8 and 36.1°C (Ziegeweid et al. 2008). At 5 to 6°C prior to the lethal endpoint, fish frantically swim around the tank, presumably looking for an escape route (Ziegeweid et al. 2008).

Dissolved oxygen likely plays a key role in temperature tolerance (Niklitschek 2001). Water temperature and dissolved oxygen levels are related, with warmer water generally holding less dissolved oxygen. In summer, the coupling of low dissolved oxygen at depth and water temperatures greater than 20°C above the thermocline limits non-stressful habitat due to a temperature-oxygen habitat squeeze (Coutant 1987). Sturgeon are more sensitive to low level dissolved oxygen conditions than other fishes and become stressed in hypoxic conditions (generally under 5 mg/L), which may limit growth, metabolism, activity, and swimming (Cech et al. 1984, Secor and Gunderson 1998, Secor and Niklitschek 2001, Cech and Crocker 2002, Secor and Niklitschek 2002, Campbell and Goodman 2004) .

Thermal plumes during portions of the year can create areas that are uninhabitable for shortnose, Atlantic, Gulf, and green sturgeon. However, because sturgeon inhabit large mainstem rivers along the Atlantic, Gulf, and Pacific Coasts, thermal plumes are expected to displace sturgeon during portions of the year and potentially provide areas of optimal bioenergetic environments when the rest of the river is less than optimal. Thermal plumes may have a short term adverse effect on shortnose, Atlantic, Gulf, and green sturgeon, but should not result in long-term or sub-lethal impacts. Furthermore, in situations where the thermal plume is stressful, all sturgeon species will be able to move up or downstream or even laterally and avoid them.

6.3.3 Chemical Discharges

Chemical discharges from CWIS may include radionuclides, including: tritium, strontium, nickel, and cesium. Chlorine, lithium hydroxide, boron, and total suspended solids may also be discharged from CWIS. At CWIS facilities, total residual chlorine is often limited to a daily average of 0.2mg/L, as measured at the point of discharge, prior to dilution in the water body. Therefore, sturgeon would be exposed to chlorine discharge. However, chlorine quickly dilutes in water, particularly in the large rivers sturgeon inhabit and more importantly, chlorine is highly reactive and evaporates from water very quickly, so chlorine levels in the river are not expected to be at toxic levels or to adversely affect shortnose, Atlantic, Gulf, or green sturgeon.

6.3.4 Indirect Effects

Sturgeon food resources, benthic invertebrates, have limited mobility. Benthic invertebrates are small and not likely to be impinged. However, benthic invertebrates could be entrained at CWIS, potentially reducing the number of invertebrates in the area. Similarly, benthic invertebrates may be affected by thermal or chemical plumes, but the effect is unlikely to reduce the abundance of benthic invertebrates and rather would be expected to alter the community dynamics, giving a competitive advantage to benthic invertebrates that are more tolerant or chemicals or temperatures. Because shortnose, Atlantic, Gulf, and green sturgeon are generalist feeders (Haley 1998, Miller 2004, Collins et al. 2008, Dumbauld et al. 2008), a change in the composition of the benthic invertebrate community will most likely have no effect on individual sturgeon. The loss of some benthic invertebrates due to entrainment may limit food resources locally, and therefore slightly reduce the total carrying capacity of sturgeon in the river.

Despite the fact that EPA, in their BE, was unable to calculate the number of CWIS that overlapped with each listed species, NMFS provided estimates of the likely lethal take of shortnose, Atlantic, Gulf, and green sturgeon. Based on the best available scientific information, NMFS analysis to date, with limited site specific information anticipates 1,198 shortnose sturgeon, 329 Gulf of Maine DPS Atlantic sturgeon, 493 New York Bight DPS Atlantic sturgeon, 383 Chesapeake Bay DPS Atlantic sturgeon, 274 Carolina DPS Atlantic sturgeon, 438 South Atlantic DPS Atlantic sturgeon, 93 Gulf sturgeon, and 78 southern DPS green sturgeon could be killed every year by impingement at CWIS. However, this information is based on monitoring impingement at only 13 of 577 CWIS (2.25 percent) in shortnose, Atlantic, Gulf, or green sturgeon habitat since 1972. And as poor as impingement monitoring has been, entrainment has been monitored at only 2 of 577 CWIS (0.35 percent) in that time.

6.4 Shortnose Sturgeon

Many shortnose sturgeon population estimates have been increasing over the past 30 years; however there are no known recolonized populations in this time. This could be an indication of an upward population trend, or of increased research and more refined sampling procedures. While the Hudson River has a shortnose sturgeon population possibly four times larger than the next largest shortnose sturgeon spawning population (Delaware or Kennebec Rivers), most rivers along the East Coast have total populations with fewer than 1,000 adults, sub-adults, and juveniles. Those populations are at greater risk of being extirpated by a combination of anthropogenic threats and natural, stochastic events.

Currently, shortnose sturgeon appear to have been extirpated from Florida, the southern half of Georgia (below the Altamaha River), all of north Carolina above the Cape Fear River, all of Virginia, and likely all of Maryland (Rogers and Weber 1995, Kynard 1997, Kahnle et al. 1998, NMFS 1998b, Collins et al. 2000, Skjeveland et al. 2000, Welsh et al. 2002, Oakley 2003). These large, in some cases, statewide extirpations of shortnose sturgeon represent critical fragmentation within their range. Furthermore, shortnose sturgeon are typically not found in waters with a salinity of 31 ppt or higher (Gilbert 1989) and therefore are unlikely to stray long distances along the coast to colonize another river if that population is extirpated.

The Rule will allow for the operation of 481 CWIS within the range of shortnose sturgeon. Our analysis based on available information at this time, with limited site specific data, suggests that the operation of CWIS could result in the lethal impingement of 1,198 shortnose sturgeon every year. While incalculable, these 481 CWIS could reduce the available food resources within the immediate vicinity of the intakes via entrainment, limiting the potential carrying capacity of each river slightly. Rivers with multiple CWIS would experience greater limitations in recovery potential. The largest river systems along the coast also support the largest shortnose sturgeon populations. This is likely because there is more habitat available and a higher carrying capacity. Therefore, the populations most at risk as a result of this rule are the small populations found in smaller river systems that have shown only stable or in some cases, downward trends, despite increased research.

The life stage of sturgeon impinged is another important consideration as to whether extirpation is likely or the anticipated lethal take associated with CWIS can be withstood. While most of the impinged shortnose sturgeon may be juveniles, the minimal monitoring data that exists suggests at least some of the impingement will affect sub-adult and adult shortnose sturgeon. The loss of 1,198 shortnose sturgeon of all life stages each year would have significant and sustained adverse impacts to each of the shortnose sturgeon spawning populations along the Atlantic Coast.

In summary, shortnose sturgeon will be directly and indirectly affected by CWIS.

6.5 Atlantic Sturgeon

There are only two published Atlantic sturgeon spawning population estimates and both of those are at least a decade old. Many managers believe that since the commercial fishery was closed in 1998 (ASMFC 1998), populations in many rivers have been growing. However, while researchers are able to capture and tag fish, analyses of effective population sizes from genetic fin clips from the juveniles of these “recovering” populations suggest very small effective population sizes along the coast (O’Leary et al. 2014). As far as spawning population sizes, it is likely that few rivers have over 1,000 adults that return to spawn every one to five years, with annual spawning runs likely in the range of 300 to 400 individuals (ASSRT 2007, Kahnle et al.

2007, Peterson et al. 2008). Most Atlantic sturgeon spawning populations are thought to be very small (ASSRT 2007)

Historically, spawning occurred in approximately 36 rivers along the Atlantic Coast, but currently is only known to occur in 21 (ASSRT 2007). Currently, Atlantic sturgeon appear to have been extirpated from Florida, all of north Carolina between the Cape Fear River and Roanoke River and those two rivers support very small populations, the Rappahanock River in Virginia, likely all of Maryland except the Nanticoke River, the entire New York Bight DPS except for the Delaware and Hudson Rivers, and possibly most rivers in Maine except for the Kennebec and Penobscot (ASSRT 2007). These large, in some cases, statewide extirpations of Atlantic sturgeon represent critical fragmentation within their range. However, a primary difference between shortnose and Atlantic sturgeon is that Atlantic sturgeon are much more migratory. While Atlantic sturgeon will travel long distances and spend time in various locations, both north and south of their natal rivers, they are extremely accurate in returning to their natal rivers to spawn. At the riverine level, Atlantic sturgeon return at an approximately 85 percent rate to their natal river. This number, while high, is well over 90 percent in rivers from the Roanoke River/Albemarle Sound and north, but there is substantial straying in the rivers of southern South Carolina and Georgia (T. King, unpublished data, 2014). However, some individuals from every generation appear to stray to nearby rivers, but at very low rates (less than one individual from its natal river per generation) (Grunwald et al. 2008).

The Rule, will allow for the operation of 484 CWIS within the range of Atlantic sturgeon. The operation of these CWIS could result in the lethal impingement of 329 Gulf of Maine DPS, 493 New York Bight DPS, 383 Chesapeake Bay DPS, 274 Carolina DPS, and 438 South Atlantic DPS Atlantic sturgeon every year. While incalculable, these 484 CWIS could reduce the available food resources within the immediate vicinity of the intakes via entrainment, limiting the potential carrying capacity of each river slightly. Atlantic sturgeon only use freshwater portions of rivers for juvenile rearing, so the loss of this habitat would equate to a reduction in juvenile carrying capacity. Rivers with multiple CWIS would experience greater limitations in recovery potential. Therefore, the populations most at risk as a result of this rule are the small populations north of Albemarle Sound, where straying is rare and the loss of a spawning population would take longer to recovery, assuming it ever would (currently there are still 15 spawning populations that have been extirpated and not recovered despite many states closing their commercial fisheries in the 1970s and it closing throughout the U.S. in 1998). The species was listed in 2012 with little information on its status because of the numerous threats facing its populations and DPSs.

The life stage of sturgeon impinged is another important consideration as to whether extirpation is likely or the anticipated lethal take associated with CWIS can be withstood. Most of the impinged Atlantic sturgeon will be juveniles and sub-adults based on the minimal monitoring data that exists, which suggests impingement will generally affect individuals less than 700 mm in length. The loss of 329 Gulf of Maine DPS, 493 New York Bight DPS, 383 Chesapeake Bay

DPS, 274 Carolina DPS, and 438 South Atlantic DPS Atlantic sturgeon (Table 9) every year would have direct effects to each of the Atlantic sturgeon spawning populations along the Atlantic Coast. Some DPSs, such as Carolina, Chesapeake Bay, and Gulf of Maine DPSs would be expected to experience extirpations more quickly than the New York Bight and South Atlantic DPS because of the size of the extant populations remaining in those DPSs and the straying rate between extant systems.

In summary, all of the DPSs of Atlantic sturgeon will be directly and indirectly affected by CWIS.

6.6 Gulf Sturgeon

Gulf sturgeon continue to spawn in seven basins along the U.S. Gulf Coast. Gulf sturgeon populations in the Suwannee River have increased in the past 40 years (Pine et al. 2001), but the populations in the other spawning rivers have remained stable or decreased slightly in response to large-scale adverse events, such as hurricanes and chemical spills (USFWS and NMFS 2009). This, despite increased research and more refined sampling procedures. Now the Suwannee River has a Gulf sturgeon population considerably larger than the other Gulf sturgeon spawning populations. The other Gulf Coast rivers have total populations of only several hundred adults (Morrow Jr. et al. 1998, Zehfuss et al. 1999). Those populations are at greater risk of being extirpated by a combination of anthropogenic threats and natural, stochastic events.

The Rule, as proposed, will allow for the continued operation of 41 CWIS within the range of Gulf sturgeon. The operation of these CWIS is likely to result in the lethal impingement of 93 Gulf sturgeon every year. While in other systems, these 41 CWIS will reduce the available food resources and therefore limit the potential carrying capacity of each river slightly, Gulf sturgeon do not feed when they enter freshwater portions of the river and therefore should not be affected by any changes to benthic invertebrate resources (Sulak et al. 2012) . The populations most at risk as a result of this rule are the six small populations found to the west of the Suwannee River that have shown only stable or in some cases, downward trends, despite increased research and 23 years of protection under the ESA.

The life stage of sturgeon impinged is another important consideration as to whether extirpation is likely or the anticipated lethal take associated with CWIS can be withstood. While most of the impinged Gulf sturgeon may be juveniles, the minimal monitoring data that exists suggests at least some of the impingement will affect sub-adult Gulf sturgeon. The loss of 93 juvenile and sub-adult Gulf sturgeon each year from the Suwannee River would have different effects than the loss of 93 Gulf sturgeon from the Pearl, Pascagoula, Escambia, Yellow, Choctawhatchee, or Apalachicola Rivers. The continued annual loss of Gulf sturgeon populations would have adverse impacts to each of those spawning populations along the Gulf Coast.

In summary, Gulf sturgeon will be directly and indirectly affected by CWIS.

6.7 Green Sturgeon

Southern DPS green sturgeon reproduce in the Sacramento and Feather River, a tributary to the Sacramento River. The population has been steady since it was listed as threatened in 2007. The primary threats to the southern DPS of green sturgeon are its isolation at the southern extent of their range and the threat of extinction from a number of causes affecting the Sacramento River and Bay Delta system.

The Rule will allow for the operation of 31 CWIS within the range of southern DPS green sturgeon. The operation of these CWIS could result in the lethal impingement of 78 green sturgeon every year. While incalculable, these 31 CWIS could reduce the available food resources within the immediate vicinity of the intakes via entrainment, resulting in a slight reduction in the potential carrying capacity of the river. There is only one spawning population in the Sacramento River system and any impingement mortalities will affect that population.

The life stage of sturgeon impinged is another important consideration as to whether extirpation is likely or the anticipated lethal take associated with CWIS can be withstood. While most of the impinged green sturgeon may be juveniles, the minimal monitoring data that exists suggests at least some of the impingement will affect sub-adult green sturgeon. The loss of shortnose sturgeon of any life stages each year would have adverse impacts to the southern DPS green sturgeon spawning population. Furthermore, green sturgeon appear to be more susceptible to impingement (Poletto et al. 2014) than other sturgeon, but there has been no monitoring of any of the 31 CWIS in green sturgeon habitat, so EPA and NMFS does not know whether the Rule will have an even greater effect than is being estimated using the best available information in this Opinion.

In summary, green sturgeon will be directly and indirectly affected by CWIS.

6.8 Critical Habitat

Critical habitat has been designated for Gulf sturgeon and green sturgeon (Southern DPS), but is not designated for Atlantic or shortnose sturgeon. In the BE, EPA estimates that 12 facilities are likely to overlap with Gulf sturgeon designated critical habitat and we concur with that finding. We have determined that the effects of 31 CWIS are likely to overlap with green sturgeon critical habitat. Designated gulf sturgeon critical habitat includes 14 geographic areas among the Gulf of Mexico rivers and tributaries. These areas include river, estuarine and marine habitat (68 FR 13370). The primary constituent elements essential for the conservation of Gulf sturgeon are those habitat components that support feeding, resting, and sheltering, reproduction, migration, and physical features necessary for maintaining the natural processes that support these habitat components. The primary constituent elements include:

- abundant prey items within riverine habitats for larval and juvenile life stages, and within estuarine and marine habitats and substrates for juvenile, subadult, and adult life stages;
- riverine spawning sites with substrates suitable for egg deposition and development, such as limestone outcrops and cut limestone banks, bedrock, large gravel or cobble beds, marl, soapstone or hard clay;

- riverine aggregation areas, also referred to as resting, holding, and staging areas, used by adult, subadult, and/or juveniles, generally, but not always, located in holes below normal riverbed depths, believed necessary for minimizing energy expenditures during fresh water residency and possibly for osmoregulatory functions;
- a flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages in the riverine environment, including migration, breeding site selection, courtship, egg fertilization, resting, and staging;
- and necessary for maintaining spawning sites in suitable condition for egg attachment, eggs sheltering, resting, and larvae staging;
- water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and
- sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g. a river unobstructed by any permanent structure, or a dammed river that still allows for passage).

Green sturgeon (Southern DPS) critical habitat includes the following areas: coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its U.S. boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; the lower Columbia River estuary; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor). It also includes freshwater river, estuarine, and marine habitats in California (74 FR 52300). In freshwater riverine and estuarine systems, the physical and biological features essential to the species include:

- food resources (abundant prey items for larval, juvenile, subadult, and adult life stages);
- substrate type or size (i.e., structural features of substrates) suitable for egg deposition and development, larval development, and spawning adults;
- water flow necessary for normal behavior, growth, and survival of all life stages;
- water quality including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and
- a migratory pathway necessary for the safe and timely passage of fish within riverine habitats and between riverine and estuarine habitats.

As discussed above, CWIS are likely to entrain some of the many benthic invertebrates around the intake pipe and thermal discharge may cause a change in the invertebrate community. These alterations caused by the Rule will affect designated critical habitat of both Gulf and green sturgeon by changing food resources in the immediate vicinity of the CWIS, affecting water quality in the immediate vicinity of the CWIS, and possibly affecting migratory pathways in the immediate vicinity of the CWIS.

Gulf sturgeon are wide ranging, reproducing in seven rivers along the Gulf Coast, with only 12 CWIS affecting their critical habitat, which covers all of those rivers as well as some shoreline areas. However, Gulf sturgeon generally do not feed while in freshwater portions of their range (Mason Jr. and Clugston 1993, Randall and Sulak 2012) , so a reduction in food resources in freshwater will not affect Gulf sturgeon critical habitat. Gulf sturgeon rely on cool water refuges while in freshwater portions of rivers and the thermal discharges could force them to use other areas of the river. However, because Gulf sturgeon are highly mobile, the limitations of water quality in the immediate vicinity of 12 CWIS within their habitat range will have a negligible impact on their designated critical habitat.

The most important aspect of Gulf sturgeon's time spent in fresh water is their upstream migration to spawning areas, followed by a downstream migration back to the Gulf of Mexico. Thermal plumes have the potential to impede upstream migration by making water too warm to migrate through, thus blocking their migratory pathway. However, there is no evidence of this occurring as all researchers in the seven Gulf sturgeon spawning rivers report Gulf sturgeon continue to spawn at upstream sites (Foster and Clugston 1997, Fox et al. 2000, Heise et al. 2004, Rogillio et al. 2007). Therefore the rivers must be large enough that while the thermal plume makes portions of the river uninhabitable, Gulf sturgeon are able to migrate by using the rest of the river. Therefore, the presence of CWIS is not likely to destroy or adversely modify Gulf sturgeon critical habitat.

Southern DPS green sturgeon only reproduce in one river system, though the Sacramento River is large and they also reproduce in a tributary to the Sacramento, the Feather River. There are 31 CWIS in southern DPS green sturgeon critical habitat. The CWIS are likely to remove benthic invertebrates from the Sacramento River system via entrainment, thus slightly reducing the amount of food available to juvenile green sturgeon. The presence of 31 CWIS in critical habitat means there will be a diminished food supply throughout their downstream migratory corridor. However, green sturgeon are generalists (Miller 2004, Dumbauld et al. 2008) and will be able to feed in other areas. The limitation is the removal of food resources from 31 locations within their designated critical habitat may limit the carrying capacity of the southern DPS green sturgeon populations. Thermal plumes may change the benthic macroinvertebrate community, but being generalists this will have no impact to green sturgeon. Furthermore, because the Sacramento River is maintained in an artificially cool state through the summer to provide rearing habitat for Sacramento River winter-run Chinook salmon, which no longer exists in the river, these areas of warmer water should actually increase juvenile green sturgeon bioenergetic responses and growth. Also, because of the size of the Sacramento River, for the same reasons migratory habitat is not likely affected for Gulf sturgeon, it is also unaffected for green sturgeon.

7 Sawfish

In the BE, EPA does not estimate the number of facilities likely to overlap with the range of ESA-listed sawfish species. Using ArcGIS to map EPA's list of facilities likely to be regulated under the Rule, we identified seven facilities that overlap with smalltooth sawfish, U.S. DPS.

7.1 Exposure

In the BE, EPA determines that impingement, entrainment, thermal and chemical discharges, and flow alterations are likely to adversely affect sawfish; however, they do not provide in depth details on these effects. We found two examples of smalltooth sawfish in thermal plumes of CWIS. In January 2001, a sawfish was reported in the warm water outflow (approximately 28°C) of the Apollo Bay power plant. A smalltooth sawfish was later caught adjacent to the outfall in an area with elevated water temperatures (22.9 °C plume compared to 17.7 °C in surrounding areas). Based on their size and other characteristics, there were at least two sawfish within the thermal plume.

There has been one example of a sawfish being impinged at a CWIS at the St. Lucie Nuclear Power Plant in Port St. Lucie, FL. This incident was the only impingement of sawfish at the facility since 1976 (30 years), resulting in a probability of 0.03 (standard deviation = 0.18) sawfish impingements annually at each CWIS. Therefore, we were able to calculate the probable annual impingement using the empirical impingement rate of 0.033 multiplied by the number of CWIS (Table 10). Because juvenile sawfish inhabit mangrove estuaries, and CWIS are not likely to be located in mangrove estuaries, we expect sub-adult and adult sawfish of either sex to be impinged.

Table 10. Total smalltooth sawfish impingement at all facilities in smalltooth sawfish habitat.

Species	Overlapping facilities	Annual mortality range
Smalltooth sawfish	7	0.23 (approximately 1 every 4 years)

7.2 Response

In the BE, EPA determines that impingement, entrainment, thermal and chemical discharges, and flow alterations are likely to adversely affect sawfish.

7.2.1 Impingement

Impingement of sawfish is likely to occur as a result of entanglement of the rostrum or "saw" in screens or nets. The lone example of a smalltooth sawfish being impinged came from the St. Lucie Nuclear Power Plant in Port St. Lucie, FL (FPL 2005):

> "On May 16, 2005, during the course of normal sea turtle netting activities at the St. Lucie Nuclear Power Plant intake canal, a smalltooth sawfish *(Pristis pectinata)* became entangled in the north capture net at approximately 5:20 PM. The biologist on duty determined that the animal was too large to handle himself and called for assistance at

approximately 5:30 PM. A crew of four biologists assembled at the intake canal at 6:00 PM and discussed a plan to remove the sawfish from the net and release it back to the ocean safely. The 100-foot net was released from the west end anchor point and was pulled into the boat up to the location of the sawfish. The net was then released from the east end anchor point and the remaining net was pulled into the boat leaving the entangled sawfish in the water alongside the boat. The rostrum, or saw, was the only part of the animal that was entangled in the net, which left the rest of its body unencumbered.

The animal was pulled into the boat ramp area, where the remaining net was offloaded. The animal remained in the shallow water of the boat ramp until preparations were made for its removal. A stretcher was laid out on the boat ramp and a winch was attached to the remaining net in order to pull the sawfish onto the stretcher. At approximately 6:30 PM, the animal was pulled from the water up the boat ramp and onto the stretcher. It was then moved into the back of a trailer normally used for transporting large sea turtles. At this point the sawfish was disentangled from the net and measurements were taken. The sawfish measured 415 cm (13.62 feet) from tail to end of rostrum and the rostrum itself measured 86 cm (2.82 feet) from base to tip. The animal was then transported via an all-terrain vehicle across the dune and to the ocean, a distance of about 100 meters. Two biologists walked behind the trailer holding up the tail end of the stretcher to ensure the animal would not slide out. The trailer was then filled with ocean water by backing it into the nearshore trough, and the animal was able to float out of the trailer and swim away freely at approximately 6:45 PM. The area where the sawfish was released was then monitored for another 25 minutes to make sure that it had acclimated and did not wash ashore (FPL 2005)."

As a result of the monitoring protocols and removal efforts at the St. Lucie facility, the sawfish survived impingement. At the time of the incident, St. Lucie had the following control measures in place: velocity cap; 5 inch mesh barrier nets; tangle nets deployed in daylight hours, seven days a week; hourly monitoring of barrier and tangle nets; quarterly inspection and repair of holes in nets; sea turtle response program; and exempted incidental take for sea turtles. These control measures were designed to minimize the adverse effects to sea turtles, but because of these controls, the impinged sawfish was released alive.

7.2.2 Thermal Discharges

The recovery plan for the smalltooth sawfish identifies warm water discharges from power stations to be a low-severity threat, leading to the compromised health of sawfish (NMFS 2009) .

Two smalltooth sawfish (U.S. DPS) have been identified in the thermal discharges of a CWIS (Simpfendorfer 2001). Sawfish may utilize these plumes as thermal refuges during colder months to enhance their survival, or they may become trapped by surrounding cold water from which they would normally migrate (Simpfendorfer and Wiley 2004). The impact of thermal discharges on the fitness of sawfish is unknown; however, there was an unconfirmed report of two sawfish being killed in the Hillsborough River during a cold-snap in January 2001 (Simpfendorfer 2001). Simpfendorfer (2001) concluded that significant use of thermal discharges may disrupt the normal migratory patterns of smalltooth sawfish.

7.2.3 Indirect Effects

Sawfish prey upon schooling fish and bottom-dwelling invertebrates. Their prey are likely to be impinged as adults (e.g., fish) or entrained as eggs or larvae (e.g., fish and invertebrates). Reduced prey availability is not considered to be a major threat to the survival or recovery of sawfish species. We do not expect the indirect effects of CWIS to reduce the fitness of any individuals.

Smalltooth sawfish appear to be recovering at a rate of 2 to5 percent per year and there is also evidence that their range is expanding. While EPA was unable to estimate the number of CWIS in smalltooth sawfish habitat, NMFS was able to determine there are seven facilities that overlap with their range. However, due to the low probability of impingement (0.033), NMFS anticipates one smalltooth sawfish will be impinged and killed once every four years at one of the seven CWIS in smalltooth sawfish habitat. There is the potential that with the range expansion will come increased interactions with CWIS. At this time, there is no solid evidence of which additional facilities, if any, would pose a threat to smalltooth sawfish and as such, no additional facilities are considered.

Thermal plumes may also affect sawfish but in an undetermined way. There is the possibility that they provide refuge during cold snaps, providing optimal and life-saving habitat, which is a beneficial effect. However, as is noted by Simpfendorfer (2001), the thermal plumes could also result in the disruption of natural migrations, with unknown, but likely negative effects (limited growth, exposure to poor water quality, exposure to fishing (commercial and recreational) bycatch, etc.). The lethal take of one smalltooth sawfish every four years is not expected to have a population or DPS level effect on smalltooth sawfish.

In summary, smalltooth sawfish will be directly and indirectly affected by CWIS.

7.3 Critical Habitat

Designated critical habitat for the U.S. DPS of smalltooth sawfish consists of two units: the Charlotte Harbor Estuary Unit, which comprises approximately 221,459 acres of coastal habitat; and the Ten Thousand Islands/Everglades Unit, which comprises approximately 619,013 acres of coastal habitat (74 FR 45353). The two units are located along the southwestern coast of Florida between Charlotte Harbor and Florida Bay. These specific areas contain the following physical and biological features that are essential to the conservation of this species and that may require special management considerations or protection: red mangroves and shallow euryhaline habitats characterized by water depths between the mean high water line and 3 ft (0.9 m) measured at mean lower low water. There is only one CWIS in smalltooth sawfish critical habitat. The potential effects to critical habitat from this CWIS are a change in depth and available habitat because of water intake. However, it is unlikely that the CWIS will remove so much water that the depth will be altered to such an extent as to make the habitat unusable for smalltooth sawfish.

Therefore, NMFS does not believe smalltooth sawfish critical habitat will likely be destroyed or adversely modified as a result of this Rule.

8 Rockfish

Several studies have been conducted on the impingement and entrainment of rockfish. These studies were conducted to evaluate population abundance and trends, rather than the effects of CWIS on rockfish; still they provide the best available information on such effects. We describe these studies in the impingement and entrainment response sections. We assume that the facilities used in these studies represent the typical facility regulated under the Rule because they did not incorporate protective measures for rockfish, as a result of ESA Section 7(a)(2) consultations or permit requirements (unlike our “best case” scenarios, described for other species).

8.1 Stressors

Rockfish are likely to be adversely affected by impingement and entrainment in CWIS; thermal, chemical, flow alteration, and indirect effects (such as prey reduction) are also likely to adversely affect rockfish.

8.2 Exposure

Applying the best available information to the three ESA-listed species, we expect larval and juvenile rockfish of 0 to 2 years to be impinged in CWIS because older rockfish are demersal and less likely to be impinged. We expect larval rockfish of up to 16 days of age to be entrained in CWIS. Impinged and entrained fish may be male or female. EPA does not identify the number of facilities that overlap with each species’ range. To estimate exposure, we mapped the facilities listed in the BE against species ranges in ArcGIS. We found that one facility overlaps with each species (Table 11). Using the best available information on rockfish impingement and entrainment, we calculated the expected annual impingement and entrainment mortality rates. In addition, individuals are likely to be exposed to thermal and chemical discharges, flow alteration, and indirect effects.

Table 11. Expected annual rockfish impingement and entrainment mortality at CWIS based on current information.

Puget Sound DPS	Overlapping facilities	Impingement	Entrainment
Bocaccio	1	406 – 1,360	23 – 1,120
Canary rockfish	1	406 – 1,360	23 – 1,120
Yelloweye rockfish	1	406 – 1,360	23 – 1,120

8.3 Response

Stressors that may affect ESA-listed pinniped species are entrapment and thermal discharges; indirect effects to prey species may also affect ESA-listed pinnipeds. General responses to these stressors are discussed below followed by subsequent species specific discussions.

8.3.1 Impingement

A study of fish impingement rates was conducted at four power-generating facilities: Ormond Beach in Oxnard, CA, Redondo Beach plant in Redondo Beach, CA, Huntington Beach plant in Huntington Beach, CA, and San Onofre in San Diego Count, CA. Samples were collected at least monthly for 17 years (1977 – 1993). A total of 27,546 impinged rockfish were counted during the study, with bocaccio and five other rockfish species accounting for 99 percent of this total (Love et al. 1998). These rockfish exhibit a range of habitat preferences and behaviors, indicating that they are representative of rockfish likely to be impinged by CWIS. In this study, impinged rockfish were between 0 and 2 years of age. Over the course of the study, overall impingement rates declined by at least two orders of magnitude, signifying severe declines in rockfish populations. By the end of the study period, bocaccio were no longer observed in the sample.

A similar study was conducted at the Moss Landing Power Plant in Moss Landing, CA, from 1979 to 1980 (Tenera 2007b). Data from the surveys was used to calculate the estimated concentration and estimated number of fish impinged per day. For bocaccio at all units, these estimates are 0.11/km^3 fish/intake volume and 194 fish/day. For other rockfishes (mainly five other species, not including bocaccio) at all units, these estimates are 0.0017/km^3 fish/intake volume and 3 fish/day. Bocaccio and rockfish were impinged throughout the year. Nearly all impinged bocaccio were young of the year; nearly all other impinged rockfish were juveniles (Tenera 2007b).

A similar study was conducted at the Morro Bay Power Plant in San Luis Obispo County, CA from 1977-1978. The number of impinged bocaccio was 1,104 individuals, which comprised seven percent of the total fish impingement. The number of impinged rockfish (not bocaccio) was 256 individuals, which comprised 1.6 percent of the total fish impingement. For all rockfishes, the estimated annual biomass was 187.62 grams per million cubic meter flow.

Comparing these datasets, annual impingement estimates are: 1,621 rockfish/year at the four power generators (406 rockfish/year/facility); 1,360 rockfish/year at Morro Bay; and 71,905 rockfish/year at Moss Landing plant in Moss Landing, CA. The last average is based on estimates, rather than total counts and is likely an overestimate. To simplify calculations, we estimate that an average CWIS facility is likely to impinge 1,000 rockfish annually. We assume that the rockfish will be 0 to 2 years in age (because older rockfish are demersal and less likely to be impinged). Finally, we assume that impinged rockfish are likely to be killed.

8.3.2 Entrainment

Table 12 shows the estimated annual entrainment rates of rockfishes (i.e., kelp, gopher, and black-and-yellow rockfishes) at Morro Power Plant in 2000 and at Diablo Canyon Power Plant in 1996 – 1997 (1996) and 1997 – 1998 (1997) (Tenera 2007a). They used the weekly sample data to calculate losses using the fecundity hindcast model, the adult equivalent loss model, and the empirical transport model (Table 12). The fecundity hindcast model describes the loss of reproductive output of adult females, and the empirical transport model describes the proportional mortality (Tenera 2007a).

Table 12. Annual estimated larvae entrainment rates and calculated loss of rockfish based on available information.

Facility	No. larvae	Annual entrained larvae	Age (mean/ max)	Fecundity hindsight (adult females)	Adult equivalent (adults)	Empirical transport (proportion mortality)
Morro 2000	360	6,407,000	5.5/11.3	13	23	0.027
Diablo 1996	17,576	275,000,000	6.4/16.4	617	1,120	0.039
Diablo 1997		222,000,000	6.4/16.4	497	905	0.048

Newborn larval rockfish (0 to 16 days) are likely to be entrained in CWIS. The number of estimated annual entrained larvae varies widely from 6 to 275 million larvae. This range likely reflects the location and characteristics of the CWIS, as well as natural variation in rockfish spawning. Entrained larvae are unlikely to survive.

8.3.3 Thermal Discharges

We were unable to find specific information on the effects of thermal discharges on rockfish. Elevated temperatures are linked to low levels of dissolved oxygen. Lethal low levels of dissolved oxygen are one of the most serious threats to the listed rockfish DPSs. Low dissolved oxygen has been found to result in the death of adult rockfish in Hood Canal (Palsson et al. 2009).

8.3.4 Chemical Discharges

While we were unable to find specific information on the effects of chemical discharges on rockfish, anoxic conditions and chemical contamination are also considered threats to rockfish recovery (NMFS 2008b).

8.3.5 Flow Alteration

Juveniles settle in nearshore habitats with sand, rock and/or cobble substrates, which provide adequate prey and protection from predators. To survive, rockfish need a specific type of substrate structure and rugosity to support feeding opportunities and predator avoidance. Changes in flow velocity and turbidity may alter the substrate.

8.3.6 Indirect Effects

Juvenile rockfish require a sufficient quantity and quality of prey items to survive. Such prey items include zooplankton (including crustaceans, polychaetes, and euphasiid eggs and larvae) and fishes (including rockfishes, hake, anchovies, etc.). These prey are likely to be impinged or entrained in CWIS.

8.4 Population and Species Level Effects

We do not have sufficient site specific information to complete the species level effects. Based on the limited information available we conclude that bocaccio, yelloweye rockfish, and canary rockfish will be directly and indirectly affected by CWIS.

8.5 Critical Habitat

Critical habitat designations have been proposed for the Puget Sound DPSs of bocaccio, canary rockfish, and yelloweye rockfish, but these do not overlap with CWIS.

9 Abalone

In the BE, EPA did not identify impingement and entrainment impacts to abalone; however, extensive adverse effects of CWIS on black abalone are documented in peer-reviewed scientific literature (Martin et al. 1977, Steinbeck et al. 1992, Neuman et al. 2010). The discharges from Diablo Canyon Power Plant have been linked to the mortality of black abalone (Martin et al. 1977, Steinbeck et al. 1992). Though NMFS issued a biological opinion in 2006 on NRC's approval of the continued operation of the Diablo Canyon Power Plant, this opinion did not describe effects on abalone, which were not listed under the ESA until 2009.

The Diablo Canyon Power Plant is a two-unit, nuclear-powered, steam-turbine power plant. It has one intake cove, housing a common intake structure, which provides cooling water to both units for the cooling of the main condensers and other machinery necessary for operation of the plant. The intake is a shoreline structure that houses bar racks, vertical traveling screens, auxiliary cooling water structures, and main circulating water pumps. On the ocean side of the intake structure, a concrete curtain wall extends approximately 2.4 m below mean sea level to prevent floating debris from entering the intake structure. As seawater enters the intake structure, it passes through one of 16 sets of bar racks designed to exclude large debris from the forebays. The bar racks consist of vertical, inclined rows of steel bars spaced about 8 centimeters (cm) apart. The underwater portion of the bar rack is approximately 10 m high depending on the tide. The overall intake opening is approximately 10 m high by 52.6 m wide.

The flow velocity of seawater is 0.3 m/sec. Sets of traveling screens with 0.95 cm stainless steel mesh screens are located behind the bar racks to remove smaller debris. The Diablo Canyon Power Plant normally operates at full power unless shut down for scheduled maintenance or refueling or for an unscheduled forced outage. During maintenance outages the circulating water pumps may be turned off for periods up to one month; however, usually one unit remains operational during these maintenance periods. During normal operations, four circulating water pumps (two for each unit) provide an average of 1,613 m^3/min, for a total of 6,450 m^3/min of ocean cooling water. The cooling water is returned to the ocean via stair-step weir structure that opens on the eastern end of Diablo Cove. At the discharge the water is usually 10 to 11°C warmer than the intake water. The maximum temperature rise allowed under the NPDES permit is 12°C. To help control biofouling of the CWIS, a combination of sodium hypochlorite and sodium bromide is injected into the water downstream of the traveling screens via a chlorine injection system. The chemicals are injected six times daily for 20 minutes per injection. The total residual oxidant concentration in the discharge stream is usually between 20 and 60 parts per billion (ppb), which is below the permitted level of 200 ppb allowed under the NPDES permit.

Copper discharged from the cooling system of Diablo Canyon Nuclear Power Plant resulted in heavy mortality to the adjacent red and black abalone populations (Martin et al. 1977). In 1988, mass mortality of black abalone occurred in association with warm water discharged from the facility (Steinbeck et al. 1992).

9.1 Stressors

Black and white abalone are likely to be adversely effected by several stressors caused by CWIS. These include: entrainment of gametes and larvae; thermal and chemical discharges; and degradations to the water quality of designated critical habitat.

9.2 Exposure

Black abalone occur from Point Arena, CA, to Bahia Tortugas and Isla Guadalupe, Baja California, Mexico. Black abalone are likely to be adversely affected by CWIS whose area of influence of the intake and/or discharge includes intertidal and shallow subtidal rocky habitat with crevices and cracks. We have determined that four facilities overlap with the range of black abalone.

White abalone occur from Point Conception, CA, to Punta Abreojos, Baja California, Mexico. White abalone are likely to be adversely affected by CWIS whose area of influence includes open low and high relief subtidal rock or boulder habitat interspersed with sand channels (NMFS 2008a). We have determined that 29 facilities overlap with the range of white abalone.

The adverse effects of entrainment, thermal discharge, and chemical discharges are likely to affect gametes, juveniles, and adults. These stressors are likely to affect a large proportion of the species or their annual recruitment, if the CWIS is located near abalone populations.

9.3 Response

Stressors that may affect ESA-listed pinniped species are entrapment and thermal discharges; indirect effects to prey species may also affect ESA-listed pinnipeds. General responses to these stressors are discussed below followed by subsequent species specific discussions.

9.3.1 Entrainment

Abalone gametes and fertilized eggs (prior to settlement) are likely to be entrained by CWIS. Black abalone may also be entrained at the larval stage, which lasts for approximately 1 to 2 weeks. Neuman et al. (2010) report that juveniles (settled and 10 to45-mm shell length) may also be entrained by power-generating facilities. Entrainment is likely to result in mortality (Neuman et al. 2010).

Abalone are broadcast spawners, releasing their gametes to the environment in synchrony. Fertilization is reliant upon dense adult aggregations and high gamete density. Below an adult threshold density, gametes released by males and females into the water column do not meet successfully because of limited gamete dispersal distances, exacerbated by the highly turbulent character of shallow ocean waters, and fertilization does not take place (Neuman et al. 2010). Depending on the environmental conditions in a given year, a facility withdrawing > 2 mgd of cooling water has the potential to entrain a high proportion of released gametes, leading to recruitment failure for that year. Though we are not aware of any such scenarios, it is unlikely that such a scenario would be detected without targeted monitoring. White et al. (2010) evaluated the consequences of larval entrainment in CWIS on benthic populations, using transport and spatial metapopulation models. They found that entrainment threatens the persistence of populations with reduced densities (i.e., endangered or threatened species). In scenarios involving extremely low settlement rates or reduced density adult populations (both apply to ESA-listed abalone species), entrainment led to population collapse (White et al. 2010). In the case of black abalone, accumulating evidence suggests that low reproductive success of widely dispersed adult populations coupled with short larval dispersal distances limits the recovery of severely reduced populations (Gruenthal and Burton 2008).

9.3.2 Thermal Discharges

In 1988, thermal discharges from the Diablo Canyon Power Plant increased water temperatures 11°C above ambient, resulting in an isolated outbreak of withering syndrome and a massive die-off of black abalone (Steinbeck et al. 1992). The heated water increases the incidence of the fatal disease, which has been identified as the primary threat to the species and continues to result in population decline (Raimondi et al. 2002). From first appearance of the signs of withering syndrome usually leads to rapid and dramatic declines in population size, most often in excess of 90 percent (Neuman et al. 2010). Temperature was indicated to be the single most important factor influencing population recovery (Tissot 1995). Thermal discharges are likely to increase the incidence and accelerate the spread of the disease (Raimondi et al. 2002), especially at temperatures over 18°C (Neuman et al. 2010). For black abalone, increased water temperatures are correlated with increased manifestation of the withering syndrome and accelerated mortality (Raimondi et al. 2002). Though white abalone are susceptible to withering syndrome in captive settings, no manifestations have been recorded in the wild.

Neuman et al. (2010) reported that power plant effluent is likely to result in the mortality or reduced growth of adults, juveniles, and larvae abalone; even moderate temperature increases are likely to be detrimental. Lab studies conducted at Diablo Canyon indicate that black abalone sperm become non-motile when released into waters above 27°C (Corporation et al. 1982). Black abalone optimum temperatures for early development (egg-to-larvae) range from 10 to 22°C (Tera Corporation 1982). In laboratory studies with white abalone the optimum temperature range for larval development and survival is 14 to18°C (Leighton 1972). Temperatures above these optimal ranges are likely to slow or terminate development. With acclimation, black abalone may survive temperatures of 29°C, and white abalone may survive temperatures 29°C; however, we consider their thermal tolerance to be 26.1 to 28°C and < 19°C, respectively (Tera Corporation 1982; Leighton 1972; unpublished data by Lafferty, cited in Hobday and Tegner 2000).

9.3.3 Chemical Discharges

Chemical discharges also adversely affect abalone. Toxic levels of copper discharged from the CWIS of Diablo Canyon Nuclear Power Plant were associated with red abalone and black abalone mortalities in a nearshore cove that received significant effluent flows (Martin et al. 1977). The median threshold lethal dose for adult red and black abalone were 65 ppb and 50 ppb Copper, respectively. The median threshold lethal dose for larval red abalone was 114 ppb Copper concentration. Histopathological abnormalities in gill tissues occur at concentrations above 32 ppb. A single toxic discharge, depending on where it occurs, could irreparably damage the few remaining viable populations of black abalone (Neuman et al. 2010).

9.3.4 Indirect Effects

CWIS are likely to entrain abalone food. In several locations, starvation, due to the reduced availability of drift algae, has also been documented (Lafferty and Kuris 1993). The reduced availability of food may increase susceptibility to withering disease (Raimondi et al. 2002).

9.4 Population and Species Level Effects

Based on the information above, entrainment and thermal discharges could contribute to recruitment failure. Neuman et al. (2010) explain that reduction in local densities below the threshold necessary for successful fertilization ($0.34/m^2$) has been a widespread and pervasive consequence of population reductions by withering syndrome and other factors. For example, at Diablo Canyon, the site of the mass mortalities due to CWIS, the density of newly recruited abalone declined to zero at an adult density of $0.32/m^2$ in 1997 (Neuman et al. 2010).

Throughout most of the species' range, local densities are less than the critical threshold density required for successful spawning and recruitment (Neuman et al. 2010). Long-term and large-scale datasets demonstrate an almost complete failure of recruitment to black abalone populations following mass mortalities due to withering syndrome (Miner et al. 2006). A lack of local larval production and dispersal limitation due to extremely localized dispersal of black abalone larvae may be the most plausible explanation for the lack of abalone recruitment to sites impacted by withering syndrome. Miner et al. (2006) conclude that the prospect of recovery of extirpated populations is poor due to a combination of documented recruitment failure and shifts in community composition away from habitat suitable for abalone.

Distant black abalone populations are not likely to seed those devastated by withering syndrome (Miner et al. 2006). Given the continued decline of most populations and the continued northward expansion of withering syndrome with warming events (Raimondi et al. 2002), we expect the trends of recruitment failure and population decline to continue. The black abalone is currently in danger of becoming extinct in the United States within the next 30 years, due to stressors that drive adult densities below values required for successful spawning and recruitment (Neuman et al. 2010). The most important of these stressors is the accelerated spread of and mortality caused by withering syndrome resulting from elevated water temperatures, which in at least one case was caused by thermal discharges from CWIS (Raimondi et al. 2002). According to Neuman et al. (2010), maximum levels of protection from other sources of mortality will be essential to maintain any prospect for recovery of black abalone while population-scale disease countermeasures are considered, developed, and implemented. Management actions that have the highest likelihood of helping to conserve and recover the species are those that reduce interactions between black abalone and anthropogenic sources of elevated sea surface temperatures, including CWIS, such that rates of withering syndrome transmission and disease-induced mortality may slow (Neuman et al. 2010).

Adverse impacts from CWIS have already resulted in mortalities of black abalone, reducing the viability of populations. White abalone are likely to be adversely affected in a similar manner, but without the catastrophic effects of withering syndrome. The black abalone has declined by more than 95 percent as a result of withering syndrome. Both species have experienced extreme declines, as a result of overexploitation. The resilience of both species to additional perturbations is low as a result of reduced population size and reduced recruitment.

In summary, both black and white abalone will be directly and indirectly affected by CWIS.

9.5 Critical Habitat

Black abalone critical habitat designation includes approximately 360 km^2 of rocky intertidal and subtidal habitat within five segments of the California coast between the Del Mar Landing Ecological Reserve to the Palos Verdes Peninsula, as well as on the Farallon Islands, Año Nuevo Island, San Miguel Island, Santa Rosa Island, Santa Cruz Island, Anacapa Island, Santa Barbara Island, and Santa Catalina Island. This designation includes rocky intertidal and subtidal habitats from the mean higher high water line to a depth of 6 m (relative to the mean lower low water line), as well as the coastal marine waters encompassed by these areas (76 FR 66806). The designated areas include the following physical feature that is essential to the conservation of the species: suitable water quality, including temperature, salinity, pH, and other chemical characteristics necessary for normal settlement, growth, behavior, and viability of black abalone. Black abalone critical habitat overlaps with at least one CWIS facility. As described above and in the designation (76 FR 66806), CWIS thermal discharges may raise water temperatures and introduce contaminants into the water. Elevated water temperatures have been linked to increased virulence of withering syndrome.

10 Corals

In the BE, EPA explains that they were unable to find data with which to evaluate whether coral species have been affected by existing CWIS and associated discharges. We performed a literature search to find any available information with which to evaluate the effects of CWIS on corals. We found information on the effects of CWIS on coral survival at the Tanguisson Power Plant in Guam (Birkeland et al. 1979) and at the Kahe Point Power Plant in Hawaii (Jokiel and Coles 1974, Coles 1984, Jokiel and Coles 1990, Richmond 1993). We also found extensive literature on the effects of elevated temperatures on corals. We found one relevant study on the entrainment of coral eggs and larvae. The study investigated the environmental impact of the CWIS at the Tanguisson Power Plant in Guam (Smith et al. 2005).

The Tanguisson Power Plant in Guam was not included in EPA's list of facilities that overlaps with species ranges or critical habitat because the BE did not include any facilities listed outside of the United States, though facilities in Territories are regulated under the Rule (with EPA as the permitting authority). The CWIS of the facility is located adjacent to the shore line northwest of the facility and draws water from the Philippine Sea (Smith et al. 2005). Its low intake velocity is 0.93 ft/sec in the channel and 1.55 ft/sec in the intake pipes. The cooling water is drawn through an intake channel cut through the reef margin and reef flat. The intake channel is 14 m wide and 2 m below the mean tide level. A retaining wall on either side of the channel flanks a portion of the intake, thus separating it from sections of the reef flat. We are not aware of ESA Section 7 consultations on the facility, nor has the facility received a Section 10 permit for incidental take. The facility has been working on an administratively extended permit from EPA since 2001. On September 30, 2010, EPA sent the facility a letter, identifying violations of the NPDES permit that included: failure to continuously monitor effluent flow, report toxicity, monitor temperature, or perform sampling and analysis. The facility appears to be typical of CWIS facilities, likely to be regulated under the Rule.

The Kahe Point Power Plant in Hawaii is an oil-fired steam electric generating station (Jokiel and Coles 1974). Cooling water for the plant is withdrawn from the ocean at the intake basin and is returned to the sea at an outfall located on a small beach. In 1971, three 90-megawatt generating units were in operation, drawing a total of approximately 14 m^3/sec (230,000 gallons per minute) of seawater for cooling purposes and discharging this water. A fourth unit of the same capacity was added in 1972, increasing the waste heat discharge rate by over 30 percent (Jokiel and Coles 1974). We are not aware of ESA section 7 consultations on the facility, nor has the facility received a section 10 permit for incidental take. The facility appears to be typical of CWIS facilities, likely to be regulated under the Rule.

10.1 Stressors

The following stressors are likely to adversely affect ESA-listed corals: entrainment of gametes and larvae, thermal discharges, and chemical discharges.

10.2 Exposure

In the BE, EPA estimates that staghorn and elkhorn coral are likely to be directly or indirectly affected by the CWIS of 16 facilities regulated under the Rule (EPA 2013). We determined that 28 facilities overlap with the ranges of staghorn and elkhorn coral. These facilities also overlap with many proposed coral species, including: pillar, boulder star, mountainous star, star, rough cactus, Lamarck's sheet, and elliptical star corals. Five facilities overlap with blue rice coral and sandpaper rice coral in Hawaii.

The BE did not include any facilities listed outside of the United States, though facilities in Territories are regulated under the Rule (with EPA as the permitting authority). For the purposes of this Opinion, we will assume that all proposed coral species overlap with at least one facility. Because we have no information on these facilities, we will assume that effects on proposed corals are likely to be similar to effects on listed corals.

10.3 Response

Stressors that may affect ESA-listed pinniped species are entrapment and thermal discharges; indirect effects to prey species may also affect ESA-listed pinnipeds. General responses to these stressors are discussed below followed by subsequent species specific discussions.

10.3.1 Entrainment

During sexual reproduction, corals release gametes during annual spawning events, which last for one or a few nights. Upon fertilization, planktonic planulae larvae form. Gametes or planulae larvae are likely to be entrained in CWIS. Smith et al. (2005) estimated entrainment rates by placing surface and bottom nets near the entrance of a CWIS. The collection did not occur during the large annual reproductive event that is characteristic of approximately 85 percent of the reef-building corals in Guam. Still, an estimated total of 13,144 eggs (of unknown origin) and 80 possible coral larvae were collected in a 24-hour period. Coral larvae were collected in both the surface and bottom nets. Though Smith et al. (2005) caution against using these values for statistical projections regarding the magnitude of entrainment, we provide some qualitative observations. First, coral eggs and larvae are likely to be entrained in CWIS in the vicinity of spawning corals. Second, the volume of water withdrawals from a single facility during a single 24-hour period is large: 127,363.16 m^3 of water passed through the surface net and 89,393.76 m3 passed through the bottom net. Finally, during the annual reproductive spawning event, we would expect egg and larval entrainment to be orders of magnitude higher than the observed values (e.g., hundreds of thousands or millions). We were unable to find information on the viability of entrained coral gametes; however, at least some coral larvae are likely to survive entrainment. Entrainment is proposed to be the principal mechanism promoting high coral recruitment near the offshore thermal outfall at the Hawaii facility (Coles 1984).

White et al. (2010) evaluated the consequences of larval entrainment in CWIS on benthic populations, using transport and spatial metapopulation models. They found that entrainment threatens the persistence of populations with reduced densities (i.e., endangered or threatened species). In scenarios involving extremely low settlement rates or reduced density adult populations, entrainment led to population collapse (White et al. 2010). Staghorn and elkhorn corals have experienced extreme density reductions (i.e., greater than 97 percent) and recruitment failures. Therefore, the entrainment of gametes or larvae of these and other proposed endangered species may result in population reductions. Coral species that are proposed for listing due to concerns for future effects of climate change are less likely have reduced densities or low settlement rates; therefore, we do not expect reductions in species viability as a result.

10.3.2 Indirect Effects

Indirect effects to corals could occur from thermal discharges and chemical discharges.

Thermal Discharges

Nearly all corals transplanted to the thermal effluent area at the Tanguisson Power Plant died (3 percent survival) and those surviving were in poor health (Birkeland et al. 1979); this was true even though transplanted species had relatively high thermal tolerances. The colonies lost their zooxanthellae and died within a few weeks, apparently due to the thermal effects (Birkeland et al. 1979).

Corals rely on symbiotic, photosynthesizing zooxanthellae for energy. When water temperatures exceed 29°C, the zooxanthellae begin to lose chlorophyll; at extreme temperatures, there is a mass expulsion of the zooxanthellae. This process is known as coral bleaching. Coral mortality rates, as a result of bleaching, depend on the species, temperature increase, and exposure time. Temperature increases of 4 to 5°C for 1 to 2 days result in extreme bleaching and 90 to 95 percent mortality rates. Temperature increases of 2 to3°C for 1 to 2 days result in less extensive bleaching and 0 to 10 percent mortality rates (Jokiel and Coles 1990).

The first quantitative measurements of photosynthetic pigmentation reduction (i.e., bleaching) were performed on corals that had been exposed to thermal effluent from a power station in Hawaii (Jokiel and Coles 1974). The abstract is as follows:

> “The effect of thermal enrichment on hermatypic corals was investigated at Kahe Point, Oahu, Hawaii. The reef off the Kahe Power Plant was surveyed before and after an increase in thermal discharge that accompanied plant expansion. Abundances of dead and damaged corals correlated strongly with proximity to plant discharge and with levels of thermal enrichment. Nearly all corals in water 4° to 5° C above ambient were dead.]n areas characterized by temperature increases from 2° to 4° C, the corals lost zooxanthellar pigment and suffered high mortality rates. Damage to the corals was most severe in late summer, and coincided with annual ambient temperature maxima. During the winter months the surviving corals slowly regained zooxanthellar pigment, but there was high mortality of corals during the recovery period. When generating capacity of the plant was increased from 270 to 360 megawatts, the area of dead and damaged corals increased from 0.38 hectare (0.94 acre) to 0.71 hectare (1.76 acre).”

The thermal effluent resulted in extensive coral mortality (Jokiel and Coles 1974). For Hawaiian coral species, 31 to 32°C is lethal, and prolonged exposure to 30°C will eventually pale, bleach, and kill most coral species. The percent abundance of dead, bleached, and pale corals is correlated with outfall discharge and increased discharge resulted in increased damage. Exposure to increased levels of thermal loading did not appear to kill the corals outright but gradually weakened and eliminated them over a period of time. Such sublethal effects bring into question the practice of using short-term tolerance limits to predict environmental damage (Jokiel and Coles 1974).

Coral reefs often recover from naturally occurring temperature disturbances, such as El Nino, but recovery of the coral community did not occur at the Hawaii site until the power plant outfall was redesigned and rebuilt (Richmond 1993; Coles 1984). After the construction of an offshore thermal outfall, recruitment rates increased ten-fold above surrounding areas (Coles 1984). This elevated recruitment was temporary at some sites, where recruitment declined to zero after several years (Coles and Brown 2007).

In Taiwan, the operation of a power facility led to two mass coral bleachings, one which bleached over 90 percent of the corals on the fringing reef due to thermal effluent of more than 4°C (31.9 to over 34 °C) and the other which bleached 30 percent of the corals living between 3 to 5 m depth (Hung et al. 1998).

Transplantation is not an effective method of establishing corals in a thermal effluent (Birkeland et al. 1979). While transplantation may be a mechanism for securing the survival of endangered coral population, transplantation to reestablish a large area of reef is exceedingly expensive and economically unfeasible (Birkeland et al. 1979).

Chemical Discharges

Chlorine is often found in the chemical discharges of CWIS. Chlorine bleach has a negative effect on coral reefs (Richmond 1993). Chlorine may contribute to the death of corals, either adults or larvae (DaVis 1971).

10.4 Population and Species Level Effects

There appear to be variable effects of CWIS. Offshore discharges without excessive thermal discharges aide in recruitment (Coles 1984); however, all other studies indicate that CWIS result in coral death (Jokiel and Coles 1974, Birkeland et al. 1979, Jokiel and Coles 1990, Smith et al. 2005).

Staghorn and elkhorn corals have experienced extreme declines in abundance, greater than 97 percent. These species are therefore susceptible to recruitment failure. The impingement of large numbers of gametes or larvae is likely to reduce annual recruitment and result in population collapse for endangered species. Thermal discharges from CWIS are likely to result in bleaching events, one of the primary and continuing causes of species decline. For all species, adult corals within the range of the thermal plume of facilities are also likely to be exposed to elevated water temperatures and resultant bleaching. Because population density is already low and recruitment is already reduced, these species are not resilient to additional perturbations.

In summary, staghorn and elkhorn corals will be directly and indirectly affected by CWIS.

10.5 Critical Habitat

Critical habitat has been designated for elkhorn and staghorn coral in the following four areas: Florida, Puerto Rico, St. John/St. Thomas, and St. Croix. These areas include the following feature, which is essential to the conservation of corals: substrate of suitable quality and availability to support successful larval settlement and recruitment, and reattachment and recruitment of fragments. For purposes of this definition, ‘‘substrate of suitable quality and availability’’ means natural consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover. Though critical habitat overlaps with five CWIS facilities (within 1 km of the facility), their discharges are not likely to adversely affect hard substrate or dead coral skeleton. Therefore, the promulgation of the Rule under 316(b) of the Clean Water Act is not likely to result in destruction or adverse modification of critical habitat.

11 Johnson's Seagrass

In the BE, EPA identifies Johnson's seagrass as a species potentially affected by the proposed action. We are not aware of any biological opinions or permits that have evaluated the effect of CWIS on Johnson's seagrass; however, the effects of CWIS discharges on seagrasses are well documented in peer-reviewed scientific literature. As described in more detail below, the thermal discharges from CWIS have resulted in seagrass denuding and population decline in Florida (Roessler 1971, Thorhaug et al. 1978, Thorhaug 1979) and other areas (Robinson 2010).

11.1 Stressors

In the BE, EPA identifies the following stressors associated with the proposed action: thermal discharge, chemical discharge, flow alteration, and indirect effects. We agree that these stressors are likely to adversely affect Johnson's seagrass.

11.2 Exposure

Three CWIS facilities overlap with the range of Johnson's seagrass.

11.3 Response

Stressors that may affect Johnson's seagrass are thermal discharge, chemical discharge, flow alteration, and indirect effects.. General responses to these stressors are discussed below followed by subsequent species specific discussions.

11.3.1 Thermal discharge

Though we could not find information on the effect of CWIS on Johnson's seagrass, we found information on the adverse effects of CWIS on other seagrass species. Johnson's seagrass is likely to be similarly affected. Seagrass declines in Florida have been directly attributed to temperature increases, as a result of thermal discharges from CWIS (Roessler 1971, Thorhaug et al. 1978, Thorhaug 1979). Sustained temperatures increases of 5°C denude seagrass communities and increases of 4°C cause severe damage (Thorhaug et al. 1978). Roessler (1971) explains that thermal discharges from a power plant in Biscayne Bay caused seagrasses to be replaced by algal mats. Such damage is likely to increase over time. Roessler and Zieman (1969) report that although thermal discharge from the Turkey Point Power Plant in Biscayne Bay remained constant during the period from September 1968 to September 1969, damage to the shallow water Thalassia (turtle grass) community increased. In September 1968, an area of 12 to 14 hectares (30 to 35 acres) off the outfall was devoid of all vegetation except bluegreen algae. Surrounding this was an area of approximately 20 to 24 hectares (50 to 60 acres) where all macroalgae had been eliminated and the Thalassia heavily damaged. By September 1969 the barren area had increased to about 20 hectares (50 acres) and the surrounding damaged areas to 38 to 39 hectares (70 to 75 acres) (Roessler and Zieman 1969).

Thorhaug (1979) demonstrates that seagrass beds denuded by the thermal effects of CWIS are not likely to reseed themselves, but instead, require restoration. In other areas, CWIS lead to a total loss of seagrass, including the extirpation of species (Robinson 2010). CWIS reduce the species diversity, abundance, and density of seagrasses; such losses are likely due to increases in turbidity and temperature (Robinson 2010). Therefore, thermal discharges as a result of CWIS, are likely to reduce the abundance and distribution of Johnson’s seagrass.

11.3.2 Chemical Discharge

CWIS often use chlorine to clean their systems and reduce unwanted biological growth. Chlorine bleach (sodium hypochlorite) kills seaweed and seagrasses, and is often used to eradicate these species (Williams and Schroeder 2004). Copper, which is also released in CWIS discharges, adversely affects several seagrass species. Copper toxicity in seagrasses inhibits metabolic activity, interferes with vital pathways including photosynthesis, and reduces growth and development (Prange and Dennison 2000).

11.3.3 Flow Alteration

Flow alteration may effect seagrass as a result of increased turbidity (Robinson 2010). Increased turbidity reduces light levels in the environment and limits photosynthesis. For example, the San Onofre Nuclear Generating Station creates a turbid plume that moves over a kelp bed, reducing light and increasing the flow of particles near the substrate, which adversely affects early stages (Ambrose 1994). Unlike kelp, seagrasses store minerals in rhizomes; however, sustained periods of light deprivation are likely to result in large losses. Therefore, flow alteration as a result of CWIS is likely to reduce the fitness of Johnson’s seagrass.

11.3.4 Indirect Effects

CWIS lead to extreme modifications in community structure, including an increase in the numbers of grazing gastropods, likely as a result of increased water temperatures and current flow (Robinson 2010). These grazing gastropods contribute to the loss in density and occurrence of seagrasses.

11.4 Population and Species Level Effects

The distribution of Johnson’s seagrass is characterized as patchy, disjunct, and temporally fluctuating; its ability to repopulate an area after anthropogenic or natural disturbances is limited (69 FR 49035). The major threats to its survival and recovery include altered water quality and siltation. Given its limited distribution and inability to quickly repopulate, the species’ is expected to have little resilience to further perturbations. As described above, the thermal discharges from one facility have resulted in the denuding of seagrass beds; therefore, the thermal discharges from three facilities are likely to result in the denuding of three areas of Johnson’s seagrass, and the overall decline of the species. Chemical discharges of three facilities are likely to reduce the viability of local seabeds. Flow alterations of three facilities are likely to increase turbidity and reduce photosynthesis, resulting in fitness losses throughout the species.

While additional individual impacts may continue to occur, over the last decade the species has not demonstrated any declining trends. The proposed action will not reduce or destabilize the present range of Johnson's seagrass.

In summary, Johnson’s seagrass will be directly affected by CWIS.

11.4.1 Critical Habitat

Designated critical habitat does not overlap with any CWIS facility likely to be regulated under the Rule. All CWIS facilities are located at least 8 km from designated Johnson's seagrass critical habitat. Therefore, the promulgation of the Rule under 316(b) of the Clean Water Act is not likely to result in destruction or adverse modification of critical habitat.

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Appendix D

Example of Species Specific

Control Measures, Monitoring, and Reporting.

Example Species Specific Control Measures Control Measures

1.0 Cetaceans

If Southern Resident killer whales or Cook Inlet beluga whales may occur within the area(s) directly or indirectly affected by your cooling water intake structure(s), you must:

1.1) Implement the requirements as described for salmonids (see 7.0)

2.0 Pinnipeds

If ESA-listed seals, sea lions, or fur seals or their designated critical habitat may occur within the area(s) directly or indirectly affected by your cooling water intake structure(s), you must:

2.1) You must contact the NMFS Regional Office to determine whether you need to apply for a Marine Mammal Protection Act permit.

2.2) Install large organism exclusion devices, having a distance between exclusion bars of no greater than nine inches; and

2.3) Monitor the intake structure(s) at least every 4 hours (unless otherwise determined by the NMFS Regional Office) for the presence of pinnipeds. In the event a pinniped is found in the intake structure, you must:

- Observe the animal to determine if it has any injuries or appears stressed or unhealthy.
- Immediately contact the NMFS Regional marine mammal stranding coordinator and follow their instructions
- Gather and record information on the animal, including the species, size, condition (dead, injured, or healthy/released). Also record any tags or markings and include photos of the animal in the intake structure. Enter this information on a Marine Mammal Stranding Report Form, which must be submitted to the NMFS Regional marine mammal stranding coordinator within 48 hours of discovery. Also enter this information in your annual incidental take report, which must be submitted to the NMFS Regional Office, NMFS Office of Protected Resources, and Director.
- For healthy, sick, or injured pinnipeds, follow the procedure in 2.4.
- For dead pinnipeds, follow the procedure in 2.5.

2.4) If a live pinniped is impinged, entrapped, or entrained, you must contact and follow the instructions of the NMFS Regional marine mammal stranding coordinator. You must take all measures necessary to enable the pinniped to swim out of the intake structure on its own (e.g., reduce flow, turn off pumps, or close cover to intake wells so that sunlight enters only through the intake entrance). You must continue to monitor the pinniped every 15 minutes until it leaves or is released. Do not attempt to capture or handle the pinniped unless you are instructed to do so by the Regional marine mammal stranding coordinator. If you are instructed to capture or handle the pinniped, you must follow the instructions provided by the NMFS Regional marine mammal stranding coordinator.

2.5) If you observe a dead pinniped in the area(s) directly or indirectly affected by your cooling water intake structure(s), you must contact and follow the instructions of NMFS Regional marine mammal stranding coordinator. You must follow the NMFS Regional marine mammal stranding coordinator's protocols for collecting, storing, and transporting the carcass for necropsy. If instructed to do so, you must follow the NMFS Regional marine mammal stranding coordinator's protocol for sampling and disposing of the carcass.

3.0 Sea Turtles

If Federally-listed sea turtles or their designated critical habitat (e.g., prey) may occur within the area(s) directly or indirectly affected by your cooling water intake structure(s), you must:

3.1) Install large organism exclusion devices, having a distance between exclusion bars of no greater than nine inches; and

3.2) Monitor the intake structure(s) at least every 4 hours (unless otherwise determined by the NMFS Regional Office) for the presence of sea turtles. In the event a sea turtle is found in the intake structure, you must:

- Observe the turtle to determine if it has any injuries or appears stressed or unhealthy.
- Immediately contact the NMFS Regional sea turtle stranding coordinator and regional stranding network center and follow their instructions
- Gather and record information on the turtle, including the species, size, condition (dead, injured, or healthy/released). Also record any tags or markings on the turtle and include photos of the turtle in the intake structure. Enter this information on a Sea Turtle Stranding Report Form and submit to the sea turtle stranding coordinator and NMFS Regional Office within 48 hours. Also enter this information in your annual incidental take report, which must be submitted to the NMFS Regional Office, NMFS Office of Protected Resources, and Director.
- For healthy turtles, follow the procedure in 3.3.
- For sick or injured turtles, follow the procedure in 3.3, and 3.4, if instructed to do so.
- For dead turtles, follow the procedure in 3.5.
- For hatchlings, you must contact the NMFS Regional Office for additional requirements and instructions.

3.3) If a live sea turtle is impinged, entrained, or otherwise adversely affected, you must contact and follow the instructions of the NMFS Regional sea turtle stranding coordinator and regional stranding network center. You must take all measures necessary to enable the sea turtle to swim out of the intake structure on its own (e.g., reduce flow, turn off pumps, or close cover to intake wells so that sunlight enters only through the intake entrance). You must continue to monitor the turtle every 15 minutes until it leaves or is released. Do not attempt to capture or handle the sea turtle unless you are instructed to do so by the NMFS Regional sea turtle stranding coordinator and regional stranding network center. If you are instructed to capture or handle the sea turtle, you must follow the following guidelines or other instructions provided by the NMFS Regional sea turtle stranding coordinator or the regional stranding network center:

3.3.1. All sea turtles should be handled with care.

3.3.2. Pick up sea turtles by the front and back of the top of the carapace or by the flippers. Do not pick up sea turtles by the head or tail.

3.3.3. Dip nets, cargo nets, and other equipment should be used to lift and move turtles whenever possible.

3.3.4. If a sea turtle is actively moving, it should be released (only if healthy) or picked up by the NMFS Regional stranding coordinator or regional sea turtle stranding network center.

3.4) To resuscitate a comatose (non responsive) turtle, follow the following guidelines (50 CFR 223.206(d)(1):

3.4.1. Place the animal on its bottom shell (plastron) so that the turtle is right side up.

3.4.2 Elevate the hindquarters at least 6 inches for a period no less than 4 hours and no more than 24 hours.

3.4.3. A reflex test, performed by gently touching the eye and pinching the tail, must be administered at least every 3 hours to determine if the sea turtle is responsive.

3.4.4. Keep the turtle in a safe, contained place, shaded and moist (e.g., with a watersoaked towel over the eyes, carapace, and flippers). Observe the turtle for up to 24 hours.

3.4.5 If the turtle begins actively moving, do not release the turtle until the stranding coordinator or rehabilitation center can evaluate it.

3.4.6. If the turtle fails to move within 24 hours, it should be transported to the NMFS stranding coordinator or rehabilitation center for necropsy.

3.5) If you observe a dead sea turtle the area(a) directly or indirectly affected by your cooling water intake structure(s), you must contact and follow the instructions of the NMFS Regional sea turtle stranding coordinator, which may include contacting a sea turtle rehabilitation center. You must follow the NMFS stranding coordinator or rehabilitation center’s protocols for collecting, storing, and transporting the carcass for necropsy. If instructed to do so, you must follow the rehabilitation center’s protocol for sampling and disposing of the carcass.

If leatherback sea turtle designated critical habitat may occur within the area(s) directly or indirectly affected by your cooling water intake structure(s), you must:

3.8) Conduct monitoring studies to determine if jellyfish (e.g., larvae, polyps, medusa) are being entrained or impinged by your cooling water intake structure and provide this information to the appropriate NMFS Regional Office on an annual basis. Monitoring should:

- Be conducted between May 1st and November 30th or otherwise based on the timing and mode of local jellyfish blooms within designated critical habitat.

- Identify planula, polyps, and medusa to the lowest taxonomic level possible.
- Annual reports should include descriptions of weekly, monthly, and annual estimates of jellyfish entrainment across life stages.
- Annual reports should include a complete description of the methodology used to estimate jellyfish entrainment.

4.0 Sawfish

If Federally-listed sawfish may occur within the area(s) directly or indirectly affected by your cooling water intake structure(s), you must:

4.1) Install large organism exclusion devices, having a distance between exclusion bars of no greater than nine inches; and

4.2) Monitor the intake structure(s) at least every 4 hours (unless otherwise determined by the NMFS Regional Office) for the presence of sawfish. In the event a sawfish is found in the intake structure, you must:

- Observe the sawfish to determine if it has any injuries or appears stressed or unhealthy.
- Immediately contact the NMFS Regional Office and follow their instructions
- Gather and record information on the sawfish, including the species, size, condition (dead, injured, or healthy/released). Also record any tags or markings and include photos of the sawfish in the intake structure. Record this information in your annual incidental take report, which must be submitted to the NMFS Regional Office, NMFS Office of Protected Resources, and Director.
- For live sawfish, follow the procedure in 4.3.
- For dead sawfish, follow the procedure in 4.4.

4.3) If a live sawfish is impinged, entrapped, or entrained, you must contact and follow the instructions of the NMFS Regional Office. You must take all measures necessary to enable the sawfish to swim out of the intake structure on its own (e.g., reduce flow, turn off pumps, or close cover to intake wells so that sunlight enters only through the intake entrance). You must continue to monitor the sawfish every 15 minutes until it leaves or is released. Do not attempt to capture or handle the sawfish unless you are instructed to do so by NMFS. If you are instructed to capture or handle the sawfish, you must follow the following guidelines or other instructions provided by NMFS:

4.3.1. All sawfish should be handled with care.

4.3.2. Pick up sawfish at the center of the body. Do not pick up sawfish by the head or tail.

4.3.3. Dip nets, cargo nets, and other equipment should be used to lift and move sawfish whenever possible.

4.3.4. If a sawfish is actively moving, it should be released

4.4) If you observe a dead sawfish the area(a) directly or indirectly affected by your cooling water intake structure(s), you must contact and follow the instructions of NMFS. You must follow NMFS' protocols for collecting, storing, and transporting the carcass for necropsy. If instructed to do so, you must follow NMFS' protocol for sampling and disposing of the carcass.

4.5) For juvenile sawfish, you must also:

4.5.1 Use diversion structures near the intake canal to block sawfish from entering the cooling water intake structure.

4.5.2 Use mechanisms to reduce approach-flow velocity (i.e., the V-shaped screen) that will allow sawfish to avoid impingement on their own power should they make it into the canal.

4.5.2 Monitor diversion structure on a daily basis.

5.0 Abalone

5.0 Abalone

If Federally-listed abalone, their designated critical habitat, or habitats suitable for abalone (e.g., rocky intertidal or subtidal habitats within the depth range of the species) occur within the intake or discharge structure's area of impact (including within XX meters of the area of impact), you must:

5.1) Conduct a benthic and/or intertidal habitat characterization study within the area affected by your cooling water intake structure and discharge, and submit this information along with your NPDES permit application. This benthic habitat characterization study should include the following information:

5.1.1. A map of the study area, indicating the area of impact for the intake and/or discharge structure(s).

5.1.2. Substrate type and extent and distance from intake/discharge

5.1.3. Water depth (for subtidal studies)

5.1.4. Water temperature

5.1.5. Current patterns

5.1.6. Observation of abalone individuals in the study area, including but not limited to:

5.1.6.1. Identification of abalone species and their location

5.1.6.2. Enumeration of the number of individuals by species and the estimated shell length, habitat type (e.g., in a crevice, on open vertical or horizontal surface), and nearest neighbor distance (e.g., distance to the nearest other abalone) for each individual.

5.1.6.3. Identification of abalone aggregations (i.e., two or more individuals with nearest neighbor distances measuring two meters or less), including the number of individuals in the aggregation and the location of the aggregation.

5.2) Conduct an entrainment risk modeling study to determine the risk of federally-listed abalone (e.g., larvae) being entrained by your cooling water intake structure, and submit this information along with your NPDES permit application.

5.3) Monitor entrainment of federally-listed abalone (e.g., larvae) and provide reports to the appropriate NMFS Regional Office according to the schedule specified below. Monitoring should be based on the timing and mode of abalone spawning appropriate to the listed species present in the area affected by the intake and/or discharge structure(s).

5.3.1. Monitoring schedule: Monitoring for entrainment of abalone (e.g., larvae) is to be conducted at least twice a week during the months of March and August (peak spawning months for black abalone and white abalone, respectively) and at least once a week during the months of February, April, July, and September (white abalone spawning: February – April; black abalone spawning: July – September. Monitoring methods must be appropriate to ensure adequate and representative sampling of the intake water and entrainment of abalone.

5.3.2. Reporting schedule: During the entrainment monitoring period (February – April and July – September), weekly reports must be submitted to the appropriate NMFS Regional Office (electronic submissions are acceptable). An annual report must be submitted to the appropriate NMFS Regional Office by December 31 of each calendar year. Weekly reports should describe monitoring and analysis methods, abalone entrainment results (see 5.3.3. and 5.3.4. below), and relevant information regarding the facility's operations for the monitoring period. Annual reports should include a summary of the monitoring and analysis methods, abalone entrainment results, and relevant information regarding the facility's operations throughout the entrainment monitoring period for that year (e.g., water temperature data, spatial analysis of the water masses affected by intake and discharge, and data on other species entrained, particularly other invertebrate larvae).

5.3.3. Monitoring and estimation of abalone entrainment: As technologies allow, monitoring should include:

5.3.3.1. Identification of larvae to the lowest taxonomic level possible. It is recognized that currently taxonomic identification is limited, but advances in genetic studies, marker development, or other techniques may allow identification in the near future.

5.3.3.2. Enumeration of abalone larvae, and estimation of the number of abalone larvae entrained over the monitoring period (e.g., weekly, annually).

5.3.4. If identification and/or enumeration of abalone larvae is not feasible given currently available technologies or methods, then entrainment of abalone larvae may be estimated by:

5.3.4.1. Conducting a survey of the invertebrate community in the area of impact to determine the proportion of abalone compared to other invertebrates that overlap in spawning seasons.

5.3.4.2. Monitoring entrainment to enumerate invertebrate larvae and estimate the number of invertebrate larvae entrained over the monitoring period (e.g., weekly, annually).

5.3.4.3. Estimating the number of abalone larvae entrained (by species) over the monitoring period, based on the proportion of abalone in the invertebrate community within the area of impact.

5.4) If the average estimated weekly entrainment of abalone larvae (by species) exceeds 99.9% of the veliger potential (see 5.4.1. below) for the adult abalone population in the area of impact, your facility must reduce intake volumes to reduce the estimated average weekly entrainment of abalone larvae to be less than this level. You also must contact the appropriate NMFS Regional Office within one day of exceeding 99.9% of the veliger potential.

5.4.1. Veliger potential: The estimated number of veligers produced from a spawning event involving all adult abalone (by species) within the area, assuming (a) the ratio of females to males in the population is 1:1; (b) each individual spawns once per year; (c) each female can release 4 million eggs per spawning event; and (d) natural mortality from the egg to veliger stage is 99.9%.

5.5) Monitor the effects of the discharge on the abalone community and recruitment as follows and submit annual reports to the appropriate NMFS Regional Office.

5.6) Ensure that discharges do not increase water temperatures where any Federally-listed abalone may be found, including available suitable habitat in the area of impact, above the maximum thermal threshold identified under 5.6.1. and 5.6.2 below. Quarterly monitoring reports must be submitted to the appropriate NMFS Regional Office that describe the temperature monitoring methods, results, and relevant information on the facility's operations for the monitoring period.

5.6.1. Ensure discharges do not increase water temperatures by more than 2°C above ambient water temperatures where any Federally-listed abalone may be found, including available suitable habitat within the facilities' area of impact.

5.6.2. Ensure discharges do not increase water temperatures above a maximum of 23°C for facilities south of Point Conception, CA, or 20°C for facilities north of Point Conception, CA where any Federally-listed abalone may be found, including available suitable habitat within the facilities' area of impact

5.7) Establish replicate monitoring sites (e.g., transects, quadrats), using non-invasive, scientifically acceptable methods to monitor abalone demographics and recruitment. Experimental design should include sites within the area of influence of the discharge and an equal number of replicate sites in comparable habitat (e.g., substrate type, currents, depth, abalone presence) outside of the area of influence of the discharge. Sites should be monitored every 4 to 6 months.

5.7.1. Annual reports must include a description of the monitoring methods; a map and description of the monitoring area and sites; the number and estimated size of individual abalone (by species); the location, habitat (e.g., crevice or open vertical/horizontal surface), depth (for subtidal species), and nearest neighbor distance for each individual abalone; identification of abalone aggregations; and an evaluation of the health of each individual abalone via visual assessment (e.g., note signs of withering syndrome disease, such as a withered and discolored foot muscle or an inability to hold on to the substrate) and/or collection and analysis of fecal samples. Facilities must contact the appropriate NMFS Regional Office and follow the guidelines or instructions regarding protocols for sample collection.

5.7.2. Dead or obviously dying abalone must be collected and placed in a plastic bag (one individual per bag) labeled with the date and location of collection and immediately frozen or preserved as instructed by pathologists. Discovery of the dead or obviously dying abalone must be reported to the appropriate NMFS Regional Office as soon as possible and provide the location(s) and potential cause(s) of the mortality or mortalities. Facilities must follow the guidelines or instructions from the appropriate NMFS Regional Office regarding collection, preservation, and transport protocols.

If Federally-listed juvenile and/or adult abalone are found to be impinged, entrained or otherwise adversely affected, you must:

5.8) Immediately contact the appropriate NMFS Regional Office immediately, and follow the guidelines or instructions provided.

6.0 Corals

If Federally-listed corals or their designated critical habitat may occur within the area(s) directly or indirectly affected by your cooling water intake structure(s), you must use scientifically acceptable (e.g., published in scientific journals) methods to:

6.1) Conduct a benthic habitat characterization study of the immediate area extending 50 x 50 meters from your cooling water intake structure. This benthic habitat characterization study should include the following information:

6.1.1. Substrate type and extent
6.1.2. Water depth
6.1.3. Water temperature
6.1.4. Current patterns
6.1.5. Identification of coral species and coral coverage in the study area
6.1.6. Coral demographics (size-class structure) in the study area

6.2) Conduct plankton collection studies, using either towed or stationary nets, of the immediate area within 20 m from cooling water intake structure. Studies should be based on timing and mode of coral spawning appropriate to the listed species present.

6.2.1. Identify eggs (gametes) and larvae to the lowest taxonomic level possible (It is recognized that currently taxonomic identification is limited but advances are expected in genetic bar-coding studies, marker development, or other techniques that should allow identification in the near future.)

6.2.2. Enumerate coral eggs and larvae, as technologies allow.

6.3) Contact and coordinate with the appropriate NMFS Regional Office.

If NMFS determines your facility has a high risk for entrainment of federally listed coral species, you must:

6.4) Conduct on-going studies to determine the effect of cooling water intake on coral community and recruitment.

6.4.1. Monitor effects on coral populations.

6.4.1.1. Establish replicate benthic quadrats (i.e., 10 m radius) using scientifically acceptable methods to monitor coral demographics and recruitment. Experimental design should include at least three replicates within 25 m of intake and an equal number of replicates in comparable habitat (e.g., currents, depth, coral composition/cover) at a distance greater than 100 m. Quadrats should be monitored every 4-6 months.

6.4.1.2. Variation in coral size structure or recruitment rates/success between control and impacted quadrats in excess of 25% should be reported to the appropriate NMFS Regional Office.

6.4.2. Conduct an entrainment study to determine if federally listed corals (i.e., coral fragments, gametes, or larvae) are being entrained by your cooling water intake structure (Technological considerations mentioned in 6.2.1, above, apply.)

If Federally-listed coral species are found to be entrained or otherwise adversely affected, you must:

6.5) Contact the appropriate NMFS Regional Office immediately.

7.0 Larval fishes (bocaccio, eulachon, rockfish, larval sturgeon)

If Federally-listed bocaccio, eulachon, rockfish, or sturgeon larval-stage fishes or their designated critical habitat may occur within the area(s) directly or indirectly affected by your cooling water intake structure(s), you must implement the attached screen guidelines, as described in the July 2011 Fish Facilities Technical Team Bay Delta Conservation Plan.

7.1. Use the most biologically protective fish screen concepts as the foundation of the proposed designs, as determined by the NMFS Regional Office.

7.2. Operate at an approach velocity of 0.2 ft/s.

7.3. Required sweeping velocities should be measured adjacent (within twelve inches) to the screen face and should be equal to or greater than the approach velocity criterion (i.e., 0.2 ft/s or greater).

7.4. Target the height of fish screen panels to fifteen feet of submerged screen height to operate at 0.33 ft/s approach velocity at low river stage; taller screens may be appropriate at specific sites for purposes of reducing the length of the diversion structure. If the screens are constructed 40% taller (additional 6 feet), when the river stage exceeds the design minimum, the extra water depth will allow increased diversion capacity while meeting a 0.2 ft/s approach velocity (during critical times when fish are present). Further refinement of the relationship between screen height and river stage should be addressed during an optimization process associated with final design.

7.5. Bottoms of screen panels should be elevated three to five feet off the existing river bottom to minimize sediment and bed load impacts, and to limit exposure to benthic-oriented fish species. In the Atlantic, where sturgeon are present but salmon are not, locate the screens in shallow waters. In the Atlantic, where salmon are present but sturgeon are not, locate the screens in deep waters. Where both species are present, contact the NMFS regional Office regarding screen location.

7.6. An approximate distance of 100 feet for spacing between refugia is suggested however, final refugia spacing should be further evaluated prior to final design. In order to optimize design, construction, operations and maintenance, the refugia should be modular systems that may be installed in any fish screen slot.

7.7. Flow control baffles should allow diverted flow to be distributed vertically as well as horizontally along the screen face to distribute flow evenly over all operating screen area. Dynamic baffling should be considered to automatically regulate flow through discrete portions of the screen. Selective withdrawal to allow water to be diverted from selected areas of screen (vertically or horizontally) should also be considered.

8.0 Anadromous salmonids and adult sturgeon

If Federally-listed anadromous salmonids or sturgeon, or their designated critical habitat may occur within the area(s) directly or indirectly affected by your cooling water intake structure(s), you must implement the design criteria identified in the latest Anadromous Salmonid Passage Facility Design guidelines and coordinate with the appropriate NMFS Regional Office.

In addition, for Atlantic salmon and sturgeon, site location will play an important role in selecting criteria:

8.1 Facilities should use 3 inch trash rack spacing, in addition to screening requirements required by the NMFS Regional Office.

8.2 Facilities located in upstream freshwater tidal portions of a river must address impingement <u>and</u> entrainment of eggs/larvae, as well as impingement of older life stages, as determined in coordination with the appropriate NMFS Regional Office.

8.3. Facilities in lower brackish-saline stretches of tidal rivers and in marine habitat must address impingement of older life stages but do not need to address eggs/larvae, as they cannot survive saline conditions.

For sturgeon you must also:

8.4 Use diversion structures near the intake canal to block sturgeon from entering the cooling water intake structure.

8.5 Use mechanisms to reduce approach-flow velocity (i.e., the V-shaped screen) that will allow sturgeon to avoid impingement on their own power should they make it into the canal.

8.6 Use full time staff to maintain (i.e., inspect, clean, and repair) the diversion structure on a daily basis.