Designation of Critical Habitat for the threatened Southern Distinct Population Segment of North American Green Sturgeon

Final Biological Report

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October 2009

U.S. Department of Commerce
National Oceanic and Atmospheric Administration

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EXECUTIVE SUMMARY

Section 4 of the Federal Endangered Species Act requires the designation of critical habitat for threatened and endangered species. This report contains a biological assessment in support of a final critical habitat designation for the threatened Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*; hereafter, "Southern DPS"). A critical habitat review team (CHRT) consisting of 9 Federal biologists was convened to evaluate critical habitat for the Southern DPS. The CHRT was tasked with compiling and assessing the best available data to identify habitat features essential to the conservation of the species, determine the geographical area occupied by the species, delineate specific areas within the geographical area occupied that contain at least one essential habitat feature, identify special management considerations or protections required within each area, and evaluate the conservation value of each specific area for the Southern DPS. The CHRT defined the geographical area occupied to range from the California/Mexico border north to the Bering Sea, AK. Within the geographical area occupied, 41 specific areas were delineated within freshwater rivers, coastal bays and estuaries, and coastal marine waters. The CHRT also identified 7 presently unoccupied areas that may be essential to conservation, but for which there is insufficient information at this time to determine whether any are essential for conservation. This report summarizes the available data on green sturgeon presence, distribution, and use of each specific area and the CHRT's evaluation of the conservation value ratings for each area.

The assessment and findings provided in this report inform the analysis of the biological conservation benefits of designating each area as critical habitat for the Southern DPS. A separate economic analysis report (*Industrial Economics Inc. 2009*) was prepared to analyze the economic impacts of designating critical habitat within each area. To determine which areas to designate as critical habitat, the biological conservation benefits of designation were weighed against the economic impacts and other relevant impacts (i.e., impacts to national security and tribal lands) of designation. This weighing process and analysis was documented in the ESA 4(b)(2) report (*NMFS 2009b*) to support NMFS' final critical habitat designation.

ACKNOWLEDGEMENTS

NMFS gratefully acknowledges the commitment and efforts of the following CHRT members. NMFS thanks them for generously contributing their time and expertise to the development of this biological report in support of the green sturgeon critical habitat designation.

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We also wish to thank numerous individuals who contributed information and aided in the preparation of this report, particularly these individuals from the NMFS Southwest Region: Diane Ashton, Doug Chow, Matt Dorsey, Charleen Gavette, Doug Hampton, and Jennifer Morrison.

Finally, we thank the three peer reviewers whose review and comments added to the quality and clarity of this report: Dan Erickson (Oregon Department of Fish and Wildlife, Newport, OR), Josh Israel (UC Davis Dept. of Animal Science, Davis, CA), and Joel Van Eenennaam (UC Davis Dept. of Animal Science, Davis, CA).

BACKGROUND

On April 7, 2006, NMFS determined that the Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*; hereafter, "Southern DPS") is at risk of extinction in the foreseeable future throughout all or a significant portion of its range and listed the species as threatened under the Endangered Species Act (ESA) (71 FR 17757). The ESA requires NMFS to designate critical habitat for threatened and endangered species. To prepare the critical habitat designation for the Southern DPS, a critical habitat review team (CHRT) was convened, consisting of 9 biologists from NMFS and other Federal agencies with experience working on green sturgeon-related research and management issues, or experience in developing a critical habitat designation. The CHRT reviewed and summarized available information on green sturgeon, including recent biological surveys and reports, peer-reviewed literature, NMFS status reviews for green sturgeon (*Moyle et al. 1992; Adams et al. 2002; Biological Review Team (BRT) 2005*), and the proposed and final listing rules for green sturgeon (70 FR 17386, April 6, 2005; 71 FR 17757, April 7, 2006). The CHRT used this information to identify and evaluate critical habitat for the Southern DPS. This report contains a biological assessment of the life history, movements, and habitat use of the Southern DPS to support a final critical habitat designation for the Southern DPS of green sturgeon.

CRITICAL HABITAT

The ESA defines critical habitat under Section 3(5)(A) as:

> "(i) the specific areas within the geographical area occupied by the species at the time it is listed…, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and
>
> (ii) specific areas outside the geographical area occupied by the species at the time it is listed… upon a determination by the Secretary that such areas are essential for the conservation of the species."

Section 4(a)(3)(B)(i) of the ESA precludes from designation any lands owned by, controlled by, or designated for the use of the Department of Defense that are covered by an integrated natural resources management plan that the Secretary [of Commerce] has found in writing will benefit the listed species.

Section 4(b)(2) of the ESA requires NMFS to designate critical habitat for threatened and endangered species "on the basis of the best scientific data available and after taking into consideration the economic impact, impact on national security, and any other relevant impact, of specifying any particular area as critical habitat." This section grants the Secretary discretion to exclude any area from critical habitat if he determines "the benefits of such exclusion outweigh the benefits of specifying such area as part of the critical habitat." The Secretary may not exclude an area if it "will result in the extinction of the species."

Once critical habitat is designated, section 7 of the ESA requires Federal agencies to insure that they do not fund, authorize, or carry out any actions that will destroy or adversely modify that habitat. This is in addition to the requirement under section 7 of the ESA that Federal agencies insure their actions do not jeopardize the continued existence of listed species.

GREEN STURGEON LIFE HISTORY AND STATUS

This section provides background information on green sturgeon life history and status relevant for understanding the habitat use and needs of this species. The green sturgeon is an anadromous fish species, meaning adults spend time in the ocean but migrate into freshwater rivers to spawn. Green sturgeon are long-lived and among the most marine-oriented of the sturgeons of the family Acipenseridae (*Munro et al. 2007*). The North American form of green sturgeon (hereafter, "green sturgeon") is related to the Asian form (*Acipenser mikadoi*, also called Sakhalin sturgeon), but is most likely a different species (*Artyukhin et al. 2007*). Green sturgeon are one of two sturgeon species occurring on the U.S. West coast, the other being white sturgeon (*A. transmontanus*). Adults can grow up to 270 cm in total length (TL) and 175 kg in weight (*Moyle 2002*). However, adults greater than 2.25 m TL and 90 kg in weight are not common (*Skinner 1962; Van Eenennaam et al. 2006; Erickson and Webb 2007*). Maximum ages most likely range from 60 to 70 years or older (*Emmett et al. 1991*). Females tend to be larger than males, but males reach maturity at younger ages (*Nakamoto et al. 1995; Van Eenennaam et al. 2006; Erickson and Webb 2007*). Until recently, few studies have focused on green sturgeon due to its low abundance and low commercial value compared to white sturgeon.

Green sturgeon range from the Bering Sea, Alaska, to Ensenada, Mexico. A few green sturgeon have been observed off of the southern California coast, including fish less than 100 cm TL (*Fitch and Lavenberg 1971; Fitch and Schultz 1978, cited in Moyle et al., 1992*). Green sturgeon abundance increases north of Point Conception, California (*Moyle et al. 1995*). Green sturgeon occupy freshwater rivers from the Sacramento River up through British Columbia (*Moyle 2002*), but spawning has been confirmed in only three rivers: the Rogue River in Oregon and the Klamath and Sacramento rivers in California. Based on genetic analyses and spawning site fidelity (*Adams et al. 2002; Israel et al. 2004*), NMFS determined green sturgeon are comprised of at least two distinct population segments (DPSs):

(1) A northern DPS consisting of populations originating from coastal watersheds northward of and including the Eel River (i.e., the Klamath and Rogue rivers) ("Northern DPS"); and
(2) A southern DPS consisting of populations originating from coastal watersheds south of the Eel River ("Southern DPS"). The only known spawning population for the Southern DPS is in the Sacramento River.

The Northern DPS and Southern DPS are distinguished based on genetic data and spawning locations, but their distributions outside of natal waters generally overlap with one another (*Chadwick 1959; Miller 1972; California Department of Fish and Game 2002; Erickson and Hightower 2007; Erickson and Webb 2007; Moser and Lindley 2007; Lindley et al. 2008; Israel et al. In review*). Both Northern DPS and Southern DPS fish occupy coastal waters from southern California to Alaska and are known to aggregate in the Columbia River estuary, Washington estuaries, and Oregon estuaries (such as Winchester Bay) in the spring to late summer months (*Israel et al. 2004; Moser and Lindley 2007; Lindley et al. 2008; pers. comm. with Steve Lindley and Mary Moser, NMFS, on February 24-25, 2008*). Thus, green sturgeon observed in coastal bays, estuaries, and coastal marine waters outside of natal rivers may belong to either DPS. However, the Northern DPS of green sturgeon is not classified as a listed species under the ESA. Tagging or genetics data are needed to determine to which DPS an individual belongs. The distribution of green sturgeon, and specifically of the Southern DPS, is described in detail under the section titled "Geographical Area Occupied by the Species and Specific Areas within the Geographical Area Occupied."

Spawning

Spawning frequency is not well known, but the best information suggests that adult green sturgeon spawn every 2 - 4 years (*Lindley and Moser, NMFS, pers. comm., cited in 70 FR 17386, April 6, 2005; Erickson and Webb 2007*). Beginning in late February, adult green sturgeon migrate from the ocean into fresh water to begin their spawning migrations (*Moyle et al. 1995; pers. comm. with Dan L. Erickson, Oregon Department of Fish and Wildlife (ODFW), September 3, 2008*). Spawning occurs from March to June, with peak activity in April (*Emmett et al. 1991; Erickson and Webb 2007; pers. comm. with Dan Erickson, ODFW, and Steve Lindley, NMFS, September 3, 2008*), but in the Sacramento River spawning is confirmed to occur from March to July, with recent data indicating peak activity in May and June (*Poytress et al. 2009*). Confirmed spawning populations in North America are in the Rogue (*Erickson et al. 2002; Farr and Kern 2005; Webb and Erickson 2007*), Klamath (*Van Eenennaam et al. 2006*), and Sacramento rivers (*Moyle et al. 1992; California Department of Fish and Game 2002; Brown 2007; Poytress et al. 2009*). Klamath and Rogue river populations appear to spawn within 161 km (100 miles) of the ocean, whereas spawning in the mainstem Sacramento River has been documented over 424 km (240 miles) upstream, both downstream and upstream of Red Bluff Diversion Dam (RBDD) (*Brown 2007; Poytress et al. 2009*).

Earlier papers suggested that spawning most likely occurs in fast, deep water (> 3 m deep) over substrates ranging from clean sand to bedrock, with preferences for cobble substrates (*Emmett et al. 1991; Moyle et al. 1995*). Recent studies have provided additional information. Monitoring of green sturgeon and behavior data in the Rogue River suggests spawning occurs in sites at the base of riffles or rapids, where depths immediately increase from shallow to about 5 to 10 meters (m) depth, water flow consists of moderate to deep turbulent or eddying water, and the bottom type is made up of cobble to boulder substrates (*pers. comm. with Dan Erickson, ODFW, September 3, 2008*). Green sturgeon egg and larval sampling and habitat surveys within the Sacramento River indicate spawning occurs at or near the deepest portion of pools, in areas primarily consisting of gravel substrates (*Poytress et al. 2009*). Egg samples were collected from March to July at less than 1 m (though this was below the Red Bluff Diversion Dam) to 7.6 m depth, with spawning estimated to occur from March to July (*Poytress et al. 2009*).

Green sturgeon females produce 59,000 to 242,000 eggs, with fecundity increasing with fish length and age (*Van Eenennaam et al. 2006*). Green sturgeon eggs are the largest of the North American and European sturgeon species, ranging from 4.04 to 4.66 mm in diameter and have a thin chorion (*Van Eenennaam et al. 2001; Van Eenennaam et al. 2006*). Eggs are broadcast spawned and have the ability to adhere strongly to substrate (*Van Eenennaam et al. 2008*) or settle into crevices of river bedrock or under gravel (*Deng 2000; Van Eenennaam et al. 2001; Deng et al. 2002*). Green sturgeon eggs were previously reported to have "poor adhesion" (*Van Eenennaam et al. 2001*), "weak adhesiveness" (*Deng et al. 2002*), and "unadhesive eggs" (*Beamesderfer et al. 2007*), but these early interpretations were not entirely accurate. Eggs sampled from the Southern DPS population were found to be highly adhesive as noted by samples adhered to the metal framework of substrate samplers (*Poytress et al. 2009*). The last four Klamath River females that were ovulated all had highly adhesive fertilized eggs using a modified spawning injection regime, and the current hypothesis is that the earlier observed weakly adhesive eggs were due to the use of domperidone during the spawning induction process (*Van Eenennaam et al. 2008*). The effect of domperidone, however, has not been experimentally tested, and therefore other factors (holding time in cages, optimal timing of hormonal injections and egg collection) could potentially produce a similar effect resulting in weakly adhesive eggs. Optimum flow and temperature requirements for spawning and incubation are unclear, but spawning success in most sturgeons is related to these factors (Detlaff *et al.*, 1993). Average daily water flow ranged from 198 - 352 m^3/s in the Sacramento River (*Brown 2007; Poytress et al. 2009*), and from 58 – 260 m^3/s in the Rogue River (*Erickson and Webb 2007*) during the spawning months. Spawning may be triggered by small increases in water flow (*Schaffter 1997; Brown 2007*). Adult green sturgeon occur in the Sacramento River when temperatures are between 8 - 14°C (*Moyle 2002*). In the Rogue River, average monthly temperatures during spawning months (April – June) ranged from 10.3 to 19.1ºC, whereas the average monthly temperatures during all months when adult green sturgeon were present ranged from 8.3 – 22.8ºC (*Erickson and Webb 2007*). In laboratory studies, the optimal thermal range for green sturgeon development was from 11 to 17 - 18°C, and temperatures ≥ 23°C were lethal to embryos (*Van Eenennaam et al. 2005*).

Development of early life stages

Green sturgeon embryos have poor swimming ability and exhibit a strong drive to remain in contact with structure, preferring cover and dark habitats to open bottom and illuminated habitats in laboratory experiments (*Kynard et al. 2005*). Newly emerged green sturgeon larvae in the laboratory hatched at 144 - 216 hours, or 6 - 9 days, after fertilization (incubation temperatures ranged from 15 - 15.7°C) and ranged from 12.6 - 15 mm in length (*Van Eenennaam et al. 2001; Deng et al. 2002*). Unlike other acipenserids, newly hatched larvae did not swim up toward the water surface within the first 5 days post hatch (dph), but remained in clumps near the bottom. By 5 - 6 dph, larvae exhibited nocturnal behavior, remaining clumped near the bottom during the day and actively swimming at night (*Van Eenennaam et al. 2001; Deng et al. 2002*). Upon onset of feeding at 10 dph (23.0 – 25.2 mm length) (*Deng et al. 2002*), larvae are believed to initiate downstream migration from spawning areas, staying close to the bottom and periodically interrupting downstream movement with upstream foraging bouts (*Kynard et al. 2005*).

Little is known about larval rearing habitat and requirements. Temperatures of 15°C are believed to be optimal for larval growth, whereas temperatures below 11°C or above 19°C may be detrimental for growth (*Cech et al. 2000, cited in COSEWIC, 2004*). Substrate may also affect growth and foraging behavior. Larvae reared on flat-surfaced substrates (slate-rock and glass) had higher specific growth rates than larvae reared on cobble or sand, most likely due to lower foraging effectiveness and greater activity levels in cobble and sand substrates (*Nguyen and Crocker 2007*). Larvae complete metamorphosis to the juvenile stage at 45 dph, when fish range from 62.5 to 94.4 mm in length (*Deng et al. 2002*).

Juveniles continue to grow rapidly, reaching 300 mm in 1 year and over 600 mm within 2 - 3 years (based on Klamath River fish; *Nakamoto et al. 1995*). Laboratory experiments indicate juveniles may occupy fresh to brackish water at any age, but are able to completely transition to salt water by around 1.5 years in age (about 533 dph; mean TL of 75.2 ± 0.7 cm) (*Allen and Cech 2007*). Early juveniles at 100 and 170 dph tolerated prolonged exposure to salt water, but experienced decreased growth and activity levels and, in some cases, mortality for individuals at 100 dph, whereas juveniles at 533 dph exhibited successful osmoregulation in salt water salinities (*Allen and Cech 2007*). These results were consistent with the Nakamoto *et al*. (1995) study indicating that juveniles rear in fresh and estuarine waters for about 1 to 4 years before dispersing into salt water (at lengths of about 300 to 750 mm). Early juveniles also exhibit nocturnal behavior in all activities and initiate directed downstream movement in the fall, most likely to migrate to wintering habitats (*Kynard et al. 2005*). Juvenile green sturgeon prefer temperatures of 15 - 16°C with an upper limit of 19°C, beyond which swimming performance may decrease and cellular stress may occur (*Mayfield and Cech 2004; Allen et al. 2006*). Laboratory measurements of oxygen consumption by juveniles ranged from 61.78 ± 4.65 mg O_2 hr^{-1} kg^{-1} to 76.06 ± 7.63 mg O_2 hr^{-1} kg^{-1}, with a trend of increasing oxygen consumption with increasing body mass (*Allen and Cech 2007*). Studies on juveniles feeding in San Pablo Bay, Suisun Bay, and the Sacramento-San Joaquin Delta identified prey items of shrimp (*Neomysis awatchensis, Crangon franciscorum*), amphipods (*Corophium* spp., *Photis californica*), isopods (*Synidotea laticauda*), clams (*Macoma* spp.), annelid worms, and unidentified crabs and fishes (*Ganssle 1966; Radtke 1966*).

Adults and subadults

The CHRT defined life stages as follows: adults as sexually mature fish, subadults as sexually immature fish that have entered coastal marine waters (usually at 3 years of age), and juveniles as fish that have not yet made their first entry into marine waters. Green sturgeon spend a large portion of their lives in coastal marine waters as subadults and adults. Subadult male and female green sturgeon spend at least approximately 6 and 10 years at sea, respectively, before reaching reproductive maturity and returning to freshwater to spawn for the first time (*Nakamoto et al. 1995*). Adult green sturgeon spend as many as 2 – 4 years at sea between spawning events (Lindley and Moser, NMFS, pers. comm., cited in 70 FR 17386, April 6, 2005; *Erickson and Webb 2007; pers. comm. with Dan Erickson, ODFW, September 3, 2008*). The length at first maturity for green sturgeon is estimated to be 152 cm TL (14 - 16 years) for males and 162 cm TL (16 - 20 years) for females in the Klamath River (*Van Eenennaam et al. 2006*), and 145 cm TL for males and 166 cm TL for females in the Rogue River (*Erickson and Webb 2007*).

Adult green sturgeon enter freshwater rivers every few years to spawn (*Webb and Erickson 2007*). Adults typically begin their upstream spawning migration in the spring and either migrate downstream after spawning, or reside within the river over the summer (*Erickson et al. 2002; Benson et al. 2007; Erickson and Webb 2007*). In the Klamath River, tagged adults exhibited four movement patterns: (1) upstream spawning migration; (2) spring outmigration to the ocean; (3) summer holding (June to November) in deep pools with eddy currents (for those that do not exhibit post-spawning spring outmigration); and (4) outmigration after summer holding (*Benson et al. 2007*). Use of summer holding sites has also been observed in the Rogue River (*Erickson et al. 2002*) and in the Sacramento River (*pers. comm. with Richard Corwin, US Bureau of Reclamation (USBR), February 24-25, 2008*). Deep holding pools with complex hydraulics (e.g., turbulent areas, boils, eddies perpendicular to river flow) greater than 5 m in depth are believed to be important for spawning as well as for summer holding (*pers. comm. with Dan Erickson, ODFW, September 3, 2008; Vogel 2008; Poytress et al. 2009)*. Winter outmigration from the Klamath and Rogue rivers was initiated when temperatures dropped to 10 - 12°C or below 10°C, and discharge increased to greater than 100 m^3/s (*Erickson et al. 2002; Benson et al. 2007*). In the Sacramento River, tagged adult green sturgeon were present through December and as long as through February of the next year, before moving downstream with increased winter flows (*pers. comm. with Richard Corwin, USBR, June 5, 2008 and August 13, 2009, unpublished data with Mike Thomas, UC Davis*). Subadults may also migrate upstream, but for unknown purposes. Adults and subadults also occupy the San Francisco Bay, San Pablo Bay, Suisun Bay, and Sacramento-San Joaquin Delta adjacent to the Sacramento River. Adults and subadults primarily inhabit the Delta and bays during summer months, most likely for feeding and growth (*Kelly et al. 2007; Moser and Lindley 2007*), but are also found throughout the year, based on incidental capture data for green sturgeon in 2007 and 2008 (*Gleason et al. 2008*).

Outside of natal waters, adult and subadult green sturgeon inhabit coastal marine waters from the Bering Sea to southern California, primarily occupying waters within 110 m depth (*Erickson and Hightower 2007*). Tagged subadults and adults have been documented to make sustained coastal migrations of up to 100 km per day (S. Lindley and M. Moser, NMFS, pers. comm. cited in BRT, 2005), but may also reside in aggregation/feeding areas in coastal marine waters for several days at a time (*pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24 – 25, 2008*). There is evidence that green sturgeon inhabit certain estuaries on the northern California, Oregon, and Washington coasts during the summer, and inhabit coastal marine waters along the central California coast and between Vancouver Island, British Columbia, and southeast Alaska over the winter (*Lindley et al. 2008*). Large aggregations of green sturgeon from all known spawning populations occur in the Columbia River estuary, Washington estuaries, and Oregon estuaries (*Moser and Lindley*

2007; pers. comm. with Dan Erickson, ODFW, et al., September 3, 2008). Large numbers of green sturgeon also occur off Vancouver Island, BC (*Lindley et al. 2008*). Seasonal migrations to these oversummering and overwintering habitats are most likely driven by the presence of food resources. Although adult and subadult green sturgeon occur in coastal marine waters as far north as the Bering Sea, green sturgeon have not been observed in freshwater rivers or coastal bays and estuaries in Alaska.

Adults and subadults inhabit a wide range of environmental conditions within coastal bays and estuaries. Adults and subadults in Willapa Bay and the San Francisco Bay Estuary occurred across the entire temperature and salinity range (11.9 – 21.9°C; 8.8 – 32.1 ppt), experienced large fluctuations in temperature and salinity (up to 2°C h^{-1} and 1 practical salinity unit (PSU) h^{-1}), and occupied a wide range of dissolved oxygen levels from 6.54 to 8.98 mg O_2/l (*Kelly et al. 2007; Moser and Lindley 2007*). Tagged adults and subadults in the San Francisco Bay Estuary occupied shallow depths during directional movements, but stayed close to the bottom during non-directional movements, presumably because they were foraging (*Kelly et al. 2007*). Similar to freshwater rivers, winter outmigration from Willapa Bay was initiated when water temperatures dropped below 10°C (*Moser and Lindley 2007*).

Adult and subadult green sturgeon in the Columbia River estuary, Willapa Bay, and Grays Harbor feed on crangonid shrimp, burrowing thalassinidean shrimp (primarily the burrowing ghost shrimp *Neotrypaea californiensis*), amphipods, clams, juvenile Dungeness crab (*Cancer magister*), anchovies, sand lances (*Ammodytes hexapterus*), lingcod (*Ophiodon elongatus*), and other unidentified fish species (*P. Foley, unpublished data cited in Moyle et al., 1995; C. Tracy, minutes to U.S. Fish and Wildlife Service (USFWS) meeting, cited in Moyle et al. 1995; O. Langness, Washington Department of Fish and Wildlife (WDFW), pers. comm., cited in Moser and Lindley 2007; Dumbauld et al. 2008*). Burrowing ghost shrimp made up about 50 percent of the stomach contents of green sturgeon sampled in 2003 (*Dumbauld et al. 2008*). Subadults and adults feeding in bays and estuaries may be exposed to contaminants that may affect their growth and reproduction. Studies on white sturgeon in estuaries indicate that the bioaccumulation of pesticides and other contaminants adversely affects growth and reproductive development and may result in decreased reproductive success (*Fairey et al. 1997; Foster et al. 2001a; Foster et al. 2001b; Kruse and Scarnecchia 2002; Feist et al. 2005; Greenfield et al. 2005*). Green sturgeon are believed to experience similar risks from contaminants (70 FR 17386, April 6, 2005). Because green sturgeon spend more time in marine waters than white sturgeon, they may have less exposure to contaminants in estuaries compared to white sturgeon. However, green sturgeon may be more sensitive than white sturgeon to certain contaminants found in coastal estuaries, including methylmercury and selenium, which affected their routine and active metabolic rates, swimming performance, and avoidance of a simulated predator (*Kaufman et al. 2008*).

Status of Green Sturgeon

On April 7, 2006, NMFS issued a Final Rule to list the Southern DPS of green sturgeon as threatened under the ESA and to keep the Northern DPS on the NMFS Species of Concern List (71 FR 17757). The decision to list the Southern DPS as threatened was based on an evaluation of the status of the Southern DPS and of existing efforts to protect the species.

NMFS identified 7 extinction risk factors for the Southern DPS (*BRT, 2005; 71 FR 17757, April 7, 2006*):

1) Concentration of spawning into one spawning river, increasing the risk of catastrophic extinction;
2) Loss of spawning habitat in the upper Sacramento and Feather rivers due to migration barriers;
3) A general lack of population data, but suspected small population size;
4) Entrainment by water project operations;
5) Potentially limiting or lethal water temperatures;
6) Commercial and recreational fisheries harvest; and
7) Toxins and exotic species.

NMFS determined that green sturgeon population numbers in the Sacramento River and Delta system have declined substantially and that the Southern DPS would likely become endangered in the near future if ongoing threats were not addressed. Past and ongoing Federal, state, and local protective efforts have contributed to the conservation of the Southern DPS, but NMFS believes these efforts alone do not sufficiently reduce the extinction risks faced by the Southern DPS.

PHYSICAL OR BIOLOGICAL FEATURES ESSENTIAL FOR CONSERVATION

Joint NMFS-U.S. Fish and Wildlife Service regulations at 50 CFR 424.12(b) state that in determining what areas are critical habitat, the agencies "shall consider those physical and biological features that are essential to the conservation of a given species and that may require special management considerations or protection." Features to consider may include, but are not limited to:

(1) Space for individual and population growth, and for normal behavior;
(2) Food, water, air, light, minerals, or other nutritional or physiological requirements;
(3) Cover or shelter;
(4) Sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and generally;
(5) Habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

The regulations also require agencies to "focus on the principle biological or physical constituent elements" (hereafter referred to as "Primary Constituent Elements" or PCEs) within the specific areas considered for designation, which "may include, but are not limited to, the following:… spawning sites, feeding sites, seasonal wetland or dryland, water quality or quantity, … geological formation, vegetation type, tide, and specific soil types."

The CHRT recognized that the different systems occupied by green sturgeon at specific stages of their life cycle serve distinct purposes and thus may contain different PCEs. Based on the best available scientific information, the CHRT identified PCEs for freshwater riverine systems, estuarine areas, and coastal marine waters.

The specific PCEs essential for the conservation of the Southern DPS in freshwater riverine systems include:

1. *Food resources*. Abundant food items for larval, juvenile, subadult, and adult life stages. Although the CHRT lacked specific data on food resources for green sturgeon within freshwater riverine systems, juvenile green sturgeon most likely feed on amphipods, bivalves, and fly larvae, based on nutritional studies on the closely-related white sturgeon (*Schreiber 1962; Radtke 1966; pers. comm. with Jeff Stuart, NMFS, January 14, 2008*). These food resources are important for juvenile foraging, growth, and development during their downstream migration to the Delta and bays. It is uncertain whether adult green sturgeon feed in freshwater systems during or immediately after spawning (see discussion by *Erickson et al. 2002*). In the Rogue River, stomach samples from adult green sturgeon captured in the summer were typically empty, indicating that adult green sturgeon do not feed in freshwater during post-spawning summer months (*pers. comm. with Dan Erickson, ODFW, September 3, 2008*). One green sturgeon captured in the Rogue River had the exoskeleton of a crayfish (*Pacifasticus* spp.) and algae in its digestive tract, but it is not clear in what month the individual was captured (*Farr and Kern 2005*). Adult green sturgeon in the Rogue River are also difficult to catch by hook and line using bait during warm summer months, but can be caught when temperatures drop in mid-September to October, again indicating that adult green sturgeon do not feed during warm summer months (*pers. comm. with Dan Erickson, ODFW, September 3, 2008*). Subadults are likely different and may feed in freshwater, although direct observations of feeding and stomach content samples are not available. If subadult and adult green sturgeon feed in freshwater rivers, then they most likely feed on benthic prey species similar to those fed on in bays and estuaries, including shrimp, clams, and benthic fish (*Moyle et al. 1995; Erickson et al. 2002; Moser and Lindley 2007; Dumbauld et al. 2008*).

2. *Substrate type or size* (i.e., structural features of substrates). Substrates suitable for egg deposition and development (e.g., bedrock sills and shelves, boulder, or cobble and gravel, with interstices or irregular surfaces to “collect” eggs and provide protection from predators, and free of excessive silt and debris that could smother eggs during incubation), larval development (e.g., substrates with interstices or voids providing refuge from predators and from high flow conditions), and subadults and adults (e.g., substrates for holding and spawning). Recent monitoring studies in the Sacramento River suggest that spawning occurs at or near the deepest portion of deep pools, over substrates primarily consisting of gravel (*Poytress et al. 2009*). Studies in the Rogue River suggest spawning occurs at the base of rapids or riffles over exposed cobble or boulder substrates (*pers. comm. with Dan Erickson, ODFW, September 3, 2008*). Eggs likely adhere to substrates similar to egg size and appearance (*pers comm. with Bill Poytress, USFWS, August 10, 2009)*, or settle into crevices between substrates (*Deng 2000; Van Eenennaam et al. 2001; Deng et al. 2002; Van Eenennaam et al. 2008*). Both embryos and larvae exhibited a strong affinity for

benthic structure during laboratory studies (*Van Eenennaam et al. 2001; Deng et al. 2002; Kynard et al. 2005*), and may seek refuge within crevices, but use flat-surfaced substrates for foraging (*Nguyen and Crocker 2007*). For more details, see the sections on *Spawning* and *Development of early life stages* in this biological report.

3. *Water flow*. 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 (see section on *Spawning* in this biological report). Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11 - 19°C) (*Cech et al. 2000, cited in COSEWIC, 2004; Mayfield and Cech 2004; Van Eenennaam et al. 2005; Allen et al. 2006*). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs (*Deng et al. 2002; Parsley et al. 2002*), and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and potentially suffocating the eggs (*Deng et al. 2002; Kock et al. 2006; Poytress et al. 2009*)), to maintain surfaces for feeding (*Nguyen and Crocker 2007*), and to stimulate migration to upriver spawning sites (*Erickson and Webb 2007*). Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning success is associated with water flow and water temperature. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 400 m^3/s (average daily water flow during spawning months: 198 – 352 m^3/s) (*Brown 2007; Poytress et al. 2009*). Erickson and Webb (*2007*) correlated longer spawning migrations with increased flows for green sturgeon in the Rogue River, Oregon. The average monthly flows during spawning season ranged between 58 – 93 m^3/s during 2001, when upstream spawning migration distance was shortest, to 178 – 260 m^3/s during 2003, when upstream spawning migration distance was longest. Post-spawning downstream migrations are triggered by increased flows, ranging from 174 - 417 m^3/s in the late summer (*Vogel 2005*) and greater than 100 m^3/s in the winter (*Erickson et al. 2002; Benson et al. 2007; pers. comm. with Richard Corwin, USBR, June 5, 2008, unpublished data with Mike Thomas, UC Davis*).

4. *Water quality*. Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages (see sections on *Development of early life stages* and *Adults and subadults* in this biological report). Suitable water temperatures would include: relatively stable water temperatures within spawning reaches; temperatures within 11 - 17°C (optimal range = 14 - 16°C) in spawning reaches for egg incubation (March-August) (*Van Eenennaam et al. 2005*); temperatures below 20°C for larval development (*Werner et al. 2007*); and temperatures below 24°C for juveniles (*Mayfield and Cech 2004; Allen et al. 2006*). Suitable salinity levels range from fresh water (< 3 parts per thousand or 3‰) for larvae and early juveniles (about 100 dph) to brackish water (10‰) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (*Allen and Cech 2007; Sardella et al. 2008*). Adequate levels of

dissolved oxygen are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1} for juveniles) (*Allen and Cech 2007*). Suitable water quality would also include water with acceptably low levels of contaminants (i.e., pesticides, polyaromatic hydrocarbons (PAHs), elevated levels of heavy metals, etc.) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Waters free of elevated levels of such contaminants would protect green sturgeon from adverse impacts on growth, reproductive development, and reproductive success (e.g., reduced egg size and abnormal gonadal development) likely to result from exposure to contaminants (*Fairey et al. 1997; Foster et al. 2001a; Foster et al. 2001b; Kruse and Scarnecchia 2002; Feist et al. 2005; Greenfield et al. 2005*).

5. *Migratory corridor. A* migratory pathway necessary for the safe and timely passage of Southern DPS fish within riverine habitats and between riverine and estuarine habitats (e.g., an unobstructed river or dammed river that still allows for passage). We define safe and timely passage to mean that human-induced impediments, either physical, chemical, or biological, do not alter the migratory behavior of the fish such that its survival or the overall viability of the species is compromised (e.g., an impediment that compromises the ability of fish to reach their spawning habitat in time to encounter con-specifics and to reproduce). Unimpeded migratory corridors are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning/rearing habitats within freshwater rivers to rearing habitats within the estuaries. For example, unimpeded passage throughout the Sacramento River up to Keswick Dam (river kilometer (RKM) 486) is important, because barriers to passage (such as the RBDD, located at RKM 391) could reduce the total spawning area available to green sturgeon, increasing competition for the remaining habitat.

6. *Depth*. Deep (≥ 5 m) holding pools for both upstream and downstream holding of adult or subadult fish, with adequate water quality and flow to maintain the physiological needs of the holding adult or subadult fish (see section on *Adults and subadults* in this biological report). Deep pools of ≥ 5 m depth with complex hydraulic features and upwelling are critical for adult green sturgeon spawning and for summer holding within the Sacramento River (*Vogel 2008; Poytress et al. 2009*). Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding and/or energy conservation (*Erickson et al. 2002; Benson et al. 2007*).

7. *Sediment quality*. Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of elevated levels of contaminants (e.g., elevated levels of selenium, PAHs, and organochlorine pesticides) that can result in adverse effects on any life stages of green sturgeon. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may adversely affect the growth, reproductive development, and reproductive success of green sturgeon (see section titled *Adult and subadults* in this biological report).

The specific PCEs essential for the conservation of the Southern DPS in estuarine areas include:

1. *Food resources*. Abundant food items within estuarine habitats and substrates for juvenile, subadult, and adult life stages. As described previously (see *Green sturgeon life history and status*), prey species for juvenile, subadult, and adult green sturgeon within bays and estuaries primarily consist of benthic invertebrates and fish, including crangonid shrimp, burrowing thalassinidean shrimp, amphipods, isopods, clams, annelid worms, crabs, sand lances, and anchovies. These prey species are critical for the rearing, foraging, growth, and development of juvenile, subadult, and adult green sturgeon within the bays and estuaries.

2. *Water flow*. Within bays and estuaries adjacent to the Sacramento River (i.e., the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds. Sufficient flows are needed to attract adult green sturgeon to the Sacramento River to initiate the upstream spawning migration (*Kohlhorst et al. 1991, cited in California Department of Fish and Game (CDFG) 2002; pers. comm. with Jeff Stuart, NMFS, February 24-25, 2008*).

3. *Water quality*. Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages. Suitable water temperatures for juvenile green sturgeon should be below 24°C. At temperatures above 24°C, juvenile green sturgeon exhibit decreased swimming performance (*Mayfield and Cech 2004*) and increased cellular stress (*Allen et al. 2006*). Suitable salinities range from brackish water (10‰) to salt water (33‰). Juveniles transitioning from brackish to salt water can tolerate prolonged exposure to salt water salinities, but may exhibit decreased growth and activity levels (*Allen and Cech 2007; Sardella et al. 2008*), whereas subadults and adults tolerate a wide range of salinities (*Kelly et al. 2007; Moser and Lindley 2007*). Subadult and adult green sturgeon occupy a wide range of dissolved oxygen levels, but may need a minimum dissolved oxygen level of at least 6.54 mg 0_2/l (*Kelly et al. 2007*). As described above, adequate levels of dissolved oxygen are also required to support oxygen consumption by juveniles (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1}) (*Allen and Cech 2007*). Suitable water quality also includes waters with acceptably low levels of contaminants (e.g., pesticides, PAHs, elevated levels of heavy metals) that may disrupt the normal development of juvenile life stages, or the growth, survival, or reproduction of subadult or adult stages.

4. *Migratory corridor.* A migratory pathway necessary for the safe and timely passage of Southern DPS fish within estuarine habitats and between estuarine and riverine or marine habitats. We define safe and timely passage to mean that human-induced impediments, either physical, chemical, or biological, do not alter the migratory behavior of the fish such that its survival or the overall viability of the species is

compromised (e.g., an impediment that compromises the ability of fish to reach thermal refugia by the time they enter a particular life stage). Within the bays and estuaries adjacent to the Sacramento River, unimpeded passage is needed for juvenile green sturgeon to migrate from the river to the bays and estuaries and eventually out into the ocean. Passage within the bays and the Delta is also critical for adults and subadults for feeding and summer holding, as well as to access the Sacramento River for their upstream spawning migrations and to make their outmigration back into the ocean. For bays and estuaries outside of the Delta and the Suisun, San Pablo, and San Francisco bays, unimpeded passage is necessary for adult and subadult green sturgeon to access feeding areas, holding areas, and thermal refugia, and to ensure passage back out into the ocean.

5. *Depth*. A diversity of depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Subadult and adult green sturgeon occupy a diversity of depths within bays and estuaries for feeding and migration. Tagged adults and subadults within the San Francisco Bay estuary primarily occupied waters over shallow depths of less than 10 m, either swimming near the surface or foraging along the bottom (*Kelly et al. 2007*). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 1 – 3 m deep, indicating juveniles may require shallower depths for rearing and foraging (*Radtke 1966*). Thus, a diversity of depths is important to support different life stages and habitat uses for green sturgeon within estuarine areas.

6. *Sediment quality*. Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of elevated levels of contaminants (e.g., elevated levels of selenium, PAHs, and organochlorine pesticides) that can cause adverse effects on all life stages of green sturgeon (see description of *Sediment quality* for riverine habitats above). As described above, green sturgeon use a diversity of depths within estuarine areas, moving through shallow water near the surface and foraging along the bottom (*Kelly et al. 2007*), including in shallow intertidal mudflats (*Moser and Lindley 2007*). Sediment quality may be of particular concern within these intertidal mudflats. Because these areas occur at the interface between the land and the water, they may be particularly vulnerable to the accumulation of contaminants in sediments and in the benthic community that green sturgeon feed on.

The specific PCEs essential for the conservation of the Southern DPS in coastal marine areas include:

1. *Migratory corridor.* A migratory pathway necessary for the safe and timely passage of Southern DPS fish within marine and between estuarine and marine habitats. We define safe and timely passage to mean that human-induced impediments, either physical, chemical, or biological, do not alter the migratory behavior of the fish such that its survival or the overall viability of the species is compromised (e.g., an impediment that compromises the ability of fish to reach abundant prey resources during the summer months in Northwest Pacific estuaries). Subadult and adult green

sturgeon spend most of their lives in marine and estuarine waters outside of their natal rivers. Unimpeded passage within coastal marine waters is critical for subadult and adult green sturgeon to access oversummering habitats within coastal bays and estuaries and overwintering habitat within coastal waters between Vancouver Island, BC, and southeast Alaska. Passage is also necessary for subadults and adults to migrate back to San Francisco Bay and to the Sacramento River for spawning.

2. *Water quality*. Coastal marine waters with adequate dissolved oxygen levels and with acceptably low levels of contaminants (such as pesticides, PAHs, elevated levels of heavy metals) that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon. Based on studies of tagged subadult and adult green sturgeon in the San Francisco Bay estuary, CA, and Willapa Bay, WA, subadults and adults may need a minimum dissolved oxygen level of at least 6.54 mg 0_2/l (*Kelly et al. 2007; Moser and Lindley 2007*). As described above, exposure to, and bioaccumulation of, contaminants may adversely affect the growth, reproductive development, and reproductive success of subadult and adult green sturgeon. Thus, waters free of elevated levels of such contaminants are required for the normal development of green sturgeon for optimal survival and spawning success.

3. *Food resources*. Abundant food items for subadults and adults, which likely include benthic invertebrates and fish. Green sturgeon spend most of their lives in marine and estuarine waters along the coast. Abundant food resources are important to support subadults and adults over long-distance migrations, and may be one of the factors attracting green sturgeon to habitats far to the north (off the coast of Vancouver Island and Alaska) and to the south (Monterey Bay, CA, and off the coast of southern California) of their natal habitat. Although data on prey species in coastal marine waters is lacking, prey species likely include benthic invertebrates and fish species similar to those fed upon by green sturgeon in bays and estuaries (e.g., shrimp, clams, crabs, anchovies, sand lances) (see section titled *Adults and subadults* in this biological report).

GEOGRAPHICAL AREA OCCUPIED BY THE SPECIES AND SPECIFIC AREAS WITHIN THE GEOGRAPHICAL AREA OCCUPIED

One of the first steps in the critical habitat designation process is to define the geographical area occupied by the species at the time of listing. The CHRT relied on data from tagging and tracking studies, genetic analyses, field observations, records of fisheries harvest and incidental capture (e.g., in water diversion activities), and opportunistic sightings to provide information on the current range and distribution of green sturgeon and of the Southern DPS of green sturgeon. The range of green sturgeon extends from the Bering Sea, Alaska, to Ensenada, Mexico. Within this range, Southern DPS fish are confirmed to occur from Graves Harbor, Alaska, to Monterey Bay, California (*pers. comm. with Steve Lindley and Mary Moser, NMFS, February 24-25, 2008*). Green sturgeon have been observed northwest of Graves Harbor, AK, and south of Monterey Bay, CA, but have not been identified as belonging to either the Northern or Southern DPS. The CHRT concluded that there are no barriers or habitat conditions preventing Southern DPS green sturgeon detected in Monterey Bay, CA, and in Graves Harbor, AK, from moving further south or further north, and that the green sturgeon observed in these areas could belong to either the Northern DPS or the Southern DPS. Based on this reasoning, the geographical area occupied by the Southern DPS was defined as the entire range occupied by green sturgeon (i.e., from the Bering Sea, AK, to Ensenada, Mexico). The geographical area occupied encompassed all areas where the presence of Southern DPS fish has been confirmed, as well as areas where the presence of Southern DPS fish is likely (based on the presence of confirmed Northern DPS fish or green sturgeon of unknown DPS). Areas outside of the United States cannot be designated as critical habitat (50 CFR 424.12(h)). Thus, the geographical area occupied under consideration for this designation is limited to areas from the Bering Sea, AK (excluding Canadian waters), to the U.S.-California/Mexico border. For freshwater rivers, the CHRT concluded that green sturgeon of each DPS are likely to occur throughout their natal river systems, but, within non-natal river systems, are likely to be limited to the estuaries and would not occur upstream of the head of the tide. For the purposes of this biological analysis, the CHRT defined all green sturgeon observed upstream of the head of the tide in freshwater rivers south of the Eel River (i.e., the Sacramento River and its tributaries) as belonging to the Southern DPS, and all green sturgeon observed upstream of the head of the tide in freshwater rivers north of and including the Eel River as belonging to the Northern DPS. Thus, for freshwater rivers north of and including the Eel River, the areas upstream of the head of the tide were not considered part of the geographical area occupied by the Southern DPS.

The CHRT then identified "specific areas" within the geographical area occupied. To be eligible for designation as critical habitat under the ESA, each specific area must contain at least one PCE that may require special management considerations or protection. For each specific area, the CHRT noted whether the presence of Southern DPS green sturgeon is confirmed or likely (based on the presence of Northern DPS fish or green sturgeon of unknown DPS) and verified that each area contained one or more PCE(s) that may require special management considerations or protection. The following paragraphs summarize the CHRT's methods for delineating the specific areas and describe each specific area, including the presence of Southern DPS green sturgeon, the PCEs present, and activities that may affect the PCEs such that special management considerations or protection are needed. Figures 1 – 5 show maps of the occupied specific areas delineated and considered by the CHRT for designation. Table 1 summarizes the life stages present within each area and relevant references. Table 2 summarizes the PCEs present and activities that may adversely modify the PCEs within each specific area and necessitate special management considerations or protection.

Freshwater riverine systems, bypasses, and the Delta

Green sturgeon occupy several freshwater river systems from the Sacramento River, CA, north to British Columbia, Canada (*Moyle 2002*). As described in the previous section, Southern DPS green sturgeon occur throughout their natal river systems (i.e., the Sacramento

River, lower Feather River, and lower Yuba River), but are likely to be restricted to the estuaries in non-natal river systems (i.e., north of and including the Eel River). The CHRT delineated specific areas where Southern DPS fish occur, including: the Sacramento River, the Yolo and Sutter bypasses, the lower Feather River, and the lower Yuba River. The CHRT defined the specific areas to include riverine habitat from the river mouth upstream to and including the furthest known site of historic and/or current sighting or capture of green sturgeon, as long as the site is still accessible. The specific areas were extended upstream to a geographically identifiable point. The riverine specific areas include areas that offer at least periodic passage of Southern DPS fish to upstream sites and include sufficient habitat necessary for each riverine life stage (e.g., spawning, egg incubation, larval rearing, juvenile feeding, passage throughout the river, and/or passage into and out of estuarine or marine habitat). The width of the stream channel in the Sacramento River, lower Feather River, and lower Yuba River was defined by the ordinary high water line or the bankfull elevation. The CHRT also delineated a specific area in the Sacramento-San Joaquin Delta. Each specific area is described in detail below.

(1) *Sacramento River, CA*: The Sacramento River is the only area where spawning by Southern DPS green sturgeon has been confirmed and where all life stages of the Southern DPS are supported. The CHRT divided the Sacramento River into two specific areas to more specifically describe the PCEs present and the activities of Southern DPS fish within each area. The CHRT chose the RBDD as the dividing point, because the RBDD presents a barrier to upstream migration when the gates are lowered (from June 15 to September 1 each year).

(a) *Upper Sacramento River, CA* (from the RBDD (RKM 391) to Keswick Dam (RKM 486)): The upper Sacramento River area from upstream of the RBDD gates to Keswick Dam is largely recognized as the main spawning reach for adult Southern DPS green sturgeon. Spawning begins in March (*pers. comm. with Bill Poytress, USFWS, August 10, 2009*) and extends into July (*Brown 2007; Poytress et al. 2009*). The upper Sacramento River also supports egg incubation; larval and juvenile rearing, feeding, and migration; and adult, and possibly subadult, migration and holding. PCEs present to support these activities include: food resources for feeding; substrates suitable for spawning, egg deposition and development, and larval development; water flow; water quality; sediment quality; seasonal migratory corridors (when the RBDD gates are raised); and deep holding pools for adults (*Poytress et al. 2009*).

Adults are known to occur as far upstream as Keswick Dam and occur in the river through November/December, although one male tagged in May 2008 was found holding in the river upstream of Deer Creek until February 2009, before moving downstream (*pers. comm. with Richard Corwin, USBR, June 5, 2008 and August 13, 2009, unpublished data with Mike Thomas, UC Davis*). Subadults are likely to enter the Sacramento River as well, though for unknown reasons. Juvenile Southern DPS fish have been collected at the RBDD from May through November (two were 180 - 400 mm TL; eight were 215 - 315 mm TL) and most likely overwinter in the river, occupying the area from Hamilton City to Keswick Dam from July to December (*USFWS 1992; CDFG 2002; Gaines and Martin 2002*). One near yearling was collected in February at the RBDD (*pers. comm. with Bill Poytress, USFWS, August 10, 2009*). Larval Southern DPS fish have been collected at RBDD from early May through August, with peak catches in June and July (*CDFG 2002; Gaines and Martin 2002*). One larval Southern DPS fish (24 mm TL) was collected above RBDD at Bend Bridge on July 13, 2001 (*Brown 2007*). Larvae are believed to rear in the late spring to late summer for at least 1 - 2 months before migrating downstream (*CDFG 2002*). In 2008, the first egg samples were collected in the upper Sacramento River (*Poytress et al. 2009*). Southern DPS adults and/or subadults have been observed at the mouths of tributaries to the Sacramento River, but not in the tributaries. No green sturgeon juveniles, larvae, or eggs have been observed in surveys within the tributaries.

Several special management concerns exist within the upper Sacramento River area. Adult Southern DPS fish cannot migrate upstream to access spawning habitats within this area when the RBDD gates are closed. The RBDD gates were typically closed from May 15 to September 15 each year, but these dates were revised to June 15 to September 1 each year based on NMFS' Biological Opinion and Conference Opinion on the Long-term Central Valley Project (CVP) and State Water Project (SWP) Operations Criteria and Plan (OCAP BO) (*NMFS 2009a*). While some gates are partially open during this period, high flow rates under the gates create a velocity barrier to upstream migration. On the other hand, adult Southern DPS fish within the upper Sacramento River can migrate downstream past the RBDD during this period. However, if the gates are not raised high enough, there is the possibility of injury or mortality. Due to atypical gate operations in Spring 2007, approximately 10 dead adult green sturgeon were found at or downstream of the RBDD, with scraping, trauma, and other injuries indicating that mortality was caused by the fish getting trapped in the partially-opened gates of the RBDD (*pers. comm. with Elizabeth Campbell, USFWS, June 19, 2007*). Since this incident, gate operations were changed where the gates were either completely closed or raised to a height equal to or greater than one foot, under which green sturgeon are documented to successfully pass. In May and June 2007, after the incident described above, three tagged green sturgeon ranging from 179 to 240 cm TL were monitored and found to successfully pass under the gates when raised at least 12 inches (*pers. comm. with Richard Corwin, USBR, March 9, 2009*). As of June 15, 2009, USBR has regulated gate operations where gates have been completely closed or held at a 1.5 foot gate opening or greater, as suggested by the NMFS OCAP BO (*NMFS 2009a*). A provision of the OCAP BO (RPA Action I 3.3, pg. 771) allows the RBDD technical team to modify the openings to 12 inches if necessary to maintain structural integrity of the dam. Other concerns include: the presence and operation of dams resulting in reduced water quality and altered water flow and substrate composition; operation of water diversions; National Pollutant Discharge Elimination System (NPDES) activities and activities resulting in non-point source pollution (e.g., Iron

Mountain Mine, agricultural outfalls); in-water construction or alterations (e.g., bridge repairs, gravel augmentation, bank stabilization); and habitat restoration activities (e.g., floodplain setback/creation, gravel augmentation, barrier alteration).

(b) *Lower Sacramento River, CA* (from the Sacramento I-Street Bridge to the RBDD, excluding the Yolo and Sutter bypasses): The lower Sacramento River area extends from the downstream side of the RBDD gates to the upper boundary of the legal Delta (marked by the Sacramento I-Street Bridge at RKM 96). The lower Sacramento River serves as an important migratory corridor for adult Southern DPS green sturgeon to and from upstream spawning grounds and for larval and juvenile Southern DPS green sturgeon on their downstream migration from freshwater rearing habitats to the Delta and bays. Although the upper Sacramento River is believed to be the primary spawning area for adult Southern DPS fish, significant spawning also occurs in the lower Sacramento River (*Poytress et al. 2009*). The lower Sacramento River also supports egg incubation; larval and juvenile rearing, feeding, and migration; and adult, and possibly subadult, holding and migration. Similar to the upper Sacramento River, the PCEs present include: food resources for feeding; substrates suitable for spawning, egg deposition and development, and larval development; water flow; water quality; sediment quality; migratory corridors; and deep holding pools for adults (*Vogel 2008; Poytress et al. 2009*).

Adult Southern DPS green sturgeon enter the river in March (*Schaffter 1997*) and spawning occurs from May to mid-July (*CDFG 2002; Brown 2007; Poytress et al. 2009*). Adult Southern DPS fish were observed holding-over in summer months and aggregating within high velocity pools with eddies (*Heublein et al. 2008; Vogel 2008; Poytress et al. 2009*). In June 2007, 4 tagged adults were observed to be holding together in a deep pool (*pers. comm. with Richard Corwin, USBR, February 24-25, 2008*). Tagged adults were detected upstream of Hamilton City through December and February before moving downstream with increased flows (*pers. comm. with Richard Corwin, USBR, June 5, 2008 and August 13, 2009, unpublished data with Mike Thomas, UC Davis*). Subadults also likely occur in the lower Sacramento River, but for reasons unknown. Juvenile Southern DPS fish (≥ 100 mm) have been collected at the Glenn-Colusa Irrigation District (GCID) from July through December (*CDFG 2002*), and one juvenile (60 mm) was collected at Hamilton City in 1974 (*Kohlhorst 1976*), most likely on their downstream migration to the Delta. Larval Southern DPS fish (20 – 50 mm) first appear at GCID in early May to June and are found through October (*CDFG 2002*). Larvae are believed to rear in the river from late spring to late summer for at least 1 - 2 months before moving downstream (*CDFG 2002*). Two green sturgeon eggs were collected on artificial substrates just downstream of RBDD on June 14, 2001 (*Brown 2007*), the first collection of confirmed green sturgeon eggs in the Sacramento River. In 2008 and 2009, multiple egg samples derived from multiple spawning events spanning the months of April to July were collected approximately 14 rkm downstream of the RBDD (*Poytress et al. 2009*). To date, no green sturgeon have been observed in tributaries to the lower Sacramento River. However, tributaries to the lower Sacramento River are more likely to be used by adult, subadult, and juvenile Southern DPS fish for holding, non-natal rearing, and foraging than tributaries to the upper Sacramento River, based on accessibility, flow, and the relatively low gradients of the valley floor sections of rivers joining the lower Sacramento River (*pers. comm. with Jeff Stuart, NMFS, March 16, 2009*).

Several special management concerns exist in the lower Sacramento River. Although dams do not pose as much of a threat to passage for adults in this area, dams and water diversions do alter water flow, substrate composition, and water quality important for adult, juvenile, larval, and egg life stages. For example, Poytress *et al*. (2009) observed rapid accumulation of sand on egg sampling mats downstream of the RBDD, likely attributed to the RBDD's effects on water flow. The accumulation of sand may bury or suffocate eggs and can lead to delayed hatching or development defects in eggs and larvae, as has been observed in white sturgeon (*Kock et al. 2006*). Other activities occurring in this area that may reduce water quality and alter water flow and substrate composition include: dredging and disposal of dredged material; in-water construction or alterations (e.g., bridge repairs, gravel augmentation, bank stabilization); agricultural pesticide application and other NPDES activities and activities generating non-point source pollution (e.g., Iron Mountain Mine, agricultural outfalls); and habitat restoration activities, such as floodplain setback/creation, gravel augmentation, and alterations to barriers.

(2) *Yolo Bypass, CA*: The Yolo Bypass is located to the west of, and is partially encompassed by, the lower Sacramento River and empties out into the Delta. The Yolo Bypass is a major flood control tool that is intermittently available as habitat for green sturgeon and other fish species during high flow years when the bypass and floodplain are flooded for significant periods on the order of several weeks. The Fremont Weir, however, can act as a passage barrier when flows are too low and can result in fish strandings (*pers. comm. with Jeff Stuart, NMFS, March 16, 2009*). Data from a stream gaging station at Fremont Weir from 1935 to 1999 indicate intermittent periods of overflow at the Fremont Weir, with periods of no flow lasting from one to three years between periods in which overflow occurs (lasting from one year to seven consecutive years) (http://www.yolobasin.org/figures/Fig_2-13.pdf). Since 1999, it has not been common for the Yolo Bypass to flood after about mid-March (*pers. comm. with Ted Sommer, California Department of Water Resources (CDWR), March 11, 2009*), restricting the time frame in which this habitat is available to sturgeon and other fish species.

PCEs present in this area include food resources, water quality, sediment quality, and migratory corridors. When flooded, the bypass provides an additional migratory route for Southern DPS green sturgeon on their upstream and downstream migrations to and from the Sacramento River. Both white sturgeon and green sturgeon have been observed in the bypass. Subadult and adult Southern DPS green sturgeon are likely drawn into the lower end of the bypass by flood flows entering the Delta near Rio Vista and moving northwards through the deeper areas of the bypass (toe drain). Juvenile Southern DPS fish are likely to get swept into the bypass by flood water flows during their downstream migration to the Delta and utilize the inundated floodplain for rearing before entering the Delta at Cache Slough (*pers. comm. with Jeffrey Stuart, NMFS, February 24-25, 2008*). Although feeding by green sturgeon within the bypass has not been documented, the bypass provides a high macroinvertebrate forage base that may support feeding. Special management considerations or protection may be needed to address concerns with water flow and water quality in the bypasses. For example, water diversion operations, or the improper management or lack of management of the flood control structure (such as the Fremont Weir), could alter water flow and reduce water levels, increasing the risk of stranding and poaching of green sturgeon. In addition, pollution from agricultural runoff could adversely affect water quality (*pers. comm. with Richard Corwin, USBR, August 13, 2009, meeting minutes of the Yolo Bypass Working Group on March 26, 2004*). Habitat restoration activities occurring in the bypass may also require review by NMFS to ensure critical habitat features for green sturgeon are protected.

(3) *Sutter Bypass, CA*: The Sutter Bypass is located to the east of the lower Sacramento River and is also a major flood control tool for the Sacramento Valley. The Sutter Bypass is smaller than the Yolo Bypass, but is flooded first. Flows from Sacramento River are diverted into the Sutter Bypass first, overflowing into the Feather River and then into the Yolo Bypass (*Sommer et al. 2001*). PCEs present in the Sutter Bypass include food resources, water quality, sediment quality, and migratory corridors. The Sutter Bypass floods on the same general cycle as the Yolo Bypass (the Sutter Bypass is always flooded when the Yolo Bypass floods) and also provides a high macroinvertebrate forage base that may support green sturgeon feeding. Subadult, adult, and juvenile Southern DPS fish are likely to use the Sutter Bypass when flooded based on observations of sturgeon in the bypass during floods. Other anadromous fish species are also encountered during flood inundation, particularly steelhead and Chinook salmon (*pers. comm. with Jeff Stuart, NMFS, March 16, 2009*). Fish can enter the bypass from the south were it joins with water flowing from the lower Feather River into the Sacramento River. This point of discharge is adjacent to the Fremont weir on the northern side of the Yolo Bypass and allows flood flows from the Sutter Bypass to drain into the Yolo Bypass. Fish may enter the Sutter Bypass from upstream through one of the three weirs along the Sacramento River (Moulton, Colusa, and Tisdale weirs). Fish that enter through the Moulton or Colusa weirs first enter the Butte Basin, which subsequently drains flood waters to the Sutter Bypass. Fish entering through the Tisdale weir enter directly into the Sutter Bypass. Similar to the Yolo Bypass, water diversion operations, improper management or lack of management of the bypass, stranding and passage impediments, and agricultural runoff that could alter water flow and water quality are concerns for this area and may require special management considerations or protection. Habitat restoration activities may also need to be addressed to ensure adverse effects on critical habitat are avoided.

(4) *Lower Feather River, CA* (from the confluence with the Sacramento River upstream to the Fish Barrier Dam, RKM 109): The lower Feather River is a tributary to the Sacramento River. Conditions in the lower Feather River are highly influenced by the Oroville Dam facilities located around RKM 116. PCEs present within the lower Feather River include water flow, water quality, depths, and unobstructed migratory pathways (up to the Fish Barrier Dam) to support adult, and possibly subadult, migration. As described above, green sturgeon observed in the lower Feather River are believed to belong to the Southern DPS. Green sturgeon are known to occur in the lower Feather River below Fish Barrier Dam. The presence of adult, and possibly subadult, Southern DPS fish within the lower Feather River has been confirmed by photographs, anglers' descriptions of fish catches *(pers. comm with P. Foley, cited in CDFG 2002*), incidental sightings (*CDWR 2005*), and occasional catches of green sturgeon reported by fishing guides (*Beamesderfer et al. 2004*). Since 2006, several green sturgeon have been observed in the lower Feather River, including one individual tagged in Willapa Bay, WA (*pers. comm. with Alicia Seesholtz, CDWR, July 3, 2008*). Spawning within the lower Feather River is possible, but has not been confirmed (*CDFG 2002; CDWR 2005; Adams et al. 2007).* Several sampling surveys have been conducted in recent years to look for evidence of spawning, but no green sturgeon juveniles, larvae, or eggs have been collected to date (*CDWR 2001; 2002; 2003; 2005*). It is important to note that the sampling methods used may not have been well-suited for sampling green sturgeon juveniles, larvae, and eggs.

Special management concerns are similar to those in the upper and lower Sacramento River, including: the operation of dams and water diversion operations resulting in the alteration of water flow and reduced water quality (including thermal issues associated with the Thermalito Dam); in-water construction or alterations (e.g., bridge repairs, gravel augmentation, bank stabilization); NPDES activities and other activities resulting in non-point source pollution (e.g., agricultural pesticide application, agricultural runoff and outfalls); and habitat restoration activities.

(5) *Lower Yuba River, CA* (from the confluence with the Feather River upstream to the Daguerre Dam, RKM 19): The Yuba River is a tributary to the Feather River. PCEs present include water flow, water quality, depths, and migratory corridors to support adult, and possibly subadult, migration. As described above, green sturgeon observed in the lower Yuba River are believed to belong to the Southern DPS. We have few observations of green sturgeon in the lower Yuba River compared to the Sacramento River and lower Feather River, but there have also been few studies targeting green sturgeon in this area. Of three adult or subadult sturgeon observed below Daguerre Dam in 2006, one was confirmed to be a green sturgeon based on photographs and expert opinions (*pers. comm. with Gary Reedy, SYRCL, December 5, 2006; pers. comm. with Alicia Seesholtz, CDWR, April 24, 2008*). Historical accounts of sturgeon in the Yuba River have been reported by anglers, but these accounts do not specify whether the fish were white or green sturgeon (*Beamesderfer et al. 2004*). Spawning is possible in the river, but has not been confirmed. The CHRT believed that spawning is less likely to occur in the Yuba River than in the Feather River based on

lower documented use of the Yuba River by green sturgeon. We are not aware of any sampling efforts in the lower Yuba River that have focused on early life stages of green sturgeon and no green sturgeon juveniles, larvae, or eggs have been observed in the lower Yuba River to date. The lower Yuba River is subject to the same management concerns as described for the lower Feather River.

(6) *Sacramento - San Joaquin Delta, CA* (the legal Delta, excluding Montezuma Slough): The specific area in the Sacramento-San Joaquin Delta (hereafter referred to as the "Delta") is defined by the legal boundaries of the Delta (California Water Code Section 12220), with one modification. The CHRT defined the boundary between the Delta and Suisun Bay by a line extending from the mouth of Spoonbill Creek across the channel to the city of Pittsburg, CA, resulting in Chipps Island being fully contained within the Suisun Bay specific area. The Delta provides important rearing habitat for juveniles and subadults and important feeding and migratory habitat for juveniles, subadults, and adults. PCEs present within the Delta include: food resources (e.g., shrimp, amphipods, isopods, clams, annelid worms, crabs, and fish); water flow, water quality, and sediment quality to support migration and normal behavior, growth, and viability; and migratory corridors for migration between the Sacramento River system and the adjacent bays. Subadult and adult Southern DPS fish likely occur throughout the Delta. In Spring 2003, one adult over 2 m TL was captured in the Tracy Fish Collection Facility located in the South Delta (*Wang 2006*). Larger numbers of juveniles are caught each year in the South Delta, in the Tracy Fish Collection Facility (operated by the USBR) and the John E. Skinner Delta Fish Protective Facility (operated by the CDWR) (*CDFG 2002*). Juveniles are collected throughout the year in the south Delta and the western Delta at the Federal and state facilities and in gill-net/set-line sampling (*CDFG 2002; Bay Delta and Tributaries Project (BDAT) 2005; 2009*). Relatively large catches of juveniles were taken at the Santa Clara Shoal from June to August, primarily in areas 3 – 8 ft deep (*Radtke 1966*).

Many activities occur within the Delta that may affect the PCEs. Some activities that could alter water flow, reduce water quality, and affect food resources in the Delta include: the operation of water diversions (e.g., pumps, the Delta cross channel, deep-water shipping channel locks); dredging activities and the disposal of dredged material; in-water construction or alterations (e.g., levee building, bank stabilization, sand mining); power plant operations resulting in thermal effluent; habitat restoration activities; and NPDES activities and activities resulting in non-point source pollution (e.g., agricultural returns).

Bays and Estuaries

Southern DPS green sturgeon occupy coastal bays and estuaries from Monterey Bay, CA, to Puget Sound, WA. The Suisun, San Pablo, and San Francisco bays serve as important habitat areas for juvenile, subadult, and adult Southern DPS fish. These bays support rearing, feeding, and growth, and serve as an important migratory/connectivity corridor between the Sacramento River system and coastal marine waters. Outside of their natal system, subadult and adult Southern DPS fish also occupy coastal bays and estuaries in California, Oregon, and Washington, including estuarine waters at the mouths of non-natal rivers. Coastal bays and estuaries provide important summer habitats for subadult and adult green sturgeon, supporting migration, feeding, and growth (*Moser and Lindley 2007; Lindley et al. 2008*). The CHRT considered all coastal bays and estuaries for which there was evidence to confirm the presence of green sturgeon, noting where there were confirmed Southern DPS fish, confirmed Northern DPS fish, or confirmed green sturgeon of unknown DPS. Each specific area was defined to extend from the mouth of the bay or estuary upstream to the head of the tide. As stated in the previous section, based on the definitions for the Northern DPS and Southern DPS, any green sturgeon observed upstream of the head of the tide in freshwater rivers north of and including the Eel River were assigned to the Northern DPS. Thus, areas upstream of the head of the tide on these rivers were not included as part of the occupied specific areas for the Southern DPS. The head of tide locations for each bay or estuary were defined by the CHRT using the best available data from literature references or best professional judgment and are described in more detail in Appendix B. The boundary at the mouth of each bay or estuary was defined by the COLREGS demarcation line. COLREGS demarcation lines delineate "those waters upon which mariners shall comply with the International Regulations for Preventing Collisions at Sea, 1972 (72 COLREGS) and those waters upon which mariners shall comply with the Inland Navigation Rules" (33 CFR 80.01). Waters inside of the 72 COLREGS lines are Inland Rules waters and waters outside of the 72 COLREGS lines are COLREGS waters. The lateral extent for the specific areas in coastal bays and estuaries was defined by the mean higher high water line. The following paragraphs describe the 22 specific areas identified within coastal bays and estuaries.

(1) *Elkhorn Slough, CA* (from the mouth upstream to the head of the tide): A shallow, tidal embayment, Elkhorn Slough is located on the California coast within Monterey Bay. There is very little data on green sturgeon presence in, and use of, Elkhorn Slough. Adult and/or subadult green sturgeon of unknown DPS were collected in Elkhorn Slough and adjacent areas (i.e., Moss Landing Harbor, Jetties Slough, and Bennett Slough) in surveys from the 1970s to 1990s (*Yoklavich et al. 2002*). One green sturgeon skeleton was collected on Moss Landing Beach, just north of Elkhorn Slough (*pers. comm. with D. Catania, cited in Moyle et al. 1992*) and one green sturgeon 546 mm in length was impinged and died at the Moss Landing Power Plant in 2006 (*pers. comm. with Carol Raifsnider, Tenera Consulting, September 12, 2006*). Both green sturgeon were of unknown DPS. Based on the detection of tagged Northern DPS fish and Southern DPS fish in Monterey Bay (*pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008*), green sturgeon in Elkhorn Slough could belong to either the Southern DPS or the Northern DPS. PCEs present in this area include food resources, water quality, and migratory corridors that may support feeding and migration by subadults and adults. Special management concerns for this area include effects on benthic food resources and water quality due to dredging operations, in-water construction or alteration activities, NPDES activities and activities resulting in non-point sources pollution, and operation of the Moss Landing Power Plant.

(2) *Suisun Bay, CA*: Suisun Bay is located adjacent to the Delta, in the Central Valley, CA. The specific area within Suisun Bay extends from the boundary between Suisun Bay and the Delta (delineated by a line extending from the mouth of Spoonbill Creek across the channel to the city of Pittsburg, CA) to Carquinez Bridge, including Montezuma Slough and Suisun Marsh. Suisun Bay supports juvenile, subadult, and adult Southern DPS fish, providing important rearing habitat and an important migratory corridor from the San Pablo and San Francisco bays to and from the Delta and Sacramento River system. PCEs present in this area include food resources (e.g., *Corophium* spp., *Crago franciscorum*, *Neomysis awatchensis*, and annelid worms (*Ganssle 1966*)), depths, water flow, water quality, and migratory corridors to support juvenile rearing, feeding, and migration and subadult and adult feeding and migration. Juvenile Southern DPS fish occupy Suisun Bay throughout the year, with relatively high numbers of juveniles taken in otter/midwater trawl sampling in Carquinez Strait (*Ganssle 1966; CDFG 2002; BDAT 2009*). Adult and subadult Southern DPS fish occupy Suisun Bay and Carquinez Strait from February to December (*pers. comm. with Richard Corwin, USBR, June 5, 2008 and August 13, 2009, unpublished data with Mike Thomas, UC Davis*). Tagged adult and subadult fish exhibited both non-directional movements close to the bottom (indicative of foraging behavior) and directional movements close to the surface, occupying a wide range of temperatures, salinities, and dissolved oxygen levels (*Kelly et al. 2007*). Subadult and/or adult Southern DPS fish also likely occupy the Suisun Marsh and Montezuma Slough in areas up to tidal influence (*pers. comm. with Jeff Stuart, NMFS, February 24-25, 2008*). Activities that may disturb benthic habitats, such as dredging, deposition of dredged material, and in-water construction or alterations (e.g., wharfs, piers, pile driving, bridge construction, bank stabilization) could affect food resources and water quality within the bay.

(3) *San Pablo Bay, CA* (from Carquinez Bridge to Richmond-San Rafael Bridge, including tidally influenced areas of Petaluma River, Napa River, and Sonoma Creek): San Pablo Bay is located between Suisun and San Francisco bays. San Pablo Bay provides important rearing habitat for juvenile Southern DPS fish, as well as summer feeding and rearing habitat for subadults and adults. It also provides a migratory corridor for adults en route to, and from, spawning grounds in the upper Sacramento River. Similar to Suisun Bay, PCEs present include food resources (e.g., *Corophium* spp., *Crago franciscorum*, *Macoma* spp., *Photis california*, *Synidotea laticauda*, unidentified crab, and fish (*Ganssle 1966*)), depths, water quality, and migratory corridors to support juvenile rearing, feeding, and migration, and subadult and adult feeding and migration.

Juveniles are present throughout the year (*Ganssle 1966; CDFG 2002; BDAT 2009*) and subadults and adults occur throughout most of the year (from February to December) (*pers. comm. with Richard Corwin, USBR, June 5, 2008 and August 13, 2009, unpublished data with Mike Thomas, UC Davis*). As in Suisun Bay, tagged subadults and adults exhibited benthic foraging behavior as well as directional movements near the surface, and showed a high tolerance for the range of temperatures, salinities, and dissolved oxygen levels within the bay (*Kelly et al. 2007*). Subadult and/or adult Southern DPS fish have been observed in tidally influenced areas at the mouths of Petaluma River and Napa rivers (*pers. comm. with David Woodbury, NMFS, February 24-25, 2008*). Subadult and adult Southern DPS fish tagged in San Pablo Bay are known to migrate as far south as Monterey Bay, CA, and as far north as Graves Harbor, Alaska, with particularly large concentrations oversummering in the lower Columbia River estuary and Washington estuaries and overwintering in waters off Vancouver Island, British Columbia (*Chadwick, 1959; Miller 1972; CDFG, 2002; Lindley et al. 2008; pers. comm. with Steve Lindley and Mary Moser, NMFS, February 24-25, 2008*). Management concerns for this area are the same as those described for Suisun Bay. In addition, thermal effluent from power plants and pollution from oil refineries and other industries could reduce water quality and thus affect Southern DPS critical habitat.

(4) *San Francisco Bay, CA* (bordered by Richmond-San Rafael Bridge and the mouth of the bay, including tidally influenced areas of tributaries and sloughs in south San Francisco Bay): San Francisco Bay is a large estuary located along the central California coast, connecting the San Pablo and Suisun bays to the Pacific Ocean. San Francisco Bay provides important rearing and migratory habitat for juvenile Southern DPS green sturgeon prior to entering marine waters. It also provides an important migratory corridor for subadults and adults from the ocean to and from the bays and Sacramento River system. Similar to Suisun and San Pablo bays, the PCEs present include food resources, depths, water quality, and migratory corridors to support rearing, feeding, and migration of juveniles, and feeding and migration of subadults and adults. Juveniles are believed to be present throughout the year (*CDFG 2002*). Subadults and adults are present from February through December, with some individuals outmigrating from the Sacramento River in December or as late as February of the next year (*pers. comm. with Richard Corwin, USBR, June 5, 2008 and August 13, 2009, unpublished data with Mike Thomas, UC Davis*). Southern DPS fish in the San Francisco Bay exhibited behavior similar to that observed in Suisun and San Pablo bays (*Kelly et al. 2007*). Subadults and adults likely occur within tidally influenced areas of the sloughs surrounding San Francisco Bay (*pers. comm. with Jeff Stuart, NMFS, February 24-25, 2008*). Activities that may affect the PCEs in San Francisco Bay are similar to those in Suisun and San Pablo bays. Water quality and sediment quality are major concerns in San Francisco Bay, due to effects from the densely populated areas bordering the bay. The waters and sediments of San Francisco Bay have been listed as impaired due to levels of mercury, chlordane, diazinon, dieldrin, dioxin compounds, PCBs, DDT, selenium, PAHs, zinc, and other contaminants (California's Final 2002 303(d) List, available at: http://www.epa.gov/region09/water/tmdl/303d-2002.html). In addition, a proposed tidal energy project at the Golden Gate Bridge could alter passage and migration of green sturgeon.

(5) *Tomales Bay, CA* (from the mouth upstream to the head of the tide, including tidally influenced areas of Lagunitas Creek and Walker Creek): Tomales Bay is a long,

narrow inlet located just north of San Francisco Bay in Marin County, CA. Tomales Bay provides good habitat for benthic foragers, with lots of shallow flat areas between 1 - 2 m in depth. PCEs present include food resources and water quality to support subadults and adults. Small numbers of green sturgeon have been observed in Tomales Bay *(Blunt 1980, cited in Moyle et al. 1992; pers. comm. with D. Catania and R. Plant, cited in Moyle et al. 1992*). It is not known whether the fish belong to the Northern DPS or to the Southern DPS, and there are currently no receivers in the bay to detect tagged green sturgeon. Special management concerns for Tomales Bay include effects on food resources and water quality from various activities, including aquaculture (i.e., oyster farming), in-water construction or alterations (e.g., wharf construction, recreational boat launches, pile driving, bank stabilization), water diversions (in the upstream basin), point and non-point source pollution (e.g., agricultural runoff), and habitat restoration. Sediment contamination and high mercury levels have also resulted from historical mining activities.

(6) *Noyo Harbor, CA*: Noyo Harbor is located at the mouth of the Noyo River in Mendocino County, CA, north of Tomales Bay. Aside from one specimen collected from the Noyo River (*pers. comm. with D. Catania, cited in Moyle et al. 1992*), there are no other data on the presence of green sturgeon in the area. It is not known whether the green sturgeon collected belonged to the Northern DPS or the Southern DPS. PCEs present include food resources and water quality to support subadults and adults. The habitat may not be as suitable for green sturgeon as in Tomales Bay, because there are few mudflats and the harbor is highly dredged. Management concerns include effects on food resources, water quality, and sediment quality due to dredging activities and point and non-point source pollution (e.g., high sediment loads resulting from logging operations upstream).

(7) *Humboldt Bay system, CA*: The Humboldt Bay system, located on the northern California coast, is a deep water bay with a narrow opening at the mouth that opens into Arcata Bay to the north and Humboldt Bay to the south. The Humboldt Bay system contains PCEs including food resources, water quality, and migratory corridors to support subadult and adult green sturgeon. Survey records indicate green sturgeon are commonly observed in the Humboldt Bay system, with larger numbers taken in Arcata Bay. In South Humboldt Bay, 3 green sturgeon were caught in trawl surveys conducted over 10 years (*Samuelson 1973, cited in Moyle et al. 1992*). In Arcata Bay, 50 green sturgeon ranging in size from 57.2 – 148.6 cm TL were tagged in August 1956 (data recovered from CDFG files by D. Kohlhorst; *pers. comm. with D. Kohlhorst, cited in Moyle et al. 1992*) and 9 green sturgeon ranging from 73 – 112 cm TL were caught in 1974 (*Sopher 1974, cited in Moyle et al. 1992*). More recently, 8 green sturgeon (78 – 114 cm TL) were collected in 1988 and 1989 (*Moyle et al. 1992*), and additional green sturgeon were captured and tagged in 1992 and 1993 in Arcata Bay (*CDFG 2002*).

The Humboldt Bay system is believed to be an important oversummering habitat for Southern DPS green sturgeon, for feeding, growth, and migration. Tagged Southern DPS subadults and adults were detected in the Humboldt Bay system in 2006 and

2007 (*Pinnix 2008b*), including fish tagged in San Pablo Bay (detections: n = 6 in 2006; n = 16 in 2007) and in the Sacramento River (detections: n = 3 in 2007). Tagged Southern DPS fish spent several months within the system, entering in April to June and remaining until September and October, with larger numbers of detections in Arcata Bay (*Pinnix 2008a*). Green sturgeon of unknown DPS (tagged in Willapa Bay and Grays Harbor, WA) were also detected in the system in 2006 (n = 3) and in 2007 (n = 6) (*Pinnix 2008b*).

Activities occurring in the Humboldt Bay system that may affect the PCEs include: dredging and disposal of dredged material; in-water construction and alteration activities; and NPDES activities and other activities resulting in non-point source pollution (e.g., industrial pollution, sewer outfalls, commercial shipping) that could reduce water quality. Oyster aquaculture operations conducted in Humboldt Bay could alter benthic habitats and affect food resources, but are believed to occur in deeper benthic areas that are typically not used by green sturgeon for foraging.

(8) *Eel River, CA* (from the mouth to the head of the tide): The Eel River estuary is located on the northern California coast in Humboldt County, just south of Humboldt Bay. PCEs present include food resources, water flow, water quality, and migratory corridors to support subadult and adult green sturgeon. The presence of Southern DPS green sturgeon is likely, but not confirmed, based on the presence of Northern DPS adult, subadult, and juvenile green sturgeon in the estuary (*pers. comm. with S. Cannata, CDFG, cited in CDFG 2002*) and in the river (*Murphy and DeWitt 1951, cited in Moyle et al. 1992; CDFG 2002*). An acoustic receiver installed in 2007 detected one tagged Northern DPS green sturgeon in the estuary in 2008 (*pers. comm. with Steve Lindley, NMFS, May 8, 2008*), and may provide more information on use of the area by tagged Southern DPS and Northern DPS fish in the future. Management concerns include altered food resources and water quality resulting from timber harvest upstream, road building, gravel mining, grazing, levee modifications, and other in-water construction or alterations.

(9) *Klamath/Trinity rivers, CA* (from the mouth to the head of the tide): The Klamath/Trinity River estuary is located along the northern California coast, in southwestern Del Norte County. The estuary contains food resources, water flow, water quality, and migratory corridors for subadult and adult migration. Northern DPS green sturgeon are known to spawn in the Klamath/Trinity river and occur within the estuary and further upstream (*Adams et al. 2002*). The presence of Southern DPS fish is categorized as likely based on the presence of Northern DPS fish. Although tagged Southern DPS subadults and adults have been observed in coastal marine waters outside the mouth of the estuary, no tagged Southern DPS fish have been detected in the estuary (*pers. comm. with Steve Lindley, NMFS, March 5, 2008*). A low proportion of green sturgeon sampled in the Klamath/Trinity River were assigned to the Southern DPS based on genetic analyses (10-16%, or 16 fish, of 124 sampled) (*Israel and May 2006*). However, there is a measure of error in the genetic analysis and in the assignment of samples to the Northern DPS or Southern DPS (*Israel et al. In review*), which may account for the low proportion of green

sturgeon assigned to the Southern DPS. Special management concerns for the Klamath/Trinity River estuary include in-water construction or alterations (e.g., timber harvest, road construction and maintenance) that could affect food resources and reduce water quality.

(10) *Rogue River, OR* (from the mouth to the head of the tide): The Rogue River estuary is located on the southern Oregon coast, adjacent to the city of Gold Beach in Curry County. The estuary provides PCEs including food resources, water flow, water quality, and migratory corridors for subadult and adult migration. Northern DPS green sturgeon have been confirmed to spawn in the Rogue River (*Erickson et al. 2002; Farr and Kern 2005; Webb and Erickson 2007*). The presence of Southern DPS fish is categorized as likely based on the presence of Northern DPS fish, but thus far, no tagged Southern DPS subadults or adults have been detected in the Rogue River estuary (*pers. comm. with Steve Lindley, NMFS, March 5, 2008*). A low proportion of green sturgeon sampled in the Rogue River have been assigned to the Southern DPS based on genetic analyses (8.3 – 15.2%, or 13 fish, of 113 fish sampled) (*Israel and May 2006*), but, as described above, there is a measure of error in the genetic analyses and in the assignment of samples to the Northern DPS or Southern DPS (*Israel et al. In review*).

Several special management concerns exist for the Rogue River estuary. The lower estuary is highly modified, due to filling of the estuary for dikes, a marina, and the development of and placement of riprap along the north shore (*Hicks 2005*). These modifications could affect water quality, water flow, and food resources for green sturgeon.

(11) *Coos Bay, OR*: Coos Bay is located in Coos County in southwestern Oregon. Coos Bay is the deepest and largest of the occupied bays on the Oregon coast and is consistently occupied by green sturgeon. Coos Bay provides important summer habitat for subadult and adult green sturgeon. Oregon sport fishery catch data show 201 green sturgeon caught in Coos Bay from 1986 to 2007 (*ODFW 2009a, b*). From February 2000 to February 2004, ODFW captured and collected tissue samples from 12 green sturgeon (DPS unknown) in Coos Bay (*Rien et al. 2000; Farr et al. 2001; Farr and Rien 2002; Farr and Rien 2003; Farr and Kern 2004; Farr and Kern 2005*). Tagged green sturgeon have been detected during each of the three years that monitoring occurred from 2004 to 2006, including Southern DPS subadults and adults from San Pablo Bay (*Lindley and Moser, unpublished data, cited in the Memo to the Record from C. Grimes, October 23, 2006; pers. comm. with Dan Erickson, ODFW, et al., September 3, 2008*). PCEs present include food resources, water flow, water quality, and migratory corridors to support migration and possibly feeding by subadult and adult green sturgeon. Several activities could affect these PCEs, however, including road building (resulting in sedimentation), a proposed liquefied natural gas (LNG) project, dredging, urbanization (resulting in pollution and increased peak flows), commercial shipping, stream channelization, wetland filling and draining, and development and silviculture (resulting in the loss

of large woody debris and forested land cover) (*Lower Pony Creek Watershed Committee 2002; Oregon Department of Forestry 2004*).

(12) *Winchester Bay, OR*: Winchester Bay is located at the mouth of the Umpqua River, in Douglas County, Oregon. Winchester Bay is a large, deep bay with the greatest numbers of green sturgeon among the occupied bays in Oregon. Adult and subadult green sturgeon occupy the bay during summer months. PCEs present include food resources, water flow, water quality, and migratory corridors to support migration and possible feeding by subadult and adult green sturgeon. The sport fishery catch for green sturgeon in Winchester Bay is greater than in other coastal bays and estuaries in Oregon, with 1,889 green sturgeon caught from 1986 to 2007 (*ODFW 2009a, b*). Also, from February 2000 to February 2001, 126 green sturgeon were captured in Winchester Bay and tissue samples collected (*Rien et al. 2000; Farr et al. 2001*). The presence of Southern DPS green sturgeon in Winchester Bay has been confirmed based on tagging studies and genetic analyses. Tagged Southern DPS subadults and adults were detected in Winchester Bay in the 1950s (one green sturgeon, 117 cm TL, tagged in San Pablo Bay; *Chadwick 1959*) and more recently in 2006 (*pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008*). The proportion of green sturgeon assigned to the Southern DPS varied across sample years (ranging from a little over 50% in 2000 to a little over 20% in 2002), but may have been influenced by differences in the sample size across years (*Israel et al. In review*). Green sturgeon have been observed upstream of the head of the tide in Umpqua River, including one adult (1.8 m in length) caught at RKM 164 in April 1979 and two juveniles (about 10 cm in length) regurgitated from two smallmouth bass caught at RKM 134 in July 2000 (*BRT 2005*). These green sturgeon are believed to belong to the Northern DPS, based on our definition of the Southern DPS and our assumption that Southern DPS fish do not occur upstream of the head of tide in non-natal rivers. No green sturgeon were observed above tidal influence in the Umpqua River in sampling surveys conducted by the ODFW in 2002, 2003, and 2004 (*BRT 2005*). No sonic-tagged green sturgeon were detected by receivers above RKM 24 over a 3-year period of monitoring (the next receiver was anchored at RKM 33). Green sturgeon carrying sonic transmitters have been detected as early as April 21 and as late as December 8. Green sturgeon carrying sonic transmitters have not been found in this estuary during the months of January – March (*pers. comm. with Dan Erickson, ODFW, et al., September 3, 2008*).

Several activities occurring in the bay could affect the PCEs, including channel modifications/diking, road building (sedimentation), wetland filling and draining, other in-water construction or alterations (e.g., docks, marinas, stream channelization), urbanization (pollution and increased peak flows), NPDES activities and activities resulting in non-point source pollution (e.g., urbanization), and development and silviculture (loss of large woody debris and forest land cover) (*USDA Forest Service 1997; Oregon Department of Forestry 2004*).

(13) *Siuslaw River, OR* (from the mouth to the head of the tide): The Siuslaw River estuary is located in Lane County on the Oregon coast. PCEs in this area include water flow, water quality, and migratory corridors to support migration by subadults and adults. Several management concerns exist regarding in-water construction or alterations affecting habitat. For example, tide gates have restricted water flow and may affect passage, forestry and road building activities have increased landslides and sedimentation, forestry and grazing activities have impaired riparian vegetation, diking and levee construction may alter water flow and water quality, and the loss of large woody debris and forest land cover may affect water quality (*USDI Bureau of Land Management 1996; USDA Forest Service 1998; Ecotrust and Siuslaw Watershed Council 2002*). Little data exists on green sturgeon use of the Siuslaw River estuary. Green sturgeon adults and subadults are considered rare in the area (*Emmett et al. 1991*). The sport fishery catch records for this area report 50 green sturgeon caught from 1986 to 2007 (*ODFW 2009a, b*). Northern DPS fish tagged in the Rogue River were detected in the Siuslaw River estuary in 2006, but no Southern DPS fish have ever been detected in the area (*pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008*).

(14) *Alsea River, OR* (from the mouth to the head of the tide): The Alsea River estuary is located near the city of Waldport in Lincoln County on the Oregon coast. PCEs present in the area include water flow, water quality, and migratory corridors to support migration by subadults and adults. Several activities occur within the estuary that may affect these PCEs. For example, modified hydrology associated with forestry and road building activities may lead to loss of appropriate channel substrates; impaired riparian vegetation and loss of large woody debris and forest land cover may result from forestry, road building, agriculture, grazing, and residential development; overallocation of surface water for irrigation and municipal uses alters water flow and water quality; and diking and filling of wetlands may affect benthic habitats (*USDA Forest Service et al. 1999*). Very little data exist on green sturgeon within the Alsea River estuary. Emmett *et al.* (1991) report that green sturgeon adults and subadults are rare in the area. The sport fishery catch records for this area report 30 green sturgeon caught from 1986 to 2007 (*ODFW 2009a, b*). In addition, one tagged Northern DPS green sturgeon was detected in Alsea River estuary on June 6, 2006, but no Southern DPS green sturgeon have been detected in this area (*pers. comm. with Dan Erickson, ODFW, et al., September 3, 2008; data provided by Dr. Jim Powers, EPA, Newport, OR*).

(15) *Yaquina Bay, OR* (from the mouth to the head of the tide): Yaquina Bay is a small bay located at the mouth of Yaquina River, near Newport in Lincoln County, Oregon. PCEs present include water flow, water quality, and migratory corridors to support migration by subadults and adults. Several activities may affect these PCEs, including dredging of the lower estuary, in-water construction (e.g., urbanization; diking and draining of wetlands for urban development, agriculture, and grazing), and development and silviculture (resulting in the loss of large woody debris and forest land cover) (*Brophy 1999; Jones and Moore 2000; Garono and Brophy 2001*). Green sturgeon are reported to be common in Yaquina Bay (*Emmett et al.*

1991), but have not been observed upstream of the head of the tide. Green sturgeon are most likely using the bay as oversummering habitat, though to a lesser extent than Winchester Bay and Coos Bay. Sport fishery catch records show 201 green sturgeon caught in this area from 1986 to 2007 (*ODFW 2009a, b*). From February 2000 to February 2004, 24 green sturgeon adults and/or subadults were captured by ODFW in Yaquina Bay and tissue samples were collected (*Rien et al. 2000; Farr et al. 2001; Farr and Rien 2002; Farr and Rien 2003; Farr and Kern 2004; Farr and Kern 2005*). The presence of Southern DPS green sturgeon has been confirmed in Yaquina Bay, based on the detection of one Southern DPS fish (tagged in the Sacramento River in 2005) near the jetty on May 5, 2006 (*pers. comm. with Dan Erickson, ODFW, et al., September 3, 2008; data provided by Dr. Jim Powers, EPA, Newport, OR*).

(16) *Tillamook Bay, OR* (from the mouth to the head of the tide): Tillamook Bay is a small inlet located on the northern Oregon coast in Tillamook County. PCEs present in the bay include water flow, water quality, and migratory corridors to support migration of subadults and adults. Several activities occur within the bay that may affect these PCEs. For example, water quality may be affected by dredging (to support ocean traffic), forestry, grazing, agriculture, and urbanization in and around the bay (*Tillamook Bay National Estuary Project 1999*). The benthic habitat, water flow, and water quality may be modified by wetland diking, filling, and draining related to grazing and agriculture, as well as stream channelization and the loss of large woody debris and forested land cover resulting from development and silviculture (*Tillamook Bay National Estuary Project 1999*). The presence of Southern DPS fish is likely based on the presence of green sturgeon of unknown DPS, but not confirmed. Green sturgeon are reported to be rare in Tillamook Bay (*Emmett et al. 1991*), but the sport fishery catch data for Tillamook Bay reports 279 green sturgeon caught from 1986 to 2007, a number comparable to the green sturgeon catch in Coos Bay and Yaquina Bay over the same period (*ODFW 2009a, b*). From February 2000 to February 2004, 9 green sturgeon adults and/or subadults were captured in sampling surveys by ODFW and tissue samples collected (*Rien et al. 2000; Farr et al. 2001; Farr and Rien 2002; Farr and Rien 2003; Farr and Kern 2004; Farr and Kern 2005*). Green sturgeon have not been observed upstream of the head of the tide.

(17) *Nehalem Bay, OR* (from the mouth to the head of tide): Nehalem Bay is located on the Oregon coast between Tillamook Bay and the Columbia River estuary. Nehalem Bay is the fourth largest estuary on the Oregon coast, with extensive marshes and tidal flats (The Nehalem Estuary, Critical Wetlands, available at: http://www.nehalemtel.net/~lnwcouncil/Assessment/Estuary/ESTUARY.pdf). In the initial biological assessment for the proposed critical habitat designation, the CHRT had not identified Nehalem Bay as an occupied specific area for consideration in their analyses. During the public comment period, the ODFW provided additional information confirming that green sturgeon occupy Nehalem Bay and the area contains PCEs that may require special management considerations or protection. Sport fishery catch data records show a total of 254 green sturgeon caught in

Nehalem Bay from 1986 to 2007 (*ODFW 2009a; 2009b*). However, no genetic or telemetry data have been collected to determine whether the green sturgeon caught belong to the Northern DPS or the Southern DPS. PCEs present include water quality and migratory corridors to support subadult and adult green sturgeon. Activities occurring in the bay that may affect water quality and the benthic habitat include dredging (to support ocean traffic), forestry, grazing, agriculture, urbanization in and around the bay, wetland diking and filling, stream channelization, and the loss of large woody debris and forested land cover resulting from development and silviculture.

(18) *Lower Columbia River and estuary*: The lower Columbia River and estuary provide important summer habitat for Northern DPS and Southern DPS green sturgeon. From 1985-2001, large numbers of green sturgeon (ranging from 1,000s in the 1980s to 100s in more recent years) were caught as bycatch in the white sturgeon fishery in the Columbia River (*Beamesderfer 2000, cited in Adams et al. 2002*). Green sturgeon occupy the lower Columbia River as far upstream as Bonneville Dam (RKM 146), but large concentrations of green sturgeon predominately occur in the lower 60 rkm (*WDFW, 2002, Letter to Ms. Donna Darm (5 pp., plus enclosures, 28 pp.), cited in Adams et al. 2002; WDFW and ODFW 2002*). Green sturgeon primarily aggregate in the estuary during the summer, with peak abundance in August (*Adams et al. 2002*), presumably for optimization of growth and feeding (although all of 50 green sturgeon stomachs examined to date have been empty (*Rien 2001*)). There is no evidence for spawning by green sturgeon within the lower Columbia River and estuary, although at least one ripe adult was observed *(WDFW, 2002, Letter to Ms. Donna Darm (5 pp., plus enclosures, 28 pp.), cited in Adams et al. 2002*).

In the draft biological report to support the proposed critical habitat designation, the CHRT delineated one specific area in the lower Columbia River and estuary that extended from the river mouth to the upstream extent of green sturgeon occupancy at Bonneville Dam (RKM 146). During the public comment period, however, several commenters requested that the lower Columbia River and estuary be divided into two specific areas, one representing the lower estuary (from the river mouth to the maximum extent of saltwater intrusion at approximately RKM 74) and one representing the lower river consisting of tidal freshwater (from RKM 74 to Bonneville Dam at RKM 146) (*Johnson et al. 2003*). The CHRT agreed that the lower Columbia River and estuary should be divided into two specific areas, based on differences in environmental parameters and green sturgeon use and presence in the lower estuary (RKM 0 to 74) and the lower river (RKM 74 to 146). These two specific areas are described below.

(a) *Lower Columbia River estuary* (from the river mouth (RKM 0) upstream to RKM 74, including tidally influenced waters of tributaries): The specific area within the lower Columbia River estuary extends from the mouth of the Columbia River to RKM 74, including tributaries to the upstream extent of tidal influence. The lower Columbia River estuary contains important summer habitats to support aggregations of green sturgeon, a large proportion of which are Southern DPS green sturgeon (ranging from around 70% to almost 90% of the 175 green sturgeon sampled) (*Israel et al. In review*). Tagging studies have also confirmed the presence of Southern DPS green sturgeon in the lower Columbia River estuary. Tagged Southern DPS fish from San Pablo Bay and the Sacramento River were detected in the lower Columbia River estuary in the 1950s (two green sturgeon tagged in San Pablo Bay; *Chadwick 1959*), in the 1960s to 1970s (one green sturgeon tagged in San Pablo Bay; *Miller 1972*), and in 2005 and 2006 (*pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008*). Based on CDFG tagging studies from September 1954 to October 1990, Southern DPS green sturgeon occupy the lower Columbia River estuary from July to December (n = 8 fish, 104 - 130 cm TL; *CDFG 2002*).

Commercial gillnet harvest data for green sturgeon from 1981 – 2004 (*pers. comm. with Brad James, WDFW, May 31, 2007*) show greater numbers of green sturgeon catch in this specific area compared to the lower Columbia River upstream of RKM 74. Green sturgeon harvest was high in zone 1 (RKM 1 – 32; harvest = 29,124 green sturgeon) and zone 2 (RKM 32 – 84; harvest = 8,082 green sturgeon), but declined sharply upstream of RKM 84, with a total of 290 green sturgeon caught in zones 3-5 (RKM 84 – 227) (*pers. comm. with Brad James, WDFW, May 31, 2007*). Observations by WDFW and ODFW also indicate concentrations of green sturgeon in the lower estuary with fewer numbers moving upstream. Unpublished telemetry data support these observations, showing greater numbers of detections of both Southern DPS and Northern DPS green sturgeon in the lower portion of the estuary compared to the upper portion (*pers. comm. with Mary Moser, NMFS NWFSC, February 25, 2009*). However, because the most upstream monitor location is at RKM 74, the telemetry data describe the distribution of tagged Southern DPS and Northern DPS fish within the lower estuary but do not provide any information on the movement and distribution of tagged green sturgeon upstream of RKM 74. Tagged Southern DPS green sturgeon have been detected at the monitor at RKM 74 and are able to access the lower Columbia River upstream of RKM 74, though data are not available to determine the proportion of Southern DPS green sturgeon moving upstream of RKM 74, or the relative levels of Southern DPS and Northern DPS fish in this area.

PCEs present include food resources, water flow, water quality, depth, and migratory corridors to support migration, aggregation and holding, and feeding by subadult and adult green sturgeon. Many activities occur in the lower Columbia River estuary that may affect the PCEs, including: dredging activities that could affect food resources; dams and other in-water construction or alterations (e.g., wetland diking, filling, and draining, urbanization, docks, marinas) that could alter water flow and quality; and NPDES activities and activities resulting in non-point source pollution (e.g., waterborne and sediment-associated chemical contaminants, commercial shipping) that could also reduce water quality (*Lower Columbia River Estuary Program 1999; Lower Columbia River Fish Recovery Board 2004*). Activities associated with the construction and operation of proposed LNG terminals in the lower Columbia River estuary include dredging, pile driving, and in-water construction, which may affect water quality, sediment quality, and food resources. Impoundment of the Columbia River by hydropower dams has altered the hydrograph in the Columbia River estuary and offshore plume. This has likely altered habitat available to green sturgeon, particularly in the summer months.

(b) *Lower Columbia River* (from RKM 74 to Bonneville Dam (RKM 146), including tidally influenced waters of tributaries but excluding Willamette River): The specific area within the lower Columbia River extends from the maximum extent of saltwater intrusion (RKM 74) to the upstream extent of green sturgeon occurrence (Bonneville Dam at RKM 146). The specific area includes tidally influenced waters of tributaries to the lower Columbia River, but excludes the Willamette River. Although recreational fishery data report that a few green sturgeon have been caught in the tidally influenced portion of the Willamette River, these are believed to be misidentified white sturgeon, and biologists from WDFW and ODFW both commented that there is no evidence green sturgeon occur in the Willamette River or Multnomah Channel (*pers. comm. with Olaf Langness, WDFW, to Steve Stone, NMFS, February 27, 2009; pers. comm. with Tom Rien, ODFW, to Steve Stone, NMFS, March 3, 2009*). Thus, the CHRT agreed that the Willamette River should not be included as part of this specific area.

As described above, large numbers of green sturgeon occupy the lower Columbia River and estuary during the summer months, but predominately occur in the lower 60 RKM (*WDFW, 2002, Letter to Ms. Donna Darm (5 pp., plus enclosures, 28 pp.), cited in Adams et al. 2002; WDFW and ODFW 2002*). From 1981 – 2004, 37,206 green sturgeon were harvested in the commercial gillnet fishery in the lower estuary from the mouth to RKM 74, compared to only 290 green sturgeon harvested in the river from RKM 74 to 146 (*pers. comm. with Brad James, WDFW, May 31, 2007*). Effort may have been greater in the lower estuary, but observations by WDFW and ODFW also indicate concentrations of green sturgeon in the lower estuary with fewer numbers moving upstream. It is likely that the lower Columbia River upstream of RKM 74 was a historically important area for green sturgeon prior to the hydrographical changes that have occurred in the river, and the area may be important during certain water years (*pers. comm. with Mary Moser, NMFS, August 17, 2009*).

The CHRT determined that the presence of Southern DPS green sturgeon is confirmed within the lower river from RKM 74 to 146. Although hydroacoustic receivers have not yet been installed upstream of RKM 74, tagged Southern DPS green sturgeon are detected at RKM 74 and are able to access the lower Columbia River upstream of RKM 74. Thus, the presence of Southern DPS green sturgeon is confirmed for this area.

The PCEs present are the same as those present in the lower estuary: food resources, water flow, water quality, depth, and migratory corridors to support migration, aggregation and holding, and feeding by subadult and adult green sturgeon. Similar to the lower estuary, many activities occur in the lower Columbia River that may affect the PCEs, including dredging activities, the operation of dams, in-water construction or alterations, and NPDES activities and activities resulting in non-point source pollution (*Lower Columbia River Estuary Program 1999; Lower Columbia River Fish Recovery Board 2004*). As described for the lower estuary, the construction and operation of hydropower dams has altered the hydrograph in the lower Columbia River and likely altered the habitats available to green sturgeon. Unlike the lower estuary, there are currently no proposed LNG projects in this specific area.

(19) *Willapa Bay, WA* (from the mouth to the head of the tide, including tidally influenced waters of tributaries): Willapa Bay is located north of the Columbia River on the southwestern Washington state coast, in Pacific County. Two main tributaries to Willapa Bay are Willapa River and Naselle River. Willapa Bay is recognized as an important oversummering habitat for green sturgeon. Willapa Bay is a very productive estuary with abundant food resources (e.g., burrowing shrimp, other benthic invertebrates) to support feeding by adult and subadult green sturgeon, based on gut content studies (*Moser and Lindley 2007; Dumbauld et al. 2008*) and anecdotal accounts (*Feldman et al. 2000*). Other PCEs present in this area include water flow, water quality, depth, and migratory corridors to support migration, aggregation, and holding by subadult and adult green sturgeon. Green sturgeon are reported to be more common in Willapa Bay than white sturgeon (*Emmett et al. 1991*). Historically, the largest harvests of green sturgeon occurred in Willapa Bay, ranging from about 3,000 to 4,000 fish per year in the 1960s, but harvests have declined to few or none in recent years (*WDFW, 2002, Letter to Ms. Donna Darm (5 pp., plus enclosures, 28 pp.), cited in Adams et al. 2002*). Large concentrations of green sturgeon aggregate in Willapa Bay in the summer months and occur from May to November (*Adams et al. 2002; Moser and Lindley 2007*), including both Northern DPS and Southern DPS fish. Tagged green sturgeon from all spawning areas have been detected in Willapa Bay from 2002 – 2004 (*pers. comm with Steve Lindley, NMFS, and Mary Moser, NMFS, cited in BRT 2005; Moser and Lindley 2007*). Genetic analyses indicate that a large proportion of green sturgeon in the bay belong to the Southern DPS (greater than 70% of the 98 green sturgeon sampled) (*Israel et al. In review*). Green sturgeon are believed to optimize growth potential by foraging in the estuary (*Moser and Lindley 2007*). Tagged green sturgeon exhibited a high degree of intra-estuarine movement throughout Willapa Bay as well as inter-estuarine movement between Willapa Bay and the Columbia River estuary (*Moser and Lindley 2007*).

Several activities occur within the estuary that may affect the PCEs and require special management. The pesticide carbaryl is used by oyster aquaculture operations to control burrowing shrimp, thereby reducing this important food resource for green sturgeon (*Feldman et al. 2000; Moser and Lindley 2007*). Dredging operations (for oysters), in-water construction or alteration (e.g., bank stabilization, aids to navigation), and pollution from NPDES activities and activities resulting in non-point source pollution could affect water quality, depths, or benthic food resources. In addition, the spread of non-native grasses such as *Spartina alterniflora* on mudflats may inhibit access to mudflats for foraging and alter the composition of benthic invertebrate communities that serve as food resources for green sturgeon (*pers. comm. with Mary Moser, NMFS, February 24-25, 2008*).

(20) *Grays Harbor, WA* (from the mouth to the head of the tide, including tidally influenced waters of tributaries): Grays Harbor is an estuarine bay located in Grays Harbor County on the Washington state coast, north of Willapa Bay. Like the lower Columbia River estuary and Willapa Bay, Grays Harbor provides important oversummering habitat for both adult and subadult Northern DPS and Southern DPS green sturgeon. Green sturgeon have been detected at the mouth of the Chehalis River and at Sturgeon Landing, but not upstream of the head of the tide. PCEs present in this area include food resources, water flow, water quality, depth, and migratory corridors to support feeding, migration, and aggregation and holding by green sturgeon adults and subadults. Large concentrations of green sturgeon occur in Grays Harbor, with peak abundances in August (*Adams et al. 2002*). Historically large numbers of green sturgeon were caught in tribal and commercial fisheries, for a total of about 500 green sturgeon landed per year (*WDFW, 2002, Letter to Ms. Donna Darm (5 pp., plus enclosures, 28 pp.), cited in Adams et al. 2002*). The presence of Southern DPS green sturgeon in Grays Harbor has been confirmed by both genetic analyses and tagging data. Genetic analyses indicate that about 40% of the green sturgeon sampled (n = 82 green sturgeon) in this area belong to the Southern DPS (*Israel et al. In review*). One Southern DPS fish tagged in San Pablo Bay in October 1967 was recaptured in Grays Harbor on July 25, 1969 (*Miller 1972*). In CDFG tagging studies from September 1954 to October 1990, 3 Southern DPS green sturgeon (106 – 127 cm TL) tagged in San Pablo Bay were recaptured in Grays Harbor in the commercial gill net fishery (*CDFG 2002*). In 2006, several Southern DPS fish tagged in San Pablo Bay and the Sacramento River were detected in Grays Harbor (*pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008*). Some individual green sturgeon spend the entire summer in Grays Harbor, whereas others move between estuaries. The estuary is believed to provide refuge and abundant food resources to support optimal growth potential in green sturgeon (*Moser and Lindley 2007*).

Similar to Willapa Bay, several activities occur within Grays Harbor that may affect the PCEs and require special management. Application of carbaryl in association with oyster aquaculture to control burrowing shrimp populations affects this important food resource, and possibly other prey species, for adult and subadult green sturgeon. Commercial shipping and pollution from point and non-point sources (e.g., agriculture, pulp mill runoff) may also reduce water quality with the discharge of contaminants into the water.

(21) *Puget Sound, WA*: Puget Sound is a large bay/estuary extending from the Strait of Juan de Fuca at the northern Washington state coast south to Olympia, WA. The mouth separating Puget Sound from the Strait of Juan de Fuca is defined at Admiralty Inlet. PCEs present within Puget Sound include food resources, water flow, water quality, depths, and migratory corridors for feeding, migration, aggregation, and holding by subadult and adult green sturgeon. Observations of green sturgeon in Puget Sound are much less common compared to the other estuaries in Washington. A few green sturgeon adults and/or subadults have been incidentally captured in fisheries harvest in Puget Sound, mostly in trawl fisheries (*Adams et al. 2002*). Both Northern DPS and Southern DPS green sturgeon adults and/or subadults have been detected in the area. In 2006, two Southern DPS green sturgeon tagged in San Pablo Bay were detected near Scatchet Head, south of Whidbey Island (*pers. comm. with Mary Moser, NMFS, March 7, 2008*). The extent to which Southern DPS green sturgeon use Puget Sound is unknown. Because Puget Sound is a large, closed system, green sturgeon entering the area may reside for a long time. One tagged green sturgeon was detected over several months over a two year period, suggesting the fish was foraging and perhaps holding or resting in the area. No tagged green sturgeon of either DPS has been detected in Hood Canal (*pers. comm. with Mary Moser, NMFS, February 24-25, 2008*).

The activities occurring in Puget Sound and the special management concerns associated with them are similar to those in Willapa Bay and Grays Harbor. The application of carbaryl for oyster aquaculture and its effects on burrowing shrimp and other prey populations is also a concern in Puget Sound. Dredging and in-water construction or alterations (e.g., pile driving, bridge construction, bank stabilization) could affect benthic habitats and alter water flow and water quality. In addition, pollution from commercial shipping and NPDES activities and activities generating non-point source pollution could reduce water quality within the area, particularly in the areas near large urbanized cities like Seattle.

Coastal Marine Waters

Subadult and adult green sturgeon spend most of their lives inhabiting marine and estuarine waters from southern California to Alaska. The best available data suggest that these are important habitats within which green sturgeon make seasonal, long-distance migrations most likely associated with foraging and aggregation areas along the coast. Green sturgeon primarily occur within the 110 m depth bathymetry (*Erickson and Hightower 2007*). Green sturgeon tagged in the Rogue River and tracked in marine waters typically occupied the water column at 40 – 70 m depth, but made rapid vertical ascents to or near the surface, for reasons yet unknown (*Erickson and Hightower 2007*). Based on tagging studies of both Southern DPS and Northern DPS fish, green sturgeon primarily spend their time in coastal marine waters migrating between coastal bays and estuaries, including sustained long-distance migrations of up to 100 km per day (pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, cited in BRT *2005*), most likely driven by food resources. Some tagged individuals were observed swimming at slower speeds and spending long periods of time (on the order of days) within certain areas, suggesting these individuals were foraging (*pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008*).

Within the geographical area occupied (i.e., the U.S.-California/Mexico border to the Bering Sea, AK), the CHRT divided the coastal marine waters into 12 specific areas between those estuaries or bays where Southern DPS presence is categorized as confirmed (see Appendix A for further information on how areas in coastal marine waters meet the definition of specific areas eligible for consideration as critical habitat). The presence of green sturgeon and Southern DPS fish within each specific area was based on data from tagging and tracking studies, fishery catch records, and NOAA Observer Program records. Tagged Southern DPS subadults and adults have been detected in coastal marine waters from Monterey Bay, CA, to Graves Harbor, AK, including the Strait of Juan de Fuca (*Lindley et al. 2008*). Data on green sturgeon bycatch from NOAA's West Coast Groundfish Observer Program (WCGOP) confirm the presence of green sturgeon from Monterey Bay, CA, to Cape Flattery, WA, with the greatest catch per unit effort in coastal waters from Monterey Bay to Humboldt Bay, CA (*pers. comm. with Jon Cusick, NMFS, August 7, 2008*). It is important to note that several tagged Southern DPS green sturgeon have been detected off Brooks Peninsula on the northern tip of Vancouver Island, BC (*Lindley et al. 2008*). Although WCGOP data were not available for bycatch of green sturgeon off southeast Alaska (green sturgeon were only captured in the bottom trawl fishery and bottom trawl fishing is prohibited off southeast Alaska), green sturgeon have been captured in bottom trawl fisheries throughout coastal waters off British Columbia (*Lindley et al. 2008*), confirming that the distribution of green sturgeon extends north of Vancouver Island. Patterns of telemetry data, corroborated by the fisheries records, suggest that Southern DPS fish occupy oversummering habitats in coastal bays and estuaries in California, Oregon, and Washington and occupy overwintering grounds off central California (as far south as Monterey Bay) and in coastal waters between Vancouver Island and southeast Alaska (*Lindley et al. 2008; pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008*). Based on the tagging data and the information described above, the CHRT identified the coastal marine waters from Monterey Bay, CA, to Vancouver Island, BC, as an important connectivity corridor for subadult and adult Southern DPS green sturgeon to migrate to and from oversummering habitats and overwintering habitats. Coastal marine waters off southeast Alaska were not considered part of the core connectivity corridor for green sturgeon, but were recognized as an important area at the northern extent of the overwintering range.

Several activities were identified that may affect the PCEs within coastal marine waters and require special management consideration or protection. The fact that green sturgeon were only captured in the bottom trawl fishery (based on the WCGOP bycatch data) provides evidence that green sturgeon are associated with the benthos and thus exposed to activities that disturb the bottom. Of particular concern are activities that affect prey resources. Prey resources likely include species similar to those fed on by green sturgeon in bays and estuaries (e.g., burrowing ghost shrimp, crangonid shrimp, amphipods, isopods, Dungeness crab). These species occur throughout the specific areas identified in coastal marine waters and may be affected by: commercial shipping or NPDES activities or activities resulting in non-point source pollution that can discharge contaminants and result in bioaccumulation of contaminants in green sturgeon; disposal of dredged materials that can bury prey resources; and bottom trawl fisheries that can disturb the bottom (but may result in beneficial or adverse effects on prey resources for green sturgeon). In addition, proposed tidal and wave energy projects as well as petroleum spills from commercial shipping activities may affect water quality or hinder the migration of green sturgeon along the coast and may necessitate special management considerations or protection. The following paragraphs describe each of the 12 specific areas identified within coastal marine waters. For all coastal marine specific areas, the shoreward boundary was defined by the mean lower low water line and the offshore boundary by the 60 fathom (fm) depth contour line.

(1) *CA/Mexico border to Monterey Bay, CA* (from the U.S.-California/Mexico border to the southernmost point at the mouth of Monterey Bay): PCEs present in this area include water quality and migratory corridors to support migration by subadult and adult green sturgeon. Food resources to support feeding may also be present in this area. The presence of the Southern DPS within this area is likely (based on the collection of green sturgeon of unknown DPS), but not confirmed. The southernmost receiver for detecting acoustically tagged green sturgeon is located at Carmel, CA, and no Southern DPS fish have been detected there, despite detections of Southern DPS fish in Monterey Bay just north of Carmel (*pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008*). The sparse data available on green sturgeon presence in coastal marine waters off southern California consists of records from fishery interactions. The first record of green sturgeon south of Monterey Bay was in April 1941, when one green sturgeon weighing 7 ¼ pounds was caught in 10 fm of water in a bait net set between Huntington Beach and Newport (*Roedel 1941*). In April 1957, another green sturgeon (774 mm TL and weighing 3 pounds and 14 ounces) was speared in waters 18 feet deep while it was swimming over sandy bottom between small rocky reefs just north of Point Vicente, Los Angeles County (*Norris 1957*). More recently, green sturgeon were incidentally caught in the commercial California halibut set net fishery using one-panel trammel nets. One green sturgeon was captured in July 1991 just north of Santa Barbara and another was captured in March 1993 off San Pedro (*pers. comm. with Rand Rasmussen, NMFS, July 18, 2006*).

    Several special management concerns exist for coastal waters off southern California. Benthic prey resources may be affected by the deposition of dredged material and by bottom trawl fisheries. Water quality may be affected by effluent from facilities located on the coast, including desalination plants (hypersaline outfalls), power plants (thermal effluent), LNG projects, and aquaculture facilities. In addition, in-water construction or alterations (e.g., piers), and proposed wave energy or tidal energy projects may affect fish passage along the coast by taking up space in the water column and creating barriers to migration.

(2) *Monterey Bay, CA, to San Francisco Bay, CA* (from the southern point at the mouth of Monterey Bay to the southern point at the mouth of San Francisco Bay; including

Monterey Bay): PCEs present in this area include food resources, water quality, and migratory corridors to support feeding and migration by subadult and adult green sturgeon. Telemetry data suggest that Southern DPS green sturgeon use areas off the central California coast (as far south as Monterey Bay) during the spring (*Lindley et al. 2008; pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008*). Accounts of green sturgeon in coastal marine waters from Monterey Bay to San Francisco Bay come from tagging studies and from records of incidental catch in fisheries and power plants. From May 1999 to January 2000, 8 green sturgeon of unknown DPS were incidentally caught in the commercial California halibut set net fishery (using one-panel trammel nets) in or just north of Monterey Bay, including one individual measured at 94 cm in length (*pers. comm. with Rand Rasmussen, NMFS, July 18, 2006*). One green sturgeon (546 mm in length) was found impinged and dead on the water intake screen at the Moss Landing Power Plant in January 2006 (*pers. comm. with John Steinbeck, Tenera Consulting, September 7, 2006*). From August 2001 to January 2007, 138 green sturgeon were incidentally caught on observed bottom trawl vessels participating in the West Coast Groundfish fishery in the Princeton (Half Moon Bay) port group (*pers. comm. with Janell Majewski, NMFS, January 29, 2007*). The presence of Southern DPS green sturgeon in this area is confirmed based on monitoring of tagged Southern DPS fish. Upon exiting the San Francisco Bay system, Southern DPS subadults and adults are known to migrate south as far as Monterey Bay. One Southern DPS fish (65 cm TL) tagged in San Pablo Bay in September 1948 was recaptured in Monterey Bay in April 1949 (*CDFG 2002*). Two green sturgeon tagged in San Pablo Bay in October 1967 were recaptured in December 1967, one in Monterey Bay (117 cm TL; *CDFG 2002*) and one near Santa Cruz, CA (*Miller 1972*). In 2004 and 2005, Southern DPS fish tagged in San Pablo Bay were detected in Monterey Bay (*Lindley et al. 2008*). Activities that may affect the PCEs within this area include: bottom trawl fisheries that may affect benthic habitats and food resources, and the release of effluents from power plants (thermal effluent) and desalination plants (hypersaline effluent; plants are located as far north as Santa Cruz) that may affect water quality.

(3) *San Francisco Bay, CA, to Humboldt Bay, CA* (from the southern point at the mouth of San Francisco Bay to the southern point at the mouth of Humboldt Bay): The coastal marine waters from San Francisco Bay to Humboldt contain PCEs including food resources, water quality, and migratory corridors to support feeding, migration, and aggregation by subadult and adult green sturgeon. Relatively large numbers of green sturgeon are believed to occupy this area. From August 2001 to January 2007, 325 of the 406 green sturgeon that were incidentally caught and observed on bottom trawl vessels participating in the West Coast Groundfish fishery were caught by vessels in the San Francisco port group (*pers. comm. with Janell Majewski, NOAA WCGOP, January 29, 2007*). Southern DPS green sturgeon migrating out of the San Francisco Bay system are believed to primarily move north. One Southern DPS fish (145 cm TL) tagged in San Pablo Bay in October 1979 was recaptured off Bodega Head in November 1979 (*CDFG 2002*). In 2006 and 2007, detections of large numbers of Southern DPS subadults and adults in Humboldt Bay confirm that

inter-estuarine movements from San Pablo Bay to Humboldt Bay are common (*Pinnix 2008b; a; pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008*). Several activities occurring in this area may affect the PCEs and require special management. Bottom trawl fisheries could alter benthic habitats and affect benthic food resources for green sturgeon. In addition, proposed alternative energy hydrokinetic projects may alter passage and migration of green sturgeon.

(4) *Humboldt Bay, CA, to Coos Bay, OR* (from the southern point at the mouth of Humboldt Bay to the southern point at the mouth of Coos Bay): Both subadult and adult green sturgeon occur within coastal marine waters from Humboldt Bay, CA, to Coos Bay, OR. PCEs present to support migration, feeding, and aggregations of subadult and adult green sturgeon include food resources, water quality, and migratory corridors. These waters serve as a connectivity corridor for Southern DPS migrating north from the Central Valley, CA, to Coos Bay and further north to oversummering and overwintering habitats, as described above. Several activities occur within coastal marine waters between Humboldt Bay and Coos Bay that may affect the migration and feeding of green sturgeon. Bottom trawl fisheries and the deposition of dredged material could affect benthic habitats and food resources. In addition, proposed alternative energy hydrokinetic projects may alter passage and migration of green sturgeon.

(5) *Coos Bay, OR, to Winchester Bay, OR* (from the southern point at the mouth of Coos Bay to the southern point at the mouth of Winchester Bay): Southern DPS subadults and adults occur within coastal marine waters from Coos Bay to Winchester Bay, OR, during their migrations up and down the coast. From August 2001 to January 2007, 8 out of 406 green sturgeon incidentally caught on observed West Coast groundfish bottom trawl vessels were caught by vessels in the Charleston, OR, port group (*pers. comm. with Janell Majewski, NMFS, January 29, 2007*). Erickson and Hightower (*2007*) showed concentrated catches by Oregon trawlers from Coos Bay to Newport. PCEs present in this area include food resources, water quality, and migratory corridors to support feeding, migration, and aggregation of subadult and adult green sturgeon. Several activities occur within the area that may affect these PCEs. Benthic food resources could be affected by bottom trawl fisheries and proposed alternative energy hydrokinetic projects may alter passage and migration of green sturgeon.

(6) *Winchester Bay, OR, to the Columbia River estuary* (from the southern point at the mouth of Winchester Bay to the southern point at the mouth of the Columbia River estuary): The coastal area from Winchester Bay, OR, to the Columbia River estuary provides PCEs including food resources, water quality, and migratory corridors to support feeding, migration, and aggregation of subadult and adult green sturgeon. This is an important area for migration because Southern DPS fish migrating between San Pablo Bay and Winchester Bay, the lower Columbia River estuary, and other coastal waters in Washington, as described above, must migrate through this area. Several records of green sturgeon caught in these waters were identified.

From February 2000 to February 2001, 4 green sturgeon of unknown DPS were captured for tissue sampling off of Newport, OR (*Farr et al. 2001*). From August 2001 to January 2007, 9 green sturgeon were incidentally caught on observed West Coast groundfish bottom trawl vessels in the Astoria port group (n = 7 fish), Garibaldi (Tillamook) port group (n = 1 fish), and Newport port group (n = 1 fish) (*pers. comm. with Janell Majewski, NMFS, January 29, 2007*). Logbook data provided in Erickson and Hightower (*2007*) also show concentrated catches of green sturgeon by Oregon bottom trawl fishermen in this area. Several activities may affect green sturgeon habitat within these coastal waters, including bottom trawl fisheries that could affect benthic habitats and food resources for green sturgeon, and proposed alternative energy hydrokinetic projects that may alter passage and migration of green sturgeon.

(7) *Columbia River estuary to Willapa Bay, WA* (from the southernmost point at the mouth of Columbia River estuary to the southernmost point at the mouth of Willapa Bay): The specific area encompassing coastal marine waters from the Columbia River estuary to Willapa Bay, WA, provides PCEs including food resources, water quality, and migratory corridors to support feeding, migration, and aggregation of subadult and adult green sturgeon. Tracking of tagged green sturgeon indicated substantial movement of green sturgeon between the lower Columbia River estuary and Willapa Bay (*WDFW, 2002, Letter to Ms. Donna Darm (5 pp., plus enclosures, 28 pp.), cited in Adams et al. 2002; Moser and Lindley 2007*). In 2004, 8 green sturgeon were detected in both Willapa Bay and the Columbia River estuary over the summer (*Moser and Lindley 2007*). In addition, several green sturgeon tagged in the Columbia River estuary were detected in Willapa Bay (*Moser and Lindley 2007*). Thus, the coastal marine waters between the two estuaries are an important migratory corridor for these inter-estuarine exchanges. Special management considerations or protection may be needed to address the effects of bottom trawl fisheries on benthic habitats and benthic food resources in this area.

(8) *Willapa Bay, WA, to Grays Harbor, WA* (from the southernmost point at the mouth of Willapa Bay to the southernmost point at the mouth of Grays Harbor): The specific area from Willapa Bay to Grays Harbor provides PCEs including food resources, water quality, and migratory corridors to support feeding, migration, and aggregation by subadult and adult green sturgeon. As described in the previous section, Southern DPS subadults and adults tagged in San Pablo Bay and Sacramento River occupy these coastal marine waters in their migrations to and from Willapa Bay and Grays Harbor. Similar to other areas along the coast of Oregon and Washington, special management considerations or protection may be required to address the effects of bottom trawl fisheries on benthic habitats and food resources.

(9) *Grays Harbor, WA, to the Washington-U.S./Canada border* (from the southern point at the mouth of Grays Harbor, WA, to the U.S.-Washington/Canada border): The specific area from Grays Harbor to the U.S.-Washington/Canada border contains PCEs including food resources, water quality, and migratory corridors to support

feeding, migration, and aggregation of subadult and adult green sturgeon. From August 2001 to January 2007, one green sturgeon of unknown DPS was incidentally caught on an observed West Coast groundfish bottom trawl vessel that was part of the Westport port group (*pers. comm. with Janell Majewski, NMFS, January 29, 2007*). In 2004 and 2005, Southern DPS fish tagged in San Pablo Bay were detected at Cape Elizabeth on the Washington state coast (*Lindley et al. 2008*). Southern DPS subadults and adults migrate through coastal marine waters off Washington on their way to and from Grays Harbor, the Strait of Juan de Fuca, and overwintering sites off Vancouver Island, British Columbia (*Lindley et al. 2008*). Several activities associated with special management concerns include the potential disturbance of benthic habitats and food resources caused by bottom trawl fisheries and potential effects on migration and passage of subadult and adult green sturgeon due to proposed alternative energy hydrokinetic projects.

(10) *Strait of Juan de Fuca, WA* (within U.S. waters): The specific area delineated for the Strait of Juan de Fuca extends from the Tatoosh Island – Bonilla Point BC line at the mouth to Admiralty Inlet, marking the boundary between the Strait and Puget Sound. The northern border of the specific area is delineated by the U.S./Canada border drawn through the middle of the Strait and a line drawn along the base of the San Juan Islands. The specific area extends north into Rosario Strait up to a line drawn across Rosario Strait from the northern tip of Lopez Island to Fidalgo Head, to include an acoustic receiver located in Rosario Strait where Southern DPS green sturgeon have been detected.

The Strait of Juan de Fuca connects Puget Sound and the waters surrounding the San Juan Islands in northern Washington State to the Pacific Ocean. Depths are greater at the mouth but become shallower further into the Strait. Water temperatures are lower and more similar to marine waters than to Puget Sound. The PCEs present within the Strait of Juan de Fuca include food resources to support summer feeding and water quality and migratory corridors to support migration by subadults and adults. In 2004 and 2005, Southern DPS subadults and adults tagged in San Pablo Bay were detected in the Strait of Juan de Fuca, but none were detected at receivers in the Strait of Georgia (*Lindley et al. 2008*). Green sturgeon likely enter and migrate some distance into the Strait of Juan de Fuca, but turn around and migrate along the western coast of Vancouver Island on their way north to overwintering habitats off Brooks Peninsula, rather than migrating through the Strait of Georgia. Some also migrate through the Strait of Juan de Fuca to Puget Sound. In 2006, 2 Southern DPS fish were detected at 2 receivers located just south of Anacortes in Rosario Strait (*pers. comm. with Mary Moser, NMFS, March 11, 2008*). However, green sturgeon have not been detected at any of the receivers further north in the waters surrounding the San Juan Islands and to the east of Vancouver Island, despite monitoring for tagged fish (primarily salmon) in this area (*pers. comm. with Mary Moser, NMFS, April 3, 2008*). Thus, the specific area was not extended further north past Rosario Strait or the base of the San Juan Islands. The CHRT noted that based on the best available tagging data, it appears that the western portion of the Strait of Juan de Fuca is more consistently used by green sturgeon for migration than the inner, eastern portion of the Strait. Activities that may affect the PCEs in the Strait of Juan de Fuca include: dredging and disposal of dredged materials which may affect benthic habitats and prey resources for green sturgeon; and NPDES activities and activities resulting in non-point source pollution, which may affect water quality.

(11) *U.S.-Alaska/Canada border to Yakutat Bay, AK* (from the U.S.-Alaska/Canada border to the northernmost point at the mouth of Yakutat Bay, AK): PCEs present within this area include food resources, water quality, and migratory corridors to support feeding, migration, and aggregation by subadult and adult green sturgeon. Two Southern DPS green sturgeon, one tagged in San Pablo Bay and one tagged in Willapa Bay (assigned to the Southern DPS based on genetic analyses), were detected at a receiver near Graves Harbor, AK, just south of Yakutat Bay (*Lindley et al. 2008*) (*pers. comm. with Steve Lindley, NMFS, September 12, 2007*). These two detections in the winter of 2004 - 2005 in southeast Alaska, additional detections of green sturgeon off Vancouver Island in the fall of 2005, and records of green sturgeon bycatch along the northern British Columbia coast suggest that green sturgeon spend their winters in coastal marine waters between Vancouver Island and southeast Alaska (*Lindley et al. 2008*). Thus, coastal marine waters off southeast Alaska represent the northernmost extent of this overwintering range and may be important for green sturgeon feeding, although additional information is needed. Special management considerations or protections may be required to address water quality issues related to the discharge of contaminants in commercial shipping and the potential for proposed alternative energy hydrokinetic projects to alter passage and migration of green sturgeon.

(12) *Coastal Alaskan waters northwest of Yakutat Bay, AK* (from the northernmost point at the mouth of Yakutat Bay to the Bering Strait, including the Bering Sea): This specific area includes coastal marine waters within 60 fm depth off Alaska from Yakutat Bay, AK, northwest to and including the Bering Sea. The eastern boundary is defined by the U.S./Russia and U.S./Siberia border. The northern boundary for the Bering Sea was delineated as a line across the Bering Strait. Data on green sturgeon within coastal marine waters northwest of Yakutat Bay and in the Bering Sea are sparse and the presence of Southern DPS green sturgeon has not yet been confirmed. In 2006, two green sturgeon of unknown DPS were incidentally caught on observed Alaska groundfish bottom trawl vessels. One was caught in March in the Bering Sea, on the north side of Unimak Island (136 cm fork length (FL)) and the other was caught in April in the Gulf of Alaska, on the southwest side of Kodiak Island (145.5 cm TL) (*pers. comm. with Duane Stevenson, NMFS, September 8, 2006*). In March 2009, another green sturgeon of unknown DPS was caught in the Bering Sea, on the north side of Unimak Island (*pers. comm. with Brian Mason, NMFS, July 30, 2009*). There are no other records of green sturgeon bycatch in the Alaska groundfish fishery (*pers. comm. with Jennifer Ferdinand, NMFS, November 24, 2006*). NMFS is working with the observer programs to collect data on and tissue samples from any green sturgeon caught in the future. One green sturgeon was reportedly caught at the drainage of Naknek River in Kvichak Bay (within

Bristol Bay) 12 years ago, but this record has not been confirmed (*pers. comm. with Gene Augustine, US Air Force, March 5, 2008*). There are anecdotal accounts of sturgeon observed in Lake Iliamna and the Naknek River, but these were most likely white sturgeon based on the large size of the fish (*pers. comm. with Jason Dye, Alaska Department of Fish and Game, March 6, 2008*). PCEs in this area include prey resources, water quality, and migratory corridors to support migration of green sturgeon. Activities that may affect the PCEs include the operation of bottom trawl fisheries that may affect benthic habitats and prey resources, and commercial shipping activities that may affect water quality. Other activities, such as proposed LNG projects and proposed alternative energy hydrokinetic projects, may also affect water quality and passage. However, these activities occur far up into Cook Inlet, near the city of Anchorage, and are not likely to affect coastal marine waters along the outer coast where green sturgeon are most likely to be present.

Canadian Waters

Although critical habitat cannot be designated in areas outside of the United States, the information available on green sturgeon in Canadian waters is briefly discussed here to emphasize the importance of these areas for green sturgeon and to summarize existing protections for green sturgeon in these waters. As discussed above, several tagged adult Southern DPS green sturgeon have been detected off Brooks Peninsula on the northern tip of Vancouver Island, British Columbia (*Lindley et al. 2008*). Coastal waters between Vancouver Island and southeast Alaska are believed to contain important overwintering grounds for subadult and adult green sturgeon (*Houston 1988; Lindley et al. 2008*). The use of overwintering habitats within Canadian waters emphasizes the importance of maintaining the connectivity corridor from Monterey Bay, CA, to Vancouver Island, BC, and of protecting the U.S. waters directly to the north in southeast Alaska. Green sturgeon have been recognized as a species of Special Concern in Canada since 1987 and are on the red list in British Columbia, meaning they are a candidate for listing as extirpated, endangered, or threatened (B.C. Conservation Data Centre, 2007. BC Species and Ecosystems Explorer. B.C. Ministry of Environment, Victoria, BC. Available at: http://srmapps.gov.bc.ca/apps/eswp/, accessed August 15, 2007). The retention of green sturgeon in sport fisheries is prohibited in both marine and fresh waters of British Columbia (Department of Fisheries and Oceans, 2007. 2007 – 2009 British Columbia Tidal Waters Sport Fishing Guide. Available at: http://www.pac.dfo-mpo.gc.ca/recfish/). Although the area cannot be included in the critical habitat designation for the Southern DPS, the CHRT encourages continued protections for green sturgeon within Canadian waters.

UNOCCUPIED AREAS

Section 3(5)(A)(ii) of the ESA and regulations at 50 CFR 424.12(e) authorize the designation of "specific areas outside the geographical area occupied at the time [the species] is listed," but only when: (a) "a designation limited to [the species'] present range would be inadequate to ensure the conservation of the species" (50 CFR 424.12(e)); and (b) if the Secretary determines “that such areas are essential for the conservation of the species” (ESA section 3(5)(A)(ii)). The CHRT considered that a critical habitat designation limited to presently occupied areas may not be sufficient for conservation, because such a designation would not address one of the major threats to the population identified by the Status Review Team - the concentration of spawning into one spawning river (i.e., the Sacramento River), and, as a consequence, the high risk of extirpation due to a catastrophic event.

The CHRT identified seven unoccupied areas in the Central Valley, CA, that may provide additional spawning habitat for the Southern DPS of green sturgeon and considered whether these areas are essential for conservation of the species. These seven areas include areas behind dams that are currently inaccessible to green sturgeon and areas below dams that are not currently occupied by green sturgeon. The areas include: 1) reaches upstream of Oroville Dam on the Feather River; 2) reaches upstream of Daguerre Dam on the Yuba River; 3) areas on the Pit River upstream of Keswick and Shasta dams; 4) areas on the McCloud River upstream of Keswick and Shasta dams; 5) areas on the upper Sacramento River upstream of Keswick and Shasta dams; 6) reaches on the American River; and 7) reaches on the San Joaquin River.

Of these seven areas, the CHRT identified reaches upstream of Daguerre Dam on the Yuba River as the most important for conserving the species because: (1) the current habitat conditions are likely to support spawning; (2) adult Southern DPS fish currently occupy habitat just below Daguerre Dam; (3) although the Yuba River is part of the Sacramento River drainage basin, it is separated spatially from the current, single spawning population on the Sacramento River such that if a catastrophic mortality event were to occur in the Sacramento River, a Yuba River population could safeguard the species from extinction; and (4) the CHRT believes there is a greater potential for restoration of fish passage at the Daguerre Dam in the near future than for any of the other dams located within the unoccupied areas identified by the CHRT. The CHRT also felt that reaches on the San Joaquin River, from the South Delta to the Goodwin Dam on the Stanislaus River, are important for conserving the Southern DPS for some of the same reasons mentioned above, in particular because the San Joaquin and Stanislaus rivers are part of an entirely different drainage basin than the Sacramento River. However, the CHRT was less certain regarding the prospects for reestablishing a spawning population in this area, because current conditions on the mainstem San Joaquin River are poor and it is uncertain whether conditions favorable for green sturgeon presence and spawning could be restored in this area in the near future.

At the time of the proposed critical habitat rule, the CHRT did not have sufficient data to determine whether any of these seven unoccupied areas *are essential* to the conservation of the Southern DPS. The CHRT believed it is likely that at least one additional spawning area is needed to support the conservation of the Southern DPS, but that there is insufficient information at this time regarding: (1) the historical use of the currently unoccupied areas by green sturgeon; and (2) the likelihood that the habitats within these unoccupied areas will be restored to conditions that would support green sturgeon presence and spawning (e.g., restoring fish passage and sufficient water flows and water temperatures). Of greatest importance was the lack of data to confirm that green sturgeon historically occupied any of these seven unoccupied areas. Even in currently accessible reaches of the lower American River and the San Joaquin River, there are no data to confirm green sturgeon occupancy. Thus, no unoccupied areas were proposed for designation as critical habitat. However, the proposed rule described the seven unoccupied areas identified and considered by the CHRT and solicited additional information from the public regarding the historical or current use of these areas by green sturgeon, current habitat conditions, and the potential for habitat restoration within these areas.

Several commenters agreed that there are insufficient data to designate unoccupied areas at this time, whereas two commenters disagreed and urged NMFS to designate critical habitat in currently unoccupied areas to protect additional spawning habitat for green sturgeon. The public comments did not, however, provide additional data on historical green sturgeon presence and use of these unoccupied areas. The CHRT considered all of the public comments received, but maintained their determination that, although the unoccupied areas *may be essential,* data are not available at this time to determine that any of the areas *are essential* to the conservation of the Southern DPS. Thus, the CHRT did not recommend that any of the seven unoccupied areas be designated as critical habitat at this time, but advised that these areas be monitored for green sturgeon presence and that these areas be considered in future recovery planning for the Southern DPS.

SPECIAL MANAGEMENT CONSIDERATIONS OR PROTECTION

Joint NMFS and USFWS regulations at 50 CFR 424.02(j) define "special management considerations or protection" to mean "any methods or procedures useful in protecting physical and biological features of the environment for the conservation of listed species." Based on discussions with the CHRT and consideration of the economic analysis, several activities were identified that may threaten the PCEs such that special management considerations or protection may be required. Major categories of habitat-related activities include: (1) dams; (2) water diversions; (3) dredging and disposal of dredged material (including activities associated with wetland loss and/or removal); (4) in-water construction or alterations, including channel modifications/diking, sand and gravel mining, gravel augmentation, road building and maintenance, forestry, grazing, agriculture, urbanization, and other activities; (5) NPDES activities and activities resulting in non-point source pollution; (6) power plants; (7) commercial shipping (including concerns related to exotic/invasive species introductions or spread); (8) aquaculture; (9) desalination plants; (10) proposed alternative energy hydrokinetic projects (e.g., tidal energy and wave energy projects); (11) LNG projects; (12) bottom trawling; and (13) habitat restoration activities (including concerns related to exotic/invasive species introductions or spread). All of these activities may have an effect on one or more PCE(s) via their alteration of one or more of the following: stream hydrology, water level and flow, water temperature, dissolved oxygen levels, erosion and sediment input/transport, physical habitat structure, vegetation, soils, nutrients and chemicals, fish passage, and stream/estuarine/marine benthic biota and prey resources. The CHRT identified and documented the activities occurring in each specific area as described above and listed in Table 2. In the following paragraphs, we describe the potential effects on critical habitat associated with each category of activities. This is not an exhaustive list of potential effects, but rather a description of the primary concerns and potential effects that we are aware of at this time and that should be considered in the analysis of these activities under section 7 of the ESA.

Dams and Water Diversions: Physical structures associated with dams and water diversions may impede or delay passage of Southern DPS green sturgeon. Of particular concern are structures that impede or delay passage to and from high quality spawning habitats in the Sacramento River and that may reduce the time to encounter con-specifics and reproduce. For example, the RBDD poses a barrier to upstream migration on the Sacramento River for adult green sturgeon when the gates are lowered from June 15 to September 1 (previously from May 15 to September 15) each year (*Heublein et al. 2008*). Presumably preferred spawning habitat (large areas of bedrock with high velocity water flow) are more prevalent in reaches upstream of RBDD than downstream of RBDD (*Heublein et al. 2008*). Green sturgeon that cannot move upstream of the RBDD will either spawn downstream of the RBDD or abort their spawning migration. The operation of dams and water diversion may also affect water flow, water quality parameters, substrate quality, and depth, and further compromise the ability of adult green sturgeon to reproduce successfully. Optimum flow and temperature requirements for spawning and incubation are unclear, but spawning success in most sturgeons is related to these factors (*Detlaff et al. 1993*). Effects on water flow and associated effects on water quality (i.e., water temperature) and substrate composition within the Sacramento River may affect early life stages of Southern DPS green sturgeon. For example, rapid accumulation of sand on egg sampling mats placed downstream of the RBDD was observed, most likely attributed to the effects of the RBDD on water flow (*Poytress et al. 2009*). This accumulation of sediments could fill in crevices and potentially bury or suffocate the eggs, or cause delayed hatching or development defects in eggs and larvae (*Deng et al. 2002; Kock et al. 2006*). Sufficient water flow is needed to flush silt and debris, as well as to maintain surfaces for feeding (*Nguyen and Crocker 2007*) and to reduce the incidence of fungal infestations of the eggs (*Deng et al. 2002; Parsley et al. 2002*) (see "Water Flow" under the section titled "Physical or Biological Features Essential for Conservation"). Sufficient water flow is also needed to maintain optimal water temperatures for egg incubation (11-17 ºC) (*Van Eenennaam et al. 2005*), larval development (< 20 ºC) (*Werner et al. 2007*), and juvenile rearing (< 24 ºC) (*Mayfield and Cech 2004; Allen et al. 2006*).

Dredging: Dredging activities, which include the disposal of dredged material, primarily occur within estuaries and may affect the depth, sediment quality, water quality, and prey resources for green sturgeon. Dredging may have positive effects on food resources by digging up and making prey resources more available for green sturgeon. However, negative effects may also result. Dredging and the aquatic disposal of dredged material can remove prey resources at the dredge site, as well as bury them at the disposal site, thus altering the macrobenthic community structure in bays, estuaries, and near shore marine environments for many months before the natural fauna are re-established (*Oliver et al. 1977*). In addition, dredging operations and disposal of dredged materials may result in the re-suspension and spread of contaminants embedded or buried in the sediments, which can adversely affect green sturgeon prey species and lead to bioaccumulation of contaminants in green sturgeon.

Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may adversely affect the growth, reproductive development, and reproductive success of green sturgeon (*Fairey et al. 1997; Foster et al. 2001a; Foster et al. 2001b; Kruse and Scarnecchia 2002; Feist et al. 2005; Greenfield et al. 2005*). Recent studies suggest that green sturgeon are more sensitive than white sturgeon to certain contaminants, including methylmercury and selenium (*Kaufman et al. 2008*). In addition, dredging-induced noise could potentially delay green sturgeon migrations. The effects of dredging and disposal activities on critical habitat would depend on factors such as the location, scale, frequency, and duration of these activities.

In-Water Construction or Alterations: This category consists of a broad range of activities associated with in-water structures or activities that alter the benthic habitat within rivers, estuaries, and coastal marine waters. The primary concerns are with activities that may affect water quality, sediment quality, substrate composition, or migratory corridors. Activities that may affect water quality include in-water structures (like pilings) with protective coatings containing chemicals that may leach into the water. Activities that affect sediment quality and substrate composition include those that result in increased erosion and sedimentation (such as road maintenance and construction, bridge construction, or construction or repair of breakwaters, docks, piers, pilings, bulkheads, and boat ramps) and those that directly alter benthic substrates (such as sand and gravel mining or gravel augmentation). Activities that may affect migratory corridors include the construction of in-water structures, such as docks, piers, pilings, and ramps.

Pollution: The discharge of pollutants from point and non-point sources (including but not limited to: agricultural pesticide applications, industrial discharge, stormwater runoff) can adversely affect water quality, sediment quality, and, as a result, the quality of prey resources in green sturgeon critical habitat. Exposure to, and bioaccumulation of, contaminants such as pesticides, PAHs, and elevated levels of heavy metals may adversely affect the growth, reproductive development, and reproductive success of subadult and adult green sturgeon. Green sturgeon have been found to be more sensitive than white sturgeon to contaminants such as methylmercury and selenium, with negative impacts on routine and active metabolic rates, swimming performance, and avoidance of simulated predators (*Kaufman et al. 2008*).

Power Plants: The release of thermal effluents from power plants is a concern within freshwater riverine and estuarine waters in the Central Valley, CA. Thermal effluents may raise water temperature in these habitats to lethal or sub-lethal levels for early life stages of Southern DPS green sturgeon. Optimal temperature ranges vary for each life stage, but are generally below 20°C (egg incubation: 11-17°C; larval development: below 20°C; juveniles: below 24°C) (*Mayfield and Cech 2004; Van Eenennaam et al. 2005; Allen et al. 2006; Werner et al. 2007*). Effluent from power plants may also have other effects on water quality that affect critical habitat, such as increased turbidity from suspended materials and decreased dissolved oxygen levels (*Perkins 1974*).

Commercial Shipping: Commercial shipping can negatively impact water quality and introduce non-native species and contaminants through the release of ballast water (*Buck 2007*). The introduction of non-native species is already a major problem in coastal estuaries. Non-native species may replace native species as prey for green sturgeon, and may result in greater bioaccumulation of contaminants. For example, the non-native bivalve, *Potamocorbula amurensis*, has become widespread in San Francisco Bay and the Sacramento-San Joaquin Delta and replaced other common prey items for white sturgeon. *P. amurensis* was found in the gut contents of at least one green sturgeon (*CDFG 2002*). *P. amurensis* is an efficient bioaccumulator of selenium and has been linked to increased selenium levels in white sturgeon (*Linville et al. 2002*). It follows that the spread of *P. amurensis* may result in increased consumption of this bivalve by green sturgeon and increased bioaccumulation of selenium. Petroleum spills are also a risk posed by commercial shipping activities. Petroleum spills may affect water quality and create barriers to migration.

Aquaculture: The primary concern regarding aquaculture operations is the application of pesticides and the potential impacts on water quality and prey resources for green sturgeon. The pesticide carbaryl is used by oyster aquaculture operations to control burrowing shrimp populations in Willapa Bay and Grays Harbor, thereby reducing this important food resource for green sturgeon (*Dumbauld et al. 2008*). NMFS recently issued a Biological Opinion that addresses the effects of pesticides, including carbaryl, on green sturgeon (*NMFS 2009c*). The effects on critical habitat would depend on the location and size of the aquaculture operations and the scale and frequency of use of pesticides. Studies or measures would be needed to ensure prey resources for green sturgeon are not adversely affected such that feeding is affected.

Desalination Plants: Hypersaline effluent discharge released from desalination plants may affect water quality. Proposed desalination plants are located along the coast and in coastal estuaries. A proposed project in south San Pablo Bay (just north of the Richmond-San Rafael Bridge) may affect juvenile green sturgeon rearing in the bay. Effects may include an adverse behavioral reaction (i.e., green sturgeon leaving the area) or physiological effects on green sturgeon due to increased salinity in the area (*Allen and Cech 2007; Sardella et al. 2008*).

Proposed Alternative Energy Hydrokinetic Projects: Proposed tidal energy or wave energy projects require energy generating equipment to be anchored on the bottom, with equipment rising up through the water column, depending on the type of unit. In addition, cables used to carry the electricity to shore are buried in the sediment and may emit electromagnetic fields that could potentially impede green sturgeon migration along the coast. Proposed projects may be located in coastal marine waters or coastal estuaries. Unimpeded passage within coastal marine waters is critical for subadult and adult green sturgeon to access oversummering habitats within coastal bays and estuaries and overwintering habitat within coastal waters between Vancouver Island, BC, and southeast Alaska. Passage is also necessary for subadults and adults to migrate back to San Francisco Bay and to the Sacramento River for spawning. The potential placement of hydrokinetic energy projects in coastal estuaries (including San Francisco Bay, Willapa Bay, and Grays Harbor) is of particular concern given the concentration of green sturgeon within these estuaries and the importance of unimpeded passage for foraging and spawning migrations (in San Francisco Bay).

Liquefied Natural Gas (LNG) Terminals: Liquefied natural gas (LNG) terminals pose the risk of leaks, spills, or pipeline breakage and may affect water quality. In addition, activities associated with the construction, operation, and maintenance of LNG projects may affect water quality, sediment quality, and prey resources for green sturgeon. For example, dredging operations and in-water and shoreline construction activities associated with the construction and operation of LNG terminals may result in increased erosion and sedimentation, increased turbidity, removal and disturbance of benthic prey species, and the re-suspension of contaminated sediments (*Federal Energy Regulatory Commission (FERC) 2008*).

Bottom Trawling and Other Fisheries Affecting Benthic Habitats: Fishing vessels using bottom trawl gear or other bottom tending gear may affect green sturgeon critical habitat by affecting sediment quality and available food resources for green sturgeon. Bottom trawling and the use of other bottom tending gear may result in positive effects on food resources (by digging up and making prey resources more available for green sturgeon), but may also result in adverse effects by potentially removing or disturbing benthic prey resources. It will be important to evaluate and address the effects of bottom trawling and other bottom tending gear in future consultations. NMFS plans to evaluate the effects of the West coast groundfish bottom trawl fishery on green sturgeon and the proposed critical habitat in an ESA section 7 consultation.

Habitat Restoration Projects: Habitat restoration activities are efforts undertaken to restore habitat, and can include the installation of fish passage structures and fish screens, in-stream barrier modification, bank stabilization, gravel augmentation, planting of riparian vegetation, and many other habitat-related activities. Although the primary purpose of these activities is to restore natural habitats for the benefit of native communities, these activities nonetheless modify the habitat and need to be evaluated to ensure that they do not adversely affect the habitat features essential to green sturgeon. Activities associated with habitat restoration projects may affect all of the PCEs identified for green sturgeon. For example, gravel augmentation activities may alter substrate composition within freshwater rivers and should consider potential effects on substrates for green sturgeon spawning and rearing. Bank stabilization activities may result in changes to water flow, water quality, and sediment quality in freshwater rivers and estuarine habitats for green sturgeon. Careful consideration of the location and design of these activities would be most important in the Sacramento River and adjacent estuaries, to protect spawning and rearing habitats for green sturgeon. While habitat restoration activities would be encouraged as long as they promote the conservation of the species, project modifications in the form of spatial and temporal restrictions may be required as a result of this designation.

CRITICAL HABITAT REVIEW TEAM

NMFS convened a critical habitat review team (CHRT) to assist in the assessment and evaluation of critical habitat areas for the Southern DPS. The CHRT consisted of 9 Federal biologists from NMFS, the USFWS, and the USBR with experience and expertise on green sturgeon biology, consultations, and management, or on the critical habitat designation process. The CHRT used the best available scientific and commercial data and their best professional judgment to: (1) verify the geographical area occupied by the Southern DPS at the time of listing; (2) identify the physical and biological features essential to the conservation of the species; (3) identify specific areas within the occupied area containing those essential physical and biological features; (4) identify activities that may affect these essential features and require the need for special management considerations or protection within each specific area; (5) evaluate the conservation value of each specific area; and (6) determine if any unoccupied areas are essential to conservation of the Southern DPS.

The CHRT's biological assessment of green sturgeon critical habitat consisted of 5 phases. In Phase 1, the CHRT met to discuss the critical habitat designation process, identify and synthesize the best available scientific and commercial information regarding green sturgeon habitat use and distribution, and identify and verify the specific areas within the geographical area occupied. In Phase 2, the CHRT developed a scoring system for evaluating the PCEs and a rating system for determining the overall conservation value of each specific area. The CHRT members individually scored and rated each specific area based on the 2 systems developed in this phase. In Phase 3, the CHRT reviewed the scores and ratings for each specific area and considered additional information about the relationship of each area to the other specific areas and the historical, current, and potential future use of each area by the Southern DPS. Based on the scores, ratings, and additional considerations, the CHRT assigned conservation value ratings of high, medium, or low to each specific area. In Phase 4, the CHRT identified and evaluated unoccupied areas to determine whether any unoccupied areas are essential for conservation. The CHRT's evaluations were used to develop the proposed green sturgeon critical habitat designation, published in the *Federal Register* on September 8, 2008 (73 FR 52084). NMFS provided a 105-day public comment period which closed on December 22, 2008 (73 FR 58527, October 7, 2008). In Phase 5, the CHRT reconvened to review and consider relevant public comments and additional information received in response to the proposed critical habitat designation. The CHRT revised their delineation and assessment of the specific areas based on their consideration of the additional information provided. The following paragraphs describe CHRT's analysis and the key considerations involved in each phase.

CHRT Phase 1

In Phase 1, the CHRT convened for a 2-day meeting to introduce the members to the critical habitat designation process, identify and synthesize the best available scientific and commercial data relevant to critical habitat for the Southern DPS, identify the geographical area occupied, and delineate and verify the specific areas within the geographical area occupied. First, the CHRT was given a brief overview of the statutory and regulatory requirements under the ESA regarding critical habitat. Next, the CHRT reviewed and discussed available information on green sturgeon distribution and habitat needs, identifying any additional data or data sources. The CHRT then defined the list of PCEs for the

Southern DPS, the geographical area occupied by the Southern DPS, and specific areas within the occupied range.

To confirm each specific area met the definition of critical habitat, the CHRT confirmed the presence of one or more PCEs in each area and identified special management considerations or protection that may be required. The CHRT assessed the best available information on green sturgeon distribution and use within each specific area, noting any discrepancies with their own knowledge of an area and any data sources requiring verification. CHRT members followed-up on any discrepancies or data sources requiring verification and provided feedback to the team. Because there were several areas with documented evidence of green sturgeon presence but no information regarding to which DPS the fish belong, the CHRT had to define how an area was considered "occupied" by the Southern DPS. The CHRT defined 3 categories of "occupied": 1) "Confirmed" if there was documented evidence of Southern DPS presence in the area; 2) "Likely" if there was documented evidence of green sturgeon (Northern DPS or DPS unknown) in the area; and 3) "Possible" if there was no documented evidence of green sturgeon presence in the area, but green sturgeon may be present based on best professional judgment (e.g., based on habitat conditions, proximity to occupied areas). Specific areas within which the presence of the Southern DPS was confirmed or likely were considered occupied and included in the CHRT's evaluation. The CHRT then confirmed whether each specific area contains one or more of the PCEs, based on their knowledge of the area and on green sturgeon presence and use of the area. In addition, the CHRT determined whether any current or potential activities occur within the areas that may threaten the PCEs, such that special management considerations or protection may be required. The CHRT used their knowledge of each area and their experience in section 7 consultations to identify activities for each area (Table 2).

CHRT Phase 2

In Phase 2, the CHRT developed and implemented two approaches for evaluating and assigning a conservation value to each specific area: the multi-factor scoring system approach and an alternative approach. Both approaches are described in the following paragraphs.

Multi-factor scoring system approach

The first approach was a multi-factor scoring system for evaluating the PCEs within each specific area (Tables 3 and 4). Each PCE was scored based on the level of support it provides to each of the following four factors, representing different life stages and associated habitat functions: 1) spawning and egg incubation; 2) larval/juvenile rearing and growth; 3) juvenile and/or subadult/adult migration; and 4) subadult/adult feeding, holding, and/or non-spawning aggregations. The scoring system helped generate discussion and provided a consistent framework for CHRT members to evaluate each specific area, ensuring that each member considered the PCEs and the life stages and habitat functions supported in their evaluations. It also generated quantitative scores (sums of the PCE scores across all factors) that roughly corresponded to high, medium, and low conservation value ratings and showed the variation between areas relative to one another at a finer scale. In addition, each CHRT member provided their initial conservation value rating (ICVR) for each specific area based on their evaluation of the PCEs and the total scores. Thus, the multi-factor scoring system approach generated two sets of conservation value ratings. The first was a score-based conservation value rating, in which the mean total score for each specific area was translated into a High, Medium, or Low conservation value rating. The second was the ICVR rating, based on the majority vote for the ICVR (Tables 3 and 4).

The CHRT expressed several concerns regarding the multi-factor scoring system approach. First, the CHRT members commented that scoring the PCEs was somewhat subjective because of the lack of data on the PCEs for many of the specific areas. Second, the assessment of factors 1 and 2 was based on the PCEs, whereas the assessment of factors 3 and 4 was based on the abundance of green sturgeon in the area, rather than on the PCEs. Finally, the scoring system tended to result in lower scores for areas that supported only one life stage and did not reflect the importance of such areas in the life history of green sturgeon.

Alternative conservation value rating approach

To address the concerns with the multi-factor scoring system approach, the CHRT developed an alternative approach to rate the conservation value of each specific area (Table 5). In this approach, the PCEs supporting each life stage (i.e., eggs/larvae, juveniles, and subadults/adults) were identified for each specific area. Then, the conservation value of each area was rated as High, Medium, or Low, based on consideration of the PCEs present, the life stages supported, the historical and current use of the area, and the overall assessment of the contribution of the area to the conservation of the Southern DPS. The PCE scores, factors, and total scores generated in the multi-factor scoring system were also considered. CHRT members also recorded a second conservation value rating for each specific area, representing the conservation value rating they would be willing to assign to the area if their first choice was not the majority vote. This "second vote" provided the range over which each CHRT member rated each specific area and was used when there was no clear majority in the first vote, with the first vote weighted more heavily than the second.

CHRT Phase 3

In Phase 3, the CHRT members individually scored and rated each specific area and discussed the compiled results to assign final conservation value ratings to each specific area. Table 6 summarizes the results of the multi-factor scoring system approach and the alternative approach. As shown on Table 5, the CHRT's analysis generated three sets of conservation value ratings per specific area for comparison:

(a) Score-based rating: Based on the mean total score from the multi-factor scoring system approach. The standard error and range was also calculated for each mean total score.

(b) Majority ICVR rating: Based on the majority vote for the ICVRs, assigned as part of the multi-factor scoring system approach. For most specific areas, there was a majority ICVR. If there was no clear majority, the CHRT discussed the area and reached an agreement on the majority ICVR for the area.

(c) Alternative approach rating: Based on the majority rating from the alternative approach. There was a clear majority rating for most areas. Where there was no clear majority rating, the "second vote" was considered and consensus reached among the CHRT members after discussing the areas and the reasons for the different ratings.

In general, the conservation value ratings for each area using the score-based rating, the ICVRs, and the alternative approach were the same (Table 6). Where there were differences, the conservation value rating based on the alternative approach tended to be higher than the ICVR, and the ICVR tended to be higher than the score-based rating. The score-based rating was lower for some areas because the scores were influenced by the number of life stages present in an area. If an area supported only one life stage, it tended to receive a low total score even if it was an important area for the species. The alternative approach, however, allowed the CHRT members to consider the importance of an area to the conservation of the species whether it supported only one life stage or all life stages of Southern DPS green sturgeon. All three methods were based on the best available data as well best professional judgment. Although the multi-factor scoring system provided a more quantitative approach, it was influenced by constraints in the scoring criteria. Thus, the CHRT members determined that the alternative approach provided a better representation of the conservation value of each specific area, compared to the score-based ratings and ICVRs. The CHRT ultimately relied on the alternative approach to assign the conservation value ratings for each specific area.

In assigning the final conservation value ratings for each specific area, the CHRT considered the conservation value rating from the alternative approach as well as the importance of connectivity among habitats and the confirmed presence of Southern DPS green sturgeon. The CHRT recognized that green sturgeon must migrate through estuaries and fresh water rivers to reach upstream spawning sites, as well as along the coast to access important oversummering and overwintering habitats in coastal bays and estuaries. Some of these connectivity corridors represent high-value habitats for green sturgeon, whereas some provide only low to medium value habitat for green sturgeon on their own. For example, the San Francisco, San Pablo, and Suisun bays and the Delta provide high-value feeding and rearing habitat for green sturgeon, as well as important connectivity corridors for adult Southern DPS fish migrating to and from the ocean to their spawning habitats in the Sacramento River and for juvenile Southern DPS fish migrating from rearing habitats in the Sacramento River, bays, and the Delta to the ocean. The Sacramento River itself provides an important connectivity corridor to and from spawning and rearing sites in the upper reaches. In contrast, specific areas in coastal marine waters may provide low to medium value habitat for green sturgeon based on the PCEs present. Such areas, however, may contain high-value connectivity corridors for green sturgeon migrating out of the San Francisco Bay system to important coastal bays and estuaries in California, Oregon, Washington, and Canada. The CHRT recognized that even within an area of low to medium conservation value, the presence of a connectivity corridor that provides passage to high value areas would warrant increasing the overall conservation value of the area to a high. To account for this, the CHRT assigned a separate conservation value rating to areas containing a connectivity corridor, equal to the rating of the highest-rated area for which it served as a connectivity corridor (Table 7).

The CHRT members were then asked to re-examine the conservation value ratings for the specific areas where the presence of the Southern DPS was categorized as likely (based on the presence of Northern DPS fish or green sturgeon of unknown origin), but not confirmed. These areas include the coastal marine waters within 60 fm depth from the U.S.-California/Mexico border to Monterey Bay, CA, and from Yakutat Bay, AK, to the Bering Strait (including the Bering Sea), as well as the following coastal bays and estuaries: Elkhorn Slough, Tomales Bay, Noyo Harbor, the Eel River estuary, and the Klamath/Trinity River estuary in California; and the Rogue River estuary, Siuslaw River estuary, Alsea River estuary, Tillamook Bay, and Nehalem Bay in Oregon. Yaquina Bay in Oregon was included in this list in the draft biological report, but was removed because the presence of the Southern DPS has been confirmed based on the detection of one tagged Southern DPS green sturgeon in Yaquina Bay (*pers. comm. with Dan Erickson, ODFW, September 3, 2008*). The CHRT recognized that a lack of documented evidence for Southern DPS presence within these areas may be because of the lack of monitoring or sampling effort within these areas and that a high degree of uncertainty exists as to the extent to which Southern DPS fish use these areas. The low occurrence of green sturgeon within these areas is indicated by few observations both historically and recently. The CHRT scored all of these areas, except for Tomales Bay, Tillamook Bay, and Nehalem Bay, much lower than other areas, reflecting the CHRT's assessment that these areas contribute relatively little to the conservation of the species. For the bays and estuaries, this was based on the limited area and depth to support green sturgeon migration and feeding, as well as the low documented use of these areas by green sturgeon. Tomales Bay was given a higher score and rated as "Medium," because it is a large, deep embayment providing good habitat for feeding by green sturgeon and is likely the first major bay to be encountered by subadults making their first migration into marine waters. Tillamook Bay and Nehalem Bay were given a Medium conservation value based on relatively high green sturgeon catch data for these areas and information indicating good habitat conditions for green sturgeon. As described above (see *Bays and Estuaries*), green sturgeon are commonly observed in the Eel River estuary, Klamath/Trinity River estuary, and Rogue River estuary, but are believed to primarily belong to the Northern DPS. For the coastal marine waters, the areas off the coast of Alaska and south of Monterey Bay, CA, are outside of the connectivity corridor identified by the CHRT. Although the CHRT did not include the marine waters off southeast Alaska up to Yakutat Bay, AK, as part of the primary migratory corridor, this area was rated as "Medium", because it represents the northernmost extent of the overwintering range for green sturgeon and is within the confirmed migratory range of Southern DPS fish.

Based on this information, the CHRT agreed that the conservation value ratings should be reduced by one level for the specific areas where the presence of the Southern DPS is likely, but not confirmed. This necessitated the creation of a fourth conservation value rating level ("Ultra-low"). Those specific areas that initially received a "Low" rating were assigned a final conservation value rating of "Ultra-low." Those areas that initially received a "Medium" rating were assigned a final conservation value rating of "Low." None of the specific areas where the presence of the Southern DPS was likely, but not confirmed, had received a "High" rating.

The final conservation value ratings and the justifications for each specific area are summarized in Table 7. The ratings provide an assessment of the relative importance of each specific area to the conservation of the Southern DPS. Areas rated as "High" were deemed to have a high likelihood of promoting the conservation of the Southern DPS. Areas rated as "Medium" or "Low" were deemed to have a moderate or low likelihood of promoting the conservation of the Southern DPS. Areas rated as "Ultra-low" were deemed to have a very low likelihood of promoting the conservation of the Southern DPS. The CHRT recognized that even within a rating category, variation exists. For example, freshwater riverine areas rated as "High" may be of greater conservation value to the species than coastal marine areas with the same rating. This variation was captured in the comments provided by the CHRT for each specific area. The final conservation value ratings represent the relative conservation benefit of designation of each specific area to the Southern DPS (e.g., areas with a High conservation value provide a high conservation benefit of designation to the Southern DPS).

CHRT Phase 4

In Phase 4, the CHRT was asked to identify any unoccupied areas that may be essential for the conservation of the Southern DPS. As described in the section titled "Unoccupied Areas" above, unoccupied areas may be designated as critical habitat only if: (a) a critical habitat designation limited to presently occupied areas would not be adequate to achieve conservation of the species; and (b) the unoccupied areas are determined to be essential for conservation of the species. Based on the best available data and their best professional judgment, the CHRT determined that a critical habitat designation limited to presently occupied areas may not be adequate to ensure conservation of the species. The CHRT identified and evaluated seven unoccupied areas in the Central Valley, CA, that may be essential for conservation of the Southern DPS. The CHRT considered several factors in their evaluation, including the historical use of the area by green sturgeon, the status of current habitat conditions, and the potential for restoring habitat conditions to support green sturgeon presence and spawning within the area. The CHRT members scored two factors: (1) the historical importance of the area for green sturgeon prior to habitat degradation and/or passage impairment; and (2) the potential for restoration of habitat conditions for green sturgeon, either naturally or through active conservation and restoration (Tables 8 and 9). The CHRT also identified what activities occur within each area that might trigger a section 7 consultation. As described above in the section titled *Unoccupied Areas*, the CHRT concluded that they did not have sufficient data to determine that any of the unoccupied areas *are essential* for conservation of the Southern DPS. The CHRT noted that these areas *may be essential* for conservation and emphasized the importance of gathering more information about the use of these areas by green sturgeon, for future consideration in recovery planning.

In this phase, the CHRT also considered the potential exclusion of particular occupied areas from the critical habitat designation and the effects of these exclusions on the conservation of the Southern DPS. Section 4(b)(2) of the ESA directs NMFS to consider the economic impacts, impacts on national security, and any other relevant impacts of specifying any particular area as critical habitat and provides NMFS the discretion to exclude any particular area if the benefits of exclusion outweigh the benefits of designation, as long as exclusion does not result in extinction of the species. NMFS identified potential economic impacts that may result from the critical habitat designation and represented these impacts in terms of economic costs. These economic costs were based on estimated costs for: conducting an ESA section 7 consultation; implementing project modifications to address effects on critical habitat; and other changes to activities resulting from the critical habitat designation. The economic analysis and potential impacts are described in detail in the draft economic report (*Industrial Economics Inc. 2008*), published concurrently with the proposed critical habitat rule. NMFS then identified areas eligible for exclusion by comparing the estimated economic costs (representative of the economic benefits of exclusion, or in other words, the economic impacts avoided if the area were excluded from the designation) with the final conservation value (representative of the benefits of designation) for each area. For the purposes of this analysis (called the ESA section 4(b)(2) analysis), the "particular areas" considered were the same as the "specific areas" identified by the CHRT. We identified areas that were eligible for exclusion if the estimated economic costs exceeded a threshold dollar value set by NMFS for areas with a conservation value of Medium ($100,000), Low ($10,000), or Ultra-Low ($0). For areas with a High conservation value, we did not identify any economic impacts that would outweigh the benefit of designation. Thus, we did not identify any areas of High conservation value that were eligible for exclusion. The draft ESA 4(b)(2) report (NMFS *2008a*) provided more details about the ESA section 4(b)(2) analysis. At the time of the proposed critical habitat rule, NMFS had not yet identified any impacts on national security or other relevant impacts and solicited comments from the public regarding these impacts.

At the time of the proposed rule, NMFS identified the following 15 specific areas as potentially eligible for exclusion from designation because the economic benefits of exclusion potentially outweighed the conservation benefits of designation: the lower Feather River, Elkhorn Slough, Tomales Bay, Noyo Harbor, the Eel River estuary, and the Klamath/Trinity River estuary in California; the Rogue River estuary, Coos Bay, Siuslaw River estuary, Alsea River estuary, and Tillamook Bay in Oregon; Puget Sound in Washington; and coastal marine waters within 110 m (60 fm) depth from the U.S.-California/Mexico border to Monterey Bay, from the U.S.-Alaska/Canada border to the Yakutat Bay, and from Yakutat Bay northwest to the Bering Sea. NMFS then presented the areas to the CHRT for review. To further characterize the conservation benefit of designation for these areas, NMFS asked the CHRT to determine whether exclusion of an area would significantly impede conservation of the Southern DPS. If the CHRT determined that exclusion would significantly impede conservation of the Southern DPS, NMFS considered this determination in the final conservation value for the area.

The CHRT considered the contribution of each area to species conservation and the information available on the life stages present, level of use by the Southern DPS, and habitat functions supported within each area. The CHRT concluded that exclusion of two of the areas (the lower Feather River and Coos Bay) would significantly impede conservation of the species. The CHRT determined that exclusion of Puget Sound, WA, would not significantly impede conservation or result in extinction of the species. Given the limited data available, the CHRT expressed uncertainty regarding whether the exclusion of coastal marine waters within 110 m (60 fm) depth from the U.S.-Alaska/Canada border to Yakutat Bay would significantly impede conservation of the species. NMFS proposed to exclude this area from designation, because the low number of Southern DPS detections in the area and the uncertainty regarding how activities in the area would affect critical habitat indicated that excluding this area would not significantly impede conservation or result in extinction of the species. Finally, the CHRT concluded, and NMFS concurred, that exclusion of the remaining 11 of the 15 areas eligible for exclusion would not significantly impede conservation and would not result in the extinction of the Southern DPS. The results of the CHRT's evaluation concerning areas eligible for exclusion are summarized in Table 7.

Proposed Critical Habitat Designation and Public Comment Phase

Following Phase 4, NMFS published the proposed critical habitat rule in the *Federal Register* on September 8, 2008 (73 FR 52084), with a technical correction to the map of proposed critical habitat in California published in the *Federal Register* on October 7, 2008 (73 FR 58527). The draft biological report (*NMFS 2008b*), draft economic analysis report (*Industrial Economics Inc. 2008*), and draft ESA section 4(b)(2) report (*NMFS 2008a*) were also provided for public comment and peer review. A public workshop was held in Sacramento, CA, on October 16, 2008, to collect information and comments from the public on the proposed critical habitat designation. The public comment period was established for 60 days but extended by 45 days in response to a request from the public, with a revised closing date of December 22, 2008 (73 FR 65283, November 3, 2008). NMFS received 39 public comments on the proposed critical habitat designation and supporting documents, as well as comments from three peer reviewers on the draft biological report.

CHRT Phase 5

In Phase 5, the CHRT re-convened to review the public comments and peer reviewer comments received on the proposed critical habitat designation and draft biological report and any new information identified that was not considered in the development of the proposed designation. The additional information has been incorporated into the relevant sections of this biological report. The CHRT's consideration of specific comments is summarized in the following paragraphs.

New specific areas and revisions to specific areas

Nehalem Bay, Oregon – The CHRT identified and considered one additional occupied specific area in Nehalem Bay, based on additional data provided by ODFW showing that green sturgeon occupy the bay (see description in the section titled "Geographical Area Occupied by the Species and Specific Areas within the Geographical Area Occupied", subsection "Bays and Estuaries"). The CHRT evaluated Nehalem Bay using the alternative approach and assigned it a Medium conservation value rating. Because the presence of Southern DPS green sturgeon is likely but not yet confirmed within Nehalem Bay, the conservation value rating was reduced by one level for a final conservation value rating of Low (Table 7).

Lower Columbia River estuary – Comments and additional information were received requesting that the specific area in the lower Columbia River estuary be divided into two areas based on differences in environmental factors and green sturgeon use of the areas (see description in the section titled "Geographical Area Occupied by the Species and Specific Areas within the Geographical Area Occupied", subsection "Bays and Estuaries"). Based on this information, the CHRT agreed that the lower Columbia River estuary should be divided into two specific areas: (1) the lower Columbia River estuary from the river mouth to RKM 74 (the extent of saltwater intrusion); and (2) the lower Columbia River from RKM 74 to the Bonneville Dam (RKM 146). The CHRT evaluated the two specific areas using the alternative approach. The CHRT assigned the lower Columbia River estuary (RKM 0 to 74) a final conservation value of High and assigned the lower Columbia River (RKM 74 to Bonneville Dam) a final conservation value of Low (Table 7).

San Francisco Bay, CA – Public comments were also received requesting that the San Francisco Bay specific area be divided into two specific areas: Central San Francisco Bay and South San Francisco Bay. Differences in environmental and oceanographic features can be used to distinguish Central Bay from South Bay. The CHRT determined, however, that dividing the San Francisco Bay specific area into two specific areas is not warranted, because the environmental and oceanographic differences distinguishing the Central bay from the South bay are not likely to affect green sturgeon use of the areas. Also, available data on green sturgeon captures in the Central bay and South bay do not indicate that green sturgeon use and occurrence differs between the two areas. The Coastside Fishing Club (CSFC), a local sport fishing group, reported 2 green sturgeon caught by CSFC members in Central San Francisco Bay, 3 green sturgeon caught in South-Central San Francisco Bay, and 4 green sturgeon caught in South San Francisco Bay from January to May 2006 (*pers. comm. with Pete Davidson, CSFC, May 31, 2006*). The total sport fish catch of green sturgeon during that time period is not known, because state sturgeon report cards were not required in California until March 2007 (*Gleason et al. 2008*). Green sturgeon catch data from otter trawl (1980 to 2004) and midwater trawl (1980 to 2001) sampling surveys conducted by CDFG show low numbers of green sturgeon caught throughout the bays and the Delta, with approximately 19 caught in the Delta, 27 caught in Suisun Bay/Carquinez Strait, 9 caught in San Pablo Bay, 8 caught in Central San Francisco Bay, and 2 caught in South San Francisco Bay (*Jahn 2006*).

These data provide some information about the distribution of green sturgeon throughout the bays and the Delta, but must be considered in light of the fact that the surveys and sampling gear were not designed to target green sturgeon. For example, larger numbers of green sturgeon catch would be expected in Central San Francisco Bay, given that all green sturgeon must migrate through this area in their migrations to and from the ocean. In addition, more specific information is needed on the distribution and use of the bays and Delta by juvenile green sturgeon. Based on the best available data, juvenile green sturgeon are believed to be widely distributed throughout all of the bays and the Delta. The CHRT conducted a preliminary evaluation of Central San Francisco Bay and South San Francisco Bay as separate specific areas, using the alternative approach as described above under the subsection of this biological report titled "CHRT Phase 2." The CHRT members unanimously assigned a High conservation value rating to both Central San Francisco Bay and South San Francisco Bay (the same conservation value rating assigned to the San Francisco Bay specific area). Thus, dividing the area into two specific areas would not have changed the conservation value rating of the areas. Studies specifically focused on green sturgeon, especially juveniles, are needed to address the data gaps and inform future evaluations of critical habitat.

Lower Feather River, CA – The Feather River specific area was defined from the river mouth to Oroville Dam (RKM 116). However, additional information was provided during the public comment period indicating that the uppermost barrier for anadromous fish passage is the Fish Barrier Dam (FBD) at RKM 109, not the Oroville Dam. The area between FBD and Oroville Dam may be accessible to salmonids due to steelhead stocking at the Thermalito Complex, but is not currently accessible to green sturgeon. In addition, the CDWR commented that the area between FBD and Oroville Dam currently consists of large, deep, slow pools with little complexity which would be considered low value habitat for green sturgeon. Based on the information provided, the CHRT agreed to revise the boundaries of the Feather River specific area to extend from the river mouth upstream to FBD at RKM 109.

Coastal marine areas – The CHRT revised the boundaries for the coastal marine areas based on public comments received. The CHRT had defined the specific areas in coastal marine waters to extend shoreward to include areas inundated by extreme high tide and to extend offshore to the 110 m depth contour. Public comments were received requesting that the shoreward boundary be re-defined to extend to the mean lower low water (MLLW) line along the coast, rather than extreme high tide. The CHRT agreed that, whereas studies indicate intertidal zones within estuaries and protected bays are important habitat for green sturgeon, green sturgeon use of high energy surf zones and shallow intertidal areas along the open coast is likely minimal. In addition, the CHRT compared the MLLW line along the coast with the extreme high tide line to determine whether any shallow protected waters that may be used by green sturgeon would be excluded from the specific areas if the MLLW line was used. The CHRT found that the MLLW line does not differ significantly from the extreme high tide line along the coast. The CHRT did not identify additional specific areas along the coast shoreward of the MLLW line that might be important for green sturgeon. Thus, the CHRT agreed to define the shoreward boundary for coastal marine specific areas by the MLLW line, rather than by extreme high tide. Public comments were also received requesting that the offshore boundary be defined by the 60 fm contour line, rather than the 110 m depth contour line, because: (a) navigational charts express depth in fathoms; (b) the 60 fm contour is already described in Federal regulations and used in the management of the West Coast groundfish bottom trawl fishery; and (c) 60 fm is approximately equal to 110 m (60 fm = 109.7 m). The CHRT agreed to define the offshore boundary by the 60-fm contour line, to be consistent with existing regulations.

Re-evaluation of specific areas based on additional information received

Tomales Bay, CA – The CHRT considered additional information for Tomales Bay indicating that two sturgeon had been observed in Lagunitas Creek (located at the far end into Tomales Bay). The two sturgeon were not identified to species and may be either white sturgeon or green sturgeon. The CHRT concluded that the additional information did not confirm whether Southern DPS fish use Tomales Bay, nor did it add to previously considered information on the extent of green sturgeon use of the bay. Thus, the CHRT determined that re-evaluation of Tomales Bay was not warranted and the final conservation value rating for the bay remained a Low. The CHRT noted, however, that Tomales Bay is a highly productive bay that may provide important feeding habitat for green sturgeon and studies are encouraged to monitor green sturgeon use and distribution within the bay and to confirm whether Southern DPS green sturgeon use the bay.

Yaquina Bay, OR – Additional information was provided confirming the presence of Southern DPS green sturgeon in Yaquina Bay. One green sturgeon tagged in the Sacramento River in 2005 was detected near the jetty in Yaquina Bay for one day on May 5, 2006 (*pers. comm. with Dan Erickson, ODFW, September 3, 2008*). The CHRT re-evaluated Yaquina Bay to consider this information. The CHRT previously assigned Yaquina Bay a Low conservation value rating, which was reduced to an Ultra-low because, at the time, Southern DPS presence had not been confirmed in the bay. After considering the additional data and re-evaluating the area, the CHRT again assigned Yaquina Bay a Low conservation value rating. However, because Southern DPS presence is now confirmed in Yaquina Bay, the final conservation value rating remains a Low and was not reduced to an Ultra-Low.

Tillamook Bay, OR – During the public comment period, additional green sturgeon catch data were provided showing that 279 green sturgeon of unknown DPS were caught in the sport fishery in Tillamook Bay from 1986 to 2007 (ODFW *2009a; 2009b*). This is a relatively large catch compared to other Oregon estuaries (excluding the lower Columbia River estuary), and is second only to Winchester Bay, where 1,889 green sturgeon were caught in the sport fishery over the same period (ODFW *2009a; 2009b*). Additional information was also provided indicating Tillamook Bay provides good habitat for green sturgeon, because it is large in area and volume and provides suitable depths for green sturgeon throughout 50% of the bay at mean low tide. Tillamook Bay had previously been assigned a Low conservation value rating, which was reduced to an Ultra-low because the presence of Southern DPS green sturgeon has not been confirmed in the area. Based on the additional information provided, the CHRT re-evaluated Tillamook Bay and assigned it a Medium conservation value rating. Because the presence of Southern DPS green sturgeon is likely but not yet confirmed, the final conservation value rating for Tillamook Bay was reduced to a Low.

Evaluation of additional areas eligible for exclusion

Using the economic impact estimates based on the revised economic analysis (*Industrial Economics Inc. 2009*), NMFS identified 18 areas that may be eligible for exclusion based on economic impacts. These 18 areas include all 15 of the areas considered in the proposed rule (see "Chart Phase 4" above), as well as the Yolo Bypass and Lower Yuba River in California and the lower Columbia River from RKM 74 to the Bonneville Dam. NMFS presented these 18 areas to the CHRT to further characterize the conservation benefit of designation and determine whether exclusion of these areas would significantly impede conservation of the Southern DPS. If the CHRT determined that exclusion of an area would significantly impede conservation of the Southern DPS, the final conservation value of the area was increased by one level.

The CHRT maintained its determination that exclusion of the following 12 areas would not significantly impede conservation of the Southern DPS or result in extinction of the species: Elkhorn Slough, Tomales Bay, Noyo Harbor, the Eel River estuary, and the Klamath/Trinity River estuary in California; the Rogue River estuary, Siuslaw River estuary, Alsea River estuary, and Tillamook Bay in Oregon; Puget Sound in Washington; and coastal marine waters within 110 m (60 fm) depth from the U.S.-California/Mexico border to Monterey Bay, CA, and from Yakutat Bay northwest to the Bering Sea. The CHRT also determined that exclusion of the lower Columbia River from RKM 74 to the Bonneville Dam would not significantly impede conservation of the Southern DPS or result in extinction of the species, recognizing that green sturgeon primarily occupy the lower estuary downstream of RKM 74. Members of the CHRT noted that the lower Columbia River upstream of RKM 74 may have been a historically important area for green sturgeon, but has been affected by activities that have altered the hydrography of the river. The lower Columbia River may provide important habitat for green sturgeon in certain water years and additional monitoring is needed to better understand the use of this area by green sturgeon.

The CHRT had expressed uncertainty regarding whether the exclusion of the coastal marine area within 110 m (or 60 fm) depth from the U.S.-Alaska/Canada border to Yakutat Bay, AK, would significantly impede conservation of the Southern DPS. The NOAA Observer Program provided additional information and a tissue sample from one green sturgeon caught in the Bering Sea in 2009 (*pers. comm. with Brian Mason, NMFS, July 30, 2009*), but it is not known whether the individual belongs to the Northern DPS or the Southern DPS. No other additional information was provided regarding green sturgeon use of coastal marine waters off Alaska. The CHRT could not determine that exclusion of this area would significantly impede conservation of the Southern DPS and recommended that additional monitoring be conducted on green sturgeon use and distribution in this area.

Finally, for four of the areas identified to be potentially eligible for exclusion based on economic impacts, the CHRT determined that exclusion would significantly impede conservation of the Southern DPS. Two of the areas (Yolo Bypass and the lower Yuba River in California) were not eligible for exclusion in the proposed rule, but were identified as potentially eligible for exclusion based on the revised economic impacts. The other two areas were identified as potentially eligible for exclusion in the proposed rule, but were proposed for designation because the CHRT determined that exclusion would significantly impede conservation of the Southern DPS. The following paragraphs summarize the CHRT's evaluation of these four areas.

Yolo Bypass, CA: The CHRT determined that exclusion of the Yolo Bypass would significantly impede the conservation of the Southern DPS because the area provides an important migratory corridor for juvenile, subadult, and adult Southern DPS green sturgeon during flood years. The area may be particularly important for juveniles that can use this shallow, productive, and protected off-channel area for rearing and feeding. The Yolo Bypass currently contains good habitat for supporting the Southern DPS, and the potential for the quality of this habitat to improve is likely if efforts to improve passage, reduce stranding risks, and improve water quality are made. The CHRT also noted uncertainties in the economic impacts estimates for this area. The total annualized cost impact of a critical habitat designation in the Yolo Bypass was estimated to be as high as $550,000, due in large part to the restrictions it might impose on the application of agricultural pesticides. The final economic report (*Industrial Economics Inc. 2009*) discusses the assumptions that were made in calculating this cost estimate and recounts specific scenarios that might lead to overestimated and underestimated impacts. Upon review of these assumptions, the CHRT concluded that the $550,000 cost estimate is likely an overestimate because it assumes that: (1) no changes in behavior would be undertaken by the agricultural industry to mitigate the impact of pesticide restrictions; and (2) measures implemented under a consultation for listed salmon and steelhead are not adequately protective of green sturgeon. The economic analysis estimated the costs associated with the implementation of a 60 foot to 1,000 foot buffer for pesticide application (as required under a recent biological opinion for listed salmonids) and estimated that the designation of green sturgeon critical habitat would result in additional costs equal to about 20 percent of those estimated costs. The CHRT determined, however, that the designation of green sturgeon critical habitat would not be likely to result in any additional costs because listed salmonids co-occur with green sturgeon in the Yolo Bypass and the buffers applied for listed salmonids would be adequately protective of green sturgeon. Therefore, the economic impact of the critical habitat designation for the Southern DPS in the Yolo Bypass is likely lower than $550,000.

Lower Yuba River, CA: The CHRT determined that exclusion of the lower Yuba River would significantly impede the conservation of the Southern DPS. The CHRT identified the lower Yuba River as an important area for the conservation of the Southern DPS due to its proximity to the Sacramento River and its potential to provide a secondary spawning river for the Southern DPS. Although current habitat conditions are not thought to support spawning for the Southern DPS, the area has the potential to do so in the future if habitat restoration activities are carried out (e.g., restoration of habitat or fish passage). The CHRT assigned the lower Yuba River a Medium conservation value, but noted that modifications to improve habitat conditions for spawning would raise the conservation value to a High. There is a relatively high degree of certainty that altering certain activities will protect the lower Yuba River's PCEs and could improve habitat conditions for the Southern DPS substantially, adding a second spawning area for this threatened species that is currently limited to one spawning area on the Sacramento River. The CHRT again noted some uncertainties in the economic impact analysis for this area. The estimated total annualized cost impact of a critical habitat designation in the lower Yuba River may be as high as $610,000, due in large part to costs associated with providing passage for the Southern DPS and changes in the application of agricultural pesticides. There is a great deal of uncertainty regarding what additional costs, beyond what is required for listed salmon and steelhead, are necessary to restore passage for the Southern DPS. We conclude that at this time, without knowing more about the specific flow and passage engineering requirements that the Southern DPS would need, the costs associated with the critical habitat designation are likely to be lower than those estimated by the economic analysis (approximately $300,000). As reasoned above for the Yolo Bypass, the costs associated with changes in agricultural pesticide application due to the Southern DPS critical habitat designation (approximately $400,000) are likely overestimated and the CHRT concluded, and we concur, that this cost is likely lower.

Lower Feather River, CA: The CHRT determined that exclusion of the lower Feather River would significantly impede the conservation of the Southern DPS. The CHRT identified the lower Feather River as an important area for the conservation of the Southern DPS, because it is consistently occupied by the species and most likely contains spawning habitat for the Southern DPS, potentially providing a spawning river for the Southern DPS in addition to the Sacramento River. The CHRT assigned the lower Feather River a Medium conservation value, but noted that modifications to improve habitat conditions (e.g., improved passage, restoration of water flow) would raise the conservation value to a High. There is a relatively high degree of certainty that altering certain activities will protect the lower Feather River's PCEs and could substantially improve habitat conditions for the Southern DPS. The CHRT also noted uncertainties in the economic impact analysis for this area with regard to agricultural pesticide application. The estimated total annualized cost impact of a critical habitat designation in the lower Feather River may be as high as $1.2 million, due in large part to costs associated with restrictions on the application of agricultural pesticides. As reasoned above for the Yolo Bypass, this cost is likely an overestimate and the CHRT concluded, and we concur, that this cost is likely lower.

Coos Bay, OR: The CHRT also determined that exclusion of Coos Bay would significantly impede conservation of the Southern DPS. The CHRT identified Coos Bay as an important area for the Southern DPS for several reasons. Coos Bay is the largest, deepest estuary along the Oregon coast presently occupied by Southern DPS green sturgeon. Although tagging data indicate that Southern DPS green sturgeon use Coos Bay at a lower level than Winchester Bay, Coos Bay provides a protected area for green sturgeon aggregation and feeding, has a large mixing zone, and is an important "stepping-stone" estuary between San Francisco Bay and the lower Columbia River estuary. The CHRT also indicated uncertainties in the economic impact analysis for this area. The low and high estimated economic impacts for Coos Bay differed greatly (ranging from $73,000 to $16 million), primarily due to uncertainty in the costs associated with a proposed LNG project in Coos Bay. The low cost estimate ($73,000) is based on impacts to other activities in the area and assumes that the critical habitat designation would not require any additional measures for the LNG project, or that any required measures would result in minimal costs (i.e., the economic impact to the LNG project is $0). The high cost estimate ($16 million) assumes that the LNG project would be re-sited due to the designation; however, this is an unlikely outcome. The uncertainty in costs associated with the LNG project is largely driven by a limited understanding of how LNG projects will affect green sturgeon PCEs and how LNG activities might be altered in order to avoid adversely modifying green sturgeon critical habitat. The impacts on the LNG project would likely be greater than $0, but much lower than $16 million, but we currently do not have sufficient information to estimate those costs. Thus, the estimated economic impact on Coos Bay would likely be greater than $73,000, but much lower than $16 million.

In conclusion, the CHRT determined that exclusion of the Yolo Bypass, lower Feather River, lower Yuba River, and Coos Bay would significantly impede conservation of the Southern DPS. Thus, the final conservation value for each of these areas (originally a Medium) was increased to a High. These final conservation values were used to represent the conservation benefits of designation and were weighed against the benefits of exclusion to determine whether areas warrant exclusion from the designation. The final ESA section 4(b)(2) report (*NMFS 2009b*) provides more details regarding NMFS' analysis under section 4(b)(2) of the ESA and determinations regarding areas to be excluded from the designation.

Table 1. Summary of green sturgeon presence by life stage and confirmed Southern DPS presence within the 41 specific areas identified by the CHRT. Supporting references are provided. E/L = eggs and larvae; J = juveniles; A/S = adults and subadults; SDPS = Southern DPS.

Specific Area	E/L	J	A/S	SDPS	References
Freshwater Rivers, Bypasses, and the Delta					
Upper Sacramento R., CA	X	X	X	X	**A/S**: Brown 2007; pers. comm. with Richard Corwin, USBR, June 5, 2008, unpublished data with Mike Thomas, UC Davis; Heublein et al. 2008; Poytress et al. 2009. **J**: USFWS 1992; CDFG 2002; Gaines and Martin 2002. **E/L**: CDFG 2002; Brown 2007; Poytress et al. 2009.
Lower Sacramento R., CA	X	X	X	X	**A/S**: Schaffter 1997; CDFG 2002; Brown 2007; pers. comm. with Richard Corwin, USBR, June 5, 2008, unpublished data with Mike Thomas, UC Davis; Heublein et al. 2008; Vogel 2008; Poytress et al. 2009. **J**: Kohlhorst 1976; CDFG 2002. **E/L**: CDFG 2002; Brown 2007; Poytress et al. 2009.
Yolo Bypass, CA		X	X	X	**A/S**: pers. comm. with Jeff Stuart, NMFS, February 24-25, 2008. **J**: pers. comm. with Jeff Stuart, NMFS, February 24-25, 2008.
Sutter Bypass, CA		X	X	X	**A/S**: pers. comm. with Jeff Stuart, NMFS, February 24-25, 2008. **J**: pers. comm. with Jeff Stuart, NMFS, February 24-25, 2008.
Lower Feather R., CA			X	X	**A/S**: CDFG 2002; Beamesderfer et al. 2004; CDWR 2005; Adams et al. 2007.
Lower Yuba R., CA			X	X	**A/S**: Beamesderfer et al. 2004; pers. comm. with Gary Reedy, SYRCL, December 5, 2006; pers. comm. with Alicia Seesholtz, CDWR, April 24, 2008.
Sacramento-San Joaquin Delta		X	X	X	**A/S**: Wang 2006. **J**: Radtke 1966; CDFG 2002; BDAT 2005; Jahn 2006; Wang 2006; BDAT 2009.
Bays and estuaries, including rivers to the head of the tide					
Elkhorn Slough, CA			X		**A/S**: pers. comm. with D. Catania, cited in Moyle et al. 1992; Yoklavich et al. 2002; pers. comm. with Carol Raifsnider, Tenera Consulting, September 12, 2006; pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008.
Suisun Bay, CA		X	X	X	**A/S**: Kelly et al. 2007; pers. comm. with Jeff Stuart, NMFS, February 24-25, 2008. **J**: Ganssle 1966; CDFG 2002; Jahn 2006; BDAT 2009.
San Pablo Bay, CA		X	X	X	**A/S**: Chadwick 1959; Miller 1972; Kelly et al. 2007; Lindley et al. 2008; pers. comm. with Steve Lindley, NMFS, and Mary Moser, NMFS, February 24-25, 2008; pers. comm. with David Woodbury, NMFS, February 24-25, 2008. **J**: Ganssle 1966; Miller 1972; CDFG 2002; Jahn 2006; BDAT 2009.
San Francisco Bay, CA		X	X	X	**A/S**: pers. comm. with Pete Davidson, CSFC, May 31, 2006; Jahn 2006; Kelly et al. 2007. **J**: CDFG 2002; Jahn 2006; BDAT 2009.
Tomales Bay, CA			X		**A/S**: Blunt 1980, cited in Moyle et al. 1992; pers. comm. with D. Catania and R. Plant, cited in Moyle et al. 1992.

Noyo Harbor, CA			X		**A/S**: pers. comm. with D. Catania, cited in Moyle et al. 1992.
Eel R., CA		X*	X		**A/S**: CDFG 2002. **J**: Murphy and DeWitt 1951, cited in Moyle et al. 1992; Puckett 1976, cited in CDFG 2002; pers. comm. with S. Cannata, CDFG, cited in CDFG 2002 (juveniles are believed to belong to the Northern DPS based on our definition of the Northern DPS and Southern DPS).
Humboldt Bay, CA			X	X	**A/S**: Samuelson 1973 and Sopher 1974, cited in Moyle et al. 1992; pers. comm. with D. Kohlhorst, cited in Moyle et al. 1992; Moyle et al. 1992; CDFG 2002; Pinnix 2008a and 2008b.
Klamath/Trinity R., CA			X		**A/S**: Snyder 1908 and USFWS 1980-1989, cited in Moyle et al. 1992; Adams et al. 2002; Benson et al. 2007.
Rogue R., OR			X		**A/S**: Rien et al. 2000; Farr et al. 2001; Erickson et al. 2002; Farr and Rien 2002; Farr and Rien 2003; Farr and Kern 2004; Farr and Kern 2005.
Coos Bay, OR			X	X	**A/S**: Rien et al. 2000; Farr et al. 2001; Farr and Rien 2002; ODFW 2002; Farr and Rien 2003; Farr and Kern 2004; Farr and Kern 2005; pers. comm. with S. Lindley and M. Moser, NMFS, 2006, cited in Memo to the Record by Churchill Grimes; ODFW 2009a, b.
Winchester Bay, OR		X*	X	X	**A/S**: Chadwick 1959; Neill et al. 2000; Rien et al. 2000; Farr et al. 2001; CDFG 2002; Israel and May 2006; pers. comm. with S. Lindley and M. Moser, NMFS, 2008; ODFW 2009a, b. **J**: King 1998 and Beamesderfer 2000, cited in Adams et al. 2002. Juveniles believed to belong to the Northern DPS.
Siuslaw R., OR			X		**A/S**: Emmett et al. 1991; pers. comm. with S. Lindley and M. Moser, NMFS, February 24-25, 2008 (one tagged Northern DPS fish was detected in Siuslaw River estuary); ODFW 2009a, b.
Alsea R., OR			X		**A/S**: Emmett et al. 1991; pers. comm. with D. Erickson, ODFW, September 3, 2008 (one tagged Northern DPS fish was detected in Alsea River estuary in June 2006); ODFW 2009a, b.
Yaquina R., OR			X	X	**A/S**: Emmett et al. 1991; Rien et al. 2000; Farr et al. 2001; Farr and Rien 2002; Farr and Rien 2003; Farr and Kern 2004; Farr and Kern 2005; pers. comm. with Dan Erickson, ODFW, September 3, 2008 (one tagged Southern DPS fish detected in Yaquina Bay in May 2006); ODFW 2009a, b.
Tillamook Bay, OR			X		**A/S**: Emmett et al. 1991; Rien et al. 2000; Farr et al. 2001; Farr and Rien 2002; Farr and Rien 2003; Farr and Kern 2004; Farr and Kern 2005; ODFW 2009a, b.
Nehalem Bay, OR			X		**A/S**: ODFW 2009a, b.
Lower Columbia river estuary (RKM 0 to 74)			X	X	**A/S**: Chadwick 1959; Miller 1972; Rien et al. 2000; Farr et al. 2001; Rien 2001; Adams et al. 2002; Beamesderfer 2000 cited in Adams et al. 2002; WDFW 2002 Letter to Ms. Donna Darm, cited in Adams et al. 2002; CDFG 2002; Farr and Rien 2002; WDFW and ODFW 2002; Farr and Rien 2003; Farr and Kern 2004; Israel et al. 2004; Farr and Kern 2005; Israel and May 2006; Moser and Lindley 2007; pers. comm. with B. James, WDFW, May 31, 2007; pers. comm. with S. Lindley and M. Moser, NMFS, February 24-25, 2008; pers. comm. with M. Moser, NMFS, February 25, 2009; Israel et al. in review.
Lower Columbia River (RKM 74 to 146)			X	X	**A/S**: Pers. comm. with B. James, WDFW, May 31, 2007; pers. comm. with O. Langness, WDFW, February 27, 2009; pers. comm. with T. Rien, ODFW, March 3, 2009.

Willapa Bay, WA			X	X	**A/S**: Emmett et al. 1991; Adams et al. 2002; WDFW 2002 Letter to Ms. Donna Darm, cited in Adams et al. 2002; pers. comm. with S. Lindley and M. Moser, NMFS, cited in BRT 2005; Moser and Lindley 2007; pers. comm. with O. Langness, WDFW, cited in Moser and Lindley 2007; Dumbauld et al. 2008; Israel et al. in review.
Grays Harbor, WA			X	X	**A/S**: Miller 1972; Adams et al. 2002; WDFW 2002 Letter to Ms. Donna Darm, cited in Adams et al. 2002; CDFG 2002; Moser and Lindley 2007; pers. comm. with S. Lindley and M. Moser, NMFS, February 24-25, 2008; Israel et al. in review.
Puget Sound, WA			X	X	**A/S**: Adams et al. 2002; pers. comm. with M. Moser and S. Lindley, NMFS, February 24-25, 2008; pers. comm. with M. Moser, NMFS, March 7, 2008.
Coastal marine waters (to 60 fm depth)					
US-CA/Mexico border to Monterey Bay, CA			X		**A/S**: Roedel 1941; Norris 1957; pers. comm. with R. Rasmussen, NMFS, July 18, 2006.
Monterey Bay, CA, to San Francisco Bay, CA			X	X	**A/S**: Miller 1972; CDFG 2002; pers. comm. with R. Rasmussen, NMFS, July 18, 2006; pers. comm. with J. Majewski, NMFS, January 29, 2007; Lindley et al. 2008; pers. comm. with S. Lindley and M. Moser, NMFS, February 24-25, 2008.
San Francisco Bay, CA, to Humboldt Bay, CA			X	X	**A/S**: Chadwick 1959; Miller 1972; CDFG 2002; Pinnix 2008a, b; pers. comm. with J. Majewski, NMFS, January 29, 2007.
Humboldt Bay, CA, to Coos Bay, OR			X	X	**A/S**: Chadwick 1959; Miller 1972.
Coos Bay, OR, to Winchester Bay, OR			X	X	**A/S**: Chadwick 1959; Miller 1972; pers. comm. with J. Majewski, NMFS, January 29, 2007.
Winchester Bay, OR, to Columbia R. estuary			X	X	**A/S**: Chadwick 1959; Miller 1972; Farr et al. 2001; pers. comm. with J. Majewski, NMFS, January 29, 2007.
Columbia R. estuary to Willapa Bay, WA			X	X	**A/S**: Miller 1972; Adams et al. 2002; WDFW 2002 Letter to Dr. Peter Adams, cited in Adams et al. 2002; WDFW 2002 Letter to Ms. Donna Darm, cited in Adams et al. 2002; Moser and Lindley 2007.
Willapa Bay, WA, to Grays Harbor, WA			X	X	**A/S**: Miller 1972; Adams et al. 2002; WDFW 2002 Letter to Dr. Peter Adams, cited in Adams et al. 2002.
Grays Harbor, WA, to US-WA/Canada border			X	X	**A/S**: Adams et al. 2002; WDFW 2002 Letter to Dr. Peter Adams, cited in Adams et al. 2002; pers. comm. with J. Majewski, NMFS, January 29, 2007; Lindley et al. 2008.
Strait of Juan de Fuca, WA			X	X	**A/S**: pers. comm. with J. Majewski, NMFS, January 29, 2007; Lindley et al. 2008; pers. comm. with M. Moser, NMFS, March 11, 2008.
Canada/US-AK border to Yakutat Bay, AK			X	X	**A/S**: pers. comm. with S. Lindley, NMFS, September 12, 2007; Lindley et al. 2008.
Coastal marine waters northwest of Yakutat Bay, AK (incl. the Bering Sea)			X		**A/S**: pers. comm. with D. Stevenson, NMFS, September 8, 2006; pers. comm. with J. Ferdinand, NMFS, November 24, 2006; pers. comm. with B. Mason, NMFS, July 30, 2009.

Table 2. Summary of occupied specific areas, and the river miles or surface area covered, the presence of the Southern DPS ("confirmed" based on documented evidence of the Southern DPS or "likely" based on the presence of green sturgeon of the Northern DPS or of unknown DPS), the PCEs present, and activities that may affect the PCEs within each area such that special management considerations or protection may be required.

Specific Area	River km or area covered	Southern DPS presence	PCEs present *	Activities **
Freshwater Rivers, Bypasses, and the Delta				
Upper Sacramento R., CA	95 km	Confirmed	Dp, Fd, Fl, P, S, Sq, Wq	CON, DAM, DIV, POLL, REST
Lower Sacramento R., CA	294 km	Confirmed	Dp, Fd, Fl, P, S, Sq, Wq	AG, CON, DAM, DIV, DR, POLL, REST
Yolo Bypass, CA	291 km^2	Confirmed	Fd, Sq, P, Wq	AG, DAM, DIV, POLL, REST
Sutter Bypass, CA	61 km^2	Confirmed	Fd, Sq, P, Wq	AG, CON, DAM, DIV, POLL, REST
Lower Feather R., CA	109 km	Confirmed	Dp, Fl, P, Wq	AG, CON, DAM, DIV, POLL, REST
Lower Yuba R., CA	18 km	Confirmed	Dp, Fl, P, Wq	AG, DAM, DIV, POLL, REST
Sacramento- San Joaquin Delta	784 km	Confirmed	Dp, Fd, Fl, P, S, Sq, Wq	CON, DAM, DIV, DR, POLL, PP, REST, SHIP
Bays and estuaries, including rivers to the head of the tide				
Elkhorn Slough, CA	3 km^2	Likely	Fd, Sq, P, Wq	DR, PP
Suisun Bay, CA	131 km^2	Confirmed	Dp, Fd, Fl, P, Sq, Wq	CON, DR, REST
San Pablo Bay, CA	329 km^2	Confirmed	Dp, Fd, P, Sq, Wq	CON, DR, POLL, PP, REST
San Francisco Bay, CA	700 km^2	Confirmed	Dp, Fd, P, Sq, Wq	CON, DR, EP, POLL, PP, REST, SHIP
Tomales Bay, CA	30 km^2	Likely	Fd, P, Sq, Wq	AG, AQ, DIV, POLL, REST
Noyo Harbor, CA	0.1 km^2	Likely	Fd, P, Sq, Wq	DR, POLL
Eel R., CA	22 km^2	Likely	Fd, P, Sq, Wq	CON, POLL
Humboldt Bay, CA	68 km^2	Confirmed	Fd, P, Sq, Wq	AG, AQ, POLL, SHIP
Klamath/Trinity R., CA	6 km^2	Likely	Fd, P, Sq, Wq	CON
Rogue R., OR	1 km^2	Likely	Fd, P, Sq, Wq	CON, POLL
Coos Bay, OR	48 km^2	Confirmed	Fd, P, Sq, Wq	CON, DR, LNG, POLL, SHIP
Winchester Bay, OR	22 km^2	Confirmed	Fd, P, Sq, Wq	CON, POLL
Siuslaw R., OR	1 km^2	Likely	Fd, P, Sq, Wq	CON, POLL
Alsea R., OR	2 km^2	Likely	Fd, P, Sq, Wq	CON, DIV, POLL
Yaquina R., OR	12 km^2	Confirmed	Fd, P, Sq, Wq	CON, DR, POLL
Tillamook Bay, OR	37 km^2	Likely	Fd, P, Sq, Wq	CON, POLL
Nehalem Bay, OR	8 km^2	Likely	Fd, P, Sq, Wq	CON, DR,
Lower Columbia River estuary (RKM 0 to 74)	414 km^2	Confirmed	Fd, P, Sq, Wq	CON, DAM, DR, LNG, POLL, SHIP

Table 2 (continued)

Specific Area	River km or area covered	Southern DPS presence	PCEs present *	Activities **
Bays and estuaries, including rivers to the head of the tide				
Lower Columbia River (RKM 74 to 146 (Bonneville Dam))	207 km^2	Confirmed	Fd, P, Sq, Wq	CON, DAM, DR, POLL, SHIP
Willapa Bay, WA	347 km^2	Confirmed	Fd, P, Sq, Wq	AQ, CON, EP, POLL
Grays Harbor, WA	245 km^2	Confirmed	Fd, P, Sq, Wq	AQ, POLL, SHIP
Puget Sound, WA	2,636 km^2	Confirmed	Fd, P, Sq, Wq	CON, DR, EP, POLL, SHIP
Coastal Marine Waters (within the 60 fm line)				
US-CA/Mexico border to Monterey Bay, CA	6,534 km^2	Likely	Fd, P, Wq	AQ, BOT, CON, DESAL, DR, EP, LNG, POLL, PP
Monterey Bay, CA, to San Francisco Bay, CA	3,868 km^2	Confirmed	Fd, P, Wq	BOT, CON, DESAL, DR, EP, LNG, POLL, PP
San Francisco Bay, CA, to Humboldt Bay, CA	5,385 km^2	Confirmed	Fd, P, Wq	BOT, DR, EP, LNG, POLL, PP
Humboldt Bay, CA, to Coos Bay, OR	4,865 km^2	Confirmed	Fd, P, Wq	BOT, DR, EP, LNG, POLL, PP
Coos Bay, OR, to Winchester Bay, OR	463 km^2	Confirmed	Fd, P, Wq	BOT, DR, EP, LNG
Winchester Bay, OR, to Columbia R. estuary	6,789 km^2	Confirmed	Fd, P, Wq	BOT, DR, EP, LNG, POLL
Columbia R. estuary to Willapa Bay, WA	1,167 km^2	Confirmed	Fd, P, Wq	BOT, DR, EP, LNG
Willapa Bay, WA, to Grays Harbor, WA	1,087 km^2	Confirmed	Fd, P, Wq	BOT, DR, EP, LNG
Grays Harbor, WA, to US-WA/Canada border	4,924 km^2	Confirmed	Fd, P, Wq	BOT, DR, EP, LNG, POLL
Strait of Juan de Fuca, WA	1,352 km^2	Confirmed	Fd, P, Wq	BOT, DR, EP, LNG, POLL
Canada/US-AK border to Yakutat Bay, AK	53,577 km^2	Confirmed	Fd, P, Wq	DR, EP, LNG, POLL, SHIP
Coastal Alaskan waters northwest of Yakutat Bay, AK, including the Bering Sea, to the Bering Strait	974,505 km^2	Likely	Fd, P, Wq	BOT, DR, EP, LNG, POLL, SHIP

* PCE codes: Dp = depth, Fd = food resources, Fl = water flow, P = migratory corridors, S = substrate type or size (structural), Sq = sediment quality (contaminants), Wq = water quality.

** Management activities codes: AG = agriculture, AQ = aquaculture, BOT = bottom trawl fisheries, CON = in-water construction or alterations, DAM = dams, DESAL = desalination plants, DIV = water diversions, DR = dredging and deposition of dredged material, EP = tidal/wave energy projects, LNG = LNG projects, POLL = NPDES activities and activities generating non-point source pollution, PP = power plants, REST = restoration, SHIP = commercial shipping.

Table 3. Definitions and criteria for multi-factor scoring system used to score the PCEs and evaluate the conservation value of the occupied specific areas.

Factors	Criteria
Factor 1: PCE Quality - Support of spawning and egg incubation. Considers the PCE support of spawning and egg incubation provided by the specific areas.	3 = the PCE supports spawning and egg incubation currently.
	2 = the PCE supported or likely supported spawning and egg incubation historically and likely supports spawning and incubation currently.
	1 = Uncertain but possible that the PCE supports spawning and egg incubation currently or historically.
	0 = Unlikely that the PCE supports spawning and egg incubation currently or historically.
Factor 2: PCE Quality - Support of larval/juvenile rearing and growth. Considers the PCE support of larval/juvenile rearing and growth provided by the specific areas.	3 = the PCE supports larval/juvenile rearing and growth currently.
	2 = the PCE supported or likely supported larval/juvenile rearing and growth historically and likely supports larval/juvenile rearing and growth currently.
	1 = Uncertain but possible that the PCE supports larval/juvenile rearing and growth currently or historically.
	0 = Unlikely that the PCE supports larval/juvenile rearing and growth currently or historically.
Factor 3: PCE Quality - Support of juvenile and/or subadult/adult migration. Considers the PCE support of juvenile and/or subadult/adult migration provided by the specific areas.	3 = the PCE supports both juvenile and subadult/adult migration currently.
	2 = the PCE currently supports subadult/adult migration for large numbers of subadults/adults relative to other areas.
	1 = Uncertain but possible that the PCE historically supported subadult/adult migration for large numbers of subadults/adults. The PCE currently supports subadult/adult migration for low numbers of subadults/adults relative to other areas.
	0 = the PCE supports subadult/adult migration for low numbers of subadults/adults relative to other areas, historically and currently.
Factor 4: PCE Quality - Support of subadult/adult feeding, holding, and/or non-spawning aggregations. Considers the PCE support of subadult/adult feeding, holding, and/or non-spawning aggregation provided by the specific areas.	3 = the PCE supports subadult/adult feeding, holding, and/or non-spawning aggregation for large numbers of subadults/adults relative to other areas.
	2 = Uncertain but possible that the PCE supports subadult/ adult feeding, holding, and/or non-spawning aggregation for large numbers of subadults/adults relative to other areas.
	1 = Uncertain but possible that the PCE supports subadult/ adult feeding, holding, and/or non-spawning aggregation for low numbers of subadults/adults relative to other areas.
	0 = Unlikely that the PCE supports subadult/adult feeding, holding, and/or non-spawning aggregation.

Table 4. Multi-factor scoring system table used to score the PCEs and evaluate the conservation value of the occupied specific areas.

Specific Areas	Spawning and incubation							Larval/ Juvenile rearing and growth							Juvenile and/or Subadult/Adult migration							Subadult/Adult feeding, holding, and/or non-spawning aggregation							TOTAL SCORE	Comments & references (include initial conservation value rating)
Rivers/Bypasses/Delta	Fd	S	Fl	Wq	P	Dp	Sq	Fd	S	Fl	Wq	P	Dp	Sq	Fd	S	Fl	Wq	P	Dp	Sq	Fd	S	Fl	Wq	P	Dp	Sq		
Upper Sac R., CA																														
Lower Sac R., CA																														
Yolo Bypass (Sac R.)																														
Sutter Bypass (Sac R.)																														
Lower Feather R., CA																														
Lower Yuba R., CA																														
Sac-San Joaquin Delta, CA																														
Bays/River to the head of the tide	Fd	Fl	Wq	P	Dp	Sq		Fd	Fl	Wq	P	Dp	Sq		Fd	Fl	Wq	P	Dp	Sq		Fd	Fl	Wq	P	Dp	Sq		TOTAL SCORE	Comments & references (include initial conservation value rating)
Elkhorn Slough, CA																														
Suisun Bay, CA																														
San Pablo Bay, CA																														
San Francisco Bay, CA																														
Tomales Bay, CA																														
Noyo Harbor, CA																														
Eel R., CA																														
Humboldt Bay, CA																														
Klamath/Trinity R., CA																														
Rogue R., OR																														
Coos Bay, OR																														
Winchester Bay, OR																														
Siuslaw R., OR																														
Alsea R., OR																														
Yaquina R., OR																														
Tillamook Bay, OR																														
Lower Columbia R. estuary and R.																														
Willapa Bay, WA																														
Grays Harbor, WA																														
Puget Sound, WA																														
Coastal Areas	Fd	Wq	P					Fd	Wq	P					Fd	Wq	P					Fd	Wq	P					TOTAL SCORE	Comments & references (include initial conservation value rating)
CA-Mexico border to Monterey, CA																														
Monterey Bay, CA to SF Bay, CA (including Monterey Bay)																														
SF Bay, CA to Humboldt Bay, CA																														
Humboldt Bay, CA to Coos Bay, OR																														
Coos Bay, OR to Winchester Bay, OR																														
Winchester Bay, OR to Columbia R. estuary																														
Columbia R. estuary to Willapa Bay, WA																														
Willapa Bay, WA to Grays Harbor, WA																														
Grays Harbor, WA to WA, US/Canada border																														
Strait of Juan de Fuca, WA																														
Canadian/AK, US border to Yakutat Bay, AK (including Graves Harbor)																														
Coastal AK waters northwest of Yakutat Bay, AK																														

Table 5. Evaluation table used to rate the conservation value of each specific area. Each CHRT member completed the table individually by entering the PCEs present supporting each life stage (Dp = depth, Fd = food resources, Fl = water flow, P = passage, S = substrates, Sq = sediment quality, and Wq = water quality), their first and second vote for the conservation value rating (High, Medium, Low), and their comments/justification. Responses were compiled to assign final conservation value ratings. Responses for the Upper Sacramento R. area are shown as an example and do not represent actual responses.

Specific Areas	**Life Stage**			**Conservation Value Rating**		**Notes**
	Eggs/ Larvae	**Juveniles**	**Adults/ Subadults**	**First Vote**	**Second Vote**	
Freshwater rivers, bypasses, and the Delta						
Upper Sacramento R., CA	Fd, Fl, P, S, Sq, Wq	Fd, Fl, S, Wq	Dp, Fd, Fl, P, S, Sq, Wq	High		Important habitat for spawning, rearing, and migration
Lower Sacramento R., CA						
Yolo Bypass, CA						
Sutter Bypass, CA						
Lower Feather R., CA						
Lower Yuba R., CA						
Sacramento-San Joaquin Delta						
Bays and estuaries, including rivers to the head of the tide						
Elkhorn Slough, CA						
Suisun Bay, CA						
San Pablo Bay, CA						
San Francisco Bay, CA						
Tomales Bay, CA						
Noyo Harbor, CA						
Eel R., CA						
Humboldt Bay, CA						
Klamath/Trinity R., CA						
Rogue R., OR						
Coos Bay, OR						
Winchester Bay, OR						
Siuslaw R., OR						
Alsea R., OR						
Yaquina R., OR						
Tillamook Bay, OR						
Nehalem Bay, OR						
Lower Columbia river estuary						
Lower Columbia River						
Willapa Bay, WA						
Grays Harbor, WA						
Puget Sound, WA						

Table 5 (continued)

Specific Areas	Life Stage			Conservation Value Rating		Notes
	Eggs/ Larvae	Juveniles	Adults/ Subadults	First Vote	Second Vote	
Coastal marine waters (to 60 fm depth)						
US-CA/Mexico border to Monterey Bay, CA						
Monterey Bay, CA, to San Francisco Bay, CA						
San Francisco Bay, CA, to Humboldt Bay, CA						
Humboldt Bay, CA, to Coos Bay, OR						
Coos Bay, OR, to Winchester Bay, OR						
Winchester Bay, OR, to Columbia R. estuary						
Columbia R. estuary to Willapa Bay, WA						
Willapa Bay, WA, to Grays Harbor, WA						
Grays Harbor, WA, to US-WA/Canada border						
Strait of Juan de Fuca, WA						
Canada/US-AK border to Yakutat Bay, AK						
Coastal Alaskan waters northwest of Yakutat Bay, AK, including the Bering Sea, to the Bering Strait						

Table 6. Summary comparison of conservation value (CV) evaluation results using the multi-factor scoring system and the alternative approach (H = High, M = Medium, L = Low). The multi-factor scoring system resulted in two CV ratings: the score-based rating and the initial conservation value rating (ICVR). The score-based rating was based on the mean total scores (Rivers/bypasses/Delta: L = 0-28, M = 29-56, H = 57-84; Bays/estuaries: L = 0-18, M = 19-36, H = 37-54; Coastal marine waters: L = 0-6, M = 7-12, H = 13-18; the mean total score, standard error, and range in total scores among all reviewers is provided). The ICVR was based on the majority rating from the reviewer's ICVR. Ratings of L/M (Low/Medium) and M/H (Medium/High) indicate where there was no majority rating. The majority ratings under the Alternative approach are provided. These were used to determine the Final CV ratings in the proposed and final critical habitat designation. Differences in CV ratings among approaches are highlighted in light gray. Upon consideration of public comments received, the CHRT re-evaluated Yaquina Bay and Tillamook Bay, divided the lower Columbia River estuary into 2 specific areas, and added a new specific area (Nehalem Bay, OR). The revised ratings and the Final CV ratings used to develop the final critical habitat designation are summarized.
*** The multi-factor scoring system results are provided to document the CHRT's analysis and for informational purposes. Both approaches were based on the best available data and the CHRT's best professional judgment. Use of the rating results in the final critical habitat designation and in other assessments should focus on the Final CV ratings rather than on the quantitative scores. See the description of CHRT Phases 2-5 for more details.

	Multi-factor Scoring System								
Specific Area	**Mean Total Scores**	**Standard Error**	**Range in Total Scores**	**Score-based Rating**	**Reviewer's ICVR**	**Alternative Rating**	**Final Rating (Proposed Rule)**	**Revised Rating**	**Final Rating (Final Rule)**
Freshwater rivers, bypasses, and the Delta									
Upper Sacramento R., CA	73.9	3.6	60 - 84	**H**	**H**	**H**	**H**		**H**
Lower Sacramento R., CA	70.5	4.3	49 - 84	**H**	**H**	**H**	**H**		**H**
Yolo Bypass, CA	32.3	7.2	17 - 70	**M**	**M**	**M**	**M**		**M**
Sutter Bypass, CA	31.9	6.9	17 - 70	**M**	**M**	**M**	**M**		**M**
Lower Feather R., CA	34.4	3.1	27 - 49	**M**	**M/H**	**M**	**M**		**M**
Lower Yuba R., CA	29.5	1.1	27 - 35	**M**	**M**	**M**	**M**		**M**
Sacramento-San Joaquin Delta	55.9	5.8	28 - 84	**M**	**H**	**H**	**H**		**H**
Bays and estuaries, including rivers to the head of the tide									
Elkhorn Slough, CA	7.4	1.9	0 - 18	**L**	**L**	**L**	**L**		**L**
Suisun Bay, CA	48.4	2.4	36 - 54	**H**	**H**	**H**	**H**		**H**
San Pablo Bay, CA	47.9	2.5	36 - 54	**H**	**H**	**H**	**H**		**H**
San Francisco Bay, CA	46.8	2.9	36 - 54	**H**	**H**	**H**	**H**		**H**
Tomales Bay, CA	12.5	2.8	5 - 29	**L**	**M**	**M**	**M**		**M**
Noyo Harbor, CA	6.0	1.9	0 - 15	**L**	**L**	**L**	**L**		**L**
Eel R., CA	5.6	1.9	0 - 12	**L**	**L**	**L**	**L**		**L**
Humboldt Bay, CA	16.9	2.7	6 - 30	**L**	**M**	**M**	**M**		**M**
Klamath/Trinity R., CA	4.4	2.1	0 - 12	**L**	**L**	**L**	**L**		**L**

Table 6 (continued)

Specific Area	Multi-factor Scoring System								
	Mean Total Scores	**Standard Error**	**Range in Total Scores**	**Score-based Rating**	**Reviewer's ICVR**	**Alternative Rating**	**Final Rating (Proposed Rule)**	**Revised Rating**	**Final Rating (Final Rule)**
Bays and estuaries, including rivers to the head of the tide									
Rogue R., OR	5.3	2.1	0 - 12	**L**	**L**	**L**	**L**		**L**
Coos Bay, OR	16.6	1.9	6 - 24	**L**	**M**	**M**	**M**		**M**
Winchester Bay, OR	19.5	1.9	12 – 30	**M**	**M**	**M**	**M**		**M**
Siuslaw R., OR	7.5	2.5	0 - 18	**L**	**L**	**L**	**L**		**L**
Alsea R., OR	7.0	1.7	0 – 12	**L**	**L**	**L**	**L**		**L**
Yaquina R., OR	9.3	3.3	0 – 24	**L**	**L**	**L**	**L**	**L**	**L**
Tillamook Bay, OR	8.7	1.2	6 – 12	**L**	**L**	**L**	**L**	**M**	**M**
Nehalem Bay, OR								**M**	**M**
Lower Columbia River estuary and river	25.8	2.2	18 – 36	**M**	**H**	**H**	**H**		
Lower Columbia River estuary (RKM 0 to 74)								**H**	**H**
Lower Columbia River (RKM 74 to 146)								**L**	**L**
Willapa Bay, WA	25.1	2.0	18 – 36	**M**	**H**	**H**	**H**		**H**
Grays Harbor, WA	25.1	2.1	18 - 36	**M**	**H**	**H**	**H**		**H**
Puget Sound, WA	19.0	3.9	6 - 36	**M**	**L/M**	**M**	**M**		**M**
Coastal marine waters (to 60 fm depth)									
US-CA/Mexico border to Monterey Bay, CA	4.1	0.4	0 – 9	**L**	**L**	**L**	**L**		**L**
Monterey Bay, CA, to San Francisco Bay, CA	11.6	0.4	6 – 15	**M**	**M/H**	**H**	**H**		**H**
San Francisco Bay, CA, to Humboldt Bay, CA	14.5	0.4	11 – 18	**H**	**H**	**H**	**H**		**H**
Humboldt Bay, CA, to Coos Bay, OR	14.0	0.4	12 – 18	**H**	**H**	**H**	**H**		**H**
Coos Bay, OR, to Winchester Bay, OR	15.1	0.3	12 – 18	**H**	**H**	**H**	**H**		**H**
Winchester Bay, OR, to Columbia R. estuary	15.1	0.4	9 – 18	**H**	**H**	**H**	**H**		**H**
Columbia R. estuary to Willapa Bay, WA	15.1	0.4	9 – 18	**H**	**H**	**H**	**H**		**H**
Willapa Bay, WA, to Grays Harbor, WA	15.1	0.4	9 – 18	**H**	**H**	**H**	**H**		**H**
Grays Harbor, WA, to US-WA/Canada border	13.0	0.5	6 – 18	**H**	**M**	**H**	**H**		**H**
Strait of Juan de Fuca, WA	10.1	0.4	6 – 15	**M**	**M**	**H**	**H**		**H**
Canada/US-AK border to Yakutat Bay, AK	9.4	0.6	0 – 15	**M**	**M**	**M**	**M**		**M**
Coastal Alaskan waters northwest of Yakutat Bay, AK, including the Bering Sea, to the Bering Strait	6.0	0.6	0 – 12	**L**	**L**	**L**	**L**		**L**

Table 7. Summary of the evaluation results (using the alternative approach) and final conservation value ratings for each of the occupied specific areas. For each specific area, the benefit of designation was determined based on consideration of the conservation value rating (based on the alternative approach), whether the area contains a connectivity corridor, and whether the presence of the Southern DPS was likely but not yet confirmed (the rating was reduced by one rating level; these areas are marked with an asterisk (*)). The spread in first votes for each rating is shown in the table (H = high, M = medium, L = low; for some areas, there were less than 8 votes because members of the CHRT did not feel they had the expertise to evaluate and rate those areas). For areas identified as eligible for exclusion based on economic impacts, the CHRT considered whether exclusion would significantly impede conservation of the Southern DPS. For four areas (marked by **), the CHRT determined that exclusion would significantly impede conservation and the final conservation value was increased by one level. This increase is reflected in the final CV rating. Finally, notes and comments from the CHRT's evaluation are recorded for each area. H = High, M = medium, L = low, U = ultra-low.

Specific area	H	M	L	Conservation value (CV) rating	Benefit of designating migratory corridor	Benefit of designation (final CV rating)	Would exclusion impede conservation?	Comments
Freshwater rivers, bypasses, and the Delta								
Upper Sacramento R., CA	8			**H**	**H**	**H**		The Southern DPS is unlikely to survive without this area. Identified as one of only 2 areas with extant spawning habitat. All life stages occur in this area and at least one of the 4 life stages of green sturgeon are present throughout the year. High total score.
Lower Sacramento R., CA	8			**H**	**H**	**H**		The Southern DPS is unlikely to survive without this area. Identified as one of only 2 areas with extant spawning habitat. All life stages occur in this area and at least one of the 4 life stages of green sturgeon are present throughout the year. High total score.
Yolo Bypass, CA **	2	4	1	**M**		**H**	**Yes**	Identified as an important migratory corridor during high flow events. A potential off-channel rearing/feeding area for juveniles. Potentially high-value habitat if passage problems and stranding risks are minimized. Larger of the 2 bypasses and thus may provide more habitat for green sturgeon. Exclusion of this area would significantly impede conservation of the Southern DPS.

Table 7 (continued)

Specific area	**H**	**M**	**L**	**Conservation value (CV) rating**	**Benefit of designating migratory corridor**	**Benefit of designation (final CV rating)**	**Would exclusion impede conservation?**	**Comments**
Freshwater rivers, bypasses, and the Delta								
Sutter Bypass, CA	1	5	1	**M**		**M**		Identified as an important migratory corridor during high flow events. A potential off-channel rearing/feeding area for juveniles. Potentially high-value habitat if passage problems and stranding risks are minimized
Lower Feather R., CA **	3	4	1	**M**		**H**	**Yes**	Medium-value based on current habitat conditions, but changes (e.g., restoration of habitat or fish passage) could increase the value to a "High." Spawning may have been supported historically (greater likelihood than on the Yuba R.) and may be restored.
Lower Yuba R., CA **	1	6	1	**M**		**H**	**Yes**	Medium-value based on current habitat conditions, but changes (e.g., restoration of habitat or fish passage, dam removal) could increase the value to a "High." Spawning may have been supported historically (lower likelihood than on the Feather R.) and may be restored in the future.
Sacramento- San Joaquin Delta	6	2		**H**	**H**	**H**		The Southern DPS is unlikely to survive without this area. Identified as an important area for juvenile feeding, rearing, and growth prior to ocean migration. Juveniles present throughout the year. An important connectivity corridor for migration between the Sacramento R. system and the ocean.

Table 7 (continued)

Specific area	H	M	L	Conservation value (CV) rating	Benefit of designating migratory corridor	Benefit of designation (final CV rating)	Would exclusion impede conservation?	Comments
Bays and estuaries to the head of tide								
Elkhorn Slough, CA *		1	7	**L**		**U**	**No**	Very little data on green sturgeon use. Appears to be used minimally by green sturgeon, but could be important due to its proximity to Monterey and San Francisco bays. Southern DPS presence likely.
Suisun Bay, CA	7	1		**H**	**H**	**H**		The Southern DPS is unlikely to survive without this area. Identified as an important area for juvenile rearing and osmoregulatory transition. Juveniles present throughout the year. An important migratory corridor.
San Pablo Bay, CA	7	1		**H**	**H**	**H**		The Southern DPS is unlikely to survive without this area. Identified as an important area for juvenile rearing and osmoregulatory transition. An important migratory corridor. Adults and subadults have been consistently captured in the bay over many decades. Juveniles present throughout the year.
San Francisco Bay, CA	7	1		**H**	**H**	**H**		The Southern DPS is unlikely to survive without this area. Identified as an important area for juvenile rearing and osmoregulatory transition. An important migratory corridor between the bays and Sacramento R. system and the ocean.
Tomales Bay, CA *		5	3	**M**		**L**	**No**	Very little data on green sturgeon use. This area could be important based on its large size, good feeding habitats, and proximity to San Francisco Bay. Southern DPS presence likely.

Table 7 (continued)

Specific area	H	M	L	Conservation value (CV) rating	Benefit of designating migratory corridor	Benefit of designation (final CV rating)	Would exclusion impede conservation?	Comments
Bays and estuaries to the head of tide								
Noyo Harbor, CA *			8	**L**		**U**	**No**	Very little data on green sturgeon use. Limited in area and depth. Likely minimally used. Southern DPS presence likely.
Eel R., CA *		1	7	**L**		**U**	**No**	Limited in area and depth. Southern DPS presence not confirmed. Likely minimally used by the Southern DPS, if at all. Former or intermittent spawning river for the Northern DPS (confirmed presence of larvae, juveniles, and adults in the 1990's and earlier; CDFG 2002).
Humboldt Bay, CA	2	5	1	**M**		**M**		An important area for summer rearing of Southern DPS subadults and adults that may support feeding and holding. Detections of tagged subadults/adults indicate consistent use of the bay.
Klamath/Trinity R., CA*			8	**L**		**U**	**No**	An important area for the Northern DPS, but likely minimally used by the Southern DPS, if at all. Coastal waters outside the estuary are likely more important for Southern DPS fish. Southern DPS presence likely.
Rogue R., OR *			8	**L**		**U**	**No**	An important area for the Northern DPS, but likely minimally used by the Southern DPS, if at all. Coastal waters outside the estuary are likely more important for Southern DPS fish. Southern DPS presence likely.
Coos Bay, OR **	1	6	1	**M**		**H**	**Yes**	An important area for summer rearing of Southern DPS subadults and adults that may support feeding and holding. Use by green sturgeon is lower than in Winchester Bay.

Table 7 (continued)

Specific area	H	M	L	Conservation value (CV) rating	Benefit of designating migratory corridor	Benefit of designation (final CV rating)	Would exclusion impede conservation?	Comments
Bays and estuaries to the head of tide								
Winchester Bay, OR	3	5		**M**		**M**		Identified as an important area for summer rearing of Southern DPS subadults and adults that may support feeding and holding. The CHRT rated this area to be of greater importance relative to Coos Bay, but less than the Columbia R. estuary, Willapa Bay, and Grays Harbor to the north.
Siuslaw R., OR *			8	**L**		**U**	**No**	Little data on green sturgeon use. Data suggest that green sturgeon use of the estuary is low. Southern DPS presence likely.
Alsea R., OR *			8	**L**		**U**	**No**	Little data on green sturgeon use. Data suggest that green sturgeon use of the estuary is low. Southern DPS presence likely.
Yaquina R., OR *	1	1	5	**L**		**U**		Little data on green sturgeon use. Data suggest this bay is not a significant holding or feeding area. Use by green sturgeon is greater than in the Siuslaw or Alsea. Southern DPS presence confirmed.
Tillamook Bay, OR *		5	2	**M**		**L**	**No**	From 1986 to 2007, a total of 279 green sturgeon were caught in the sport fishery, second highest only to catch in Winchester Bay. Suitable depths are available at mean low tide throughout approximately 50% of bay. Southern DPS presence likely.
Nehalem Bay, OR *		5	2	**M**		**L**		Relatively high numbers of green sturgeon observed (a total of 254 green sturgeon were caught in the sport fishery from 1986 to 2007). Contains suitable habitat for green sturgeon. Southern DPS presence likely.

Table 7 (continued)

Specific area	H	M	L	Conservation value (CV) rating	Benefit of designating migratory corridor	Benefit of designation (final CV rating)	Would exclusion impede conservation?	Comments
Bays and estuaries to the head of tide								
Lower Columbia River estuary (river mouth to RKM 74)	7			**H**		**H**		Identified as an important area for summer rearing, feeding, aggregations, and holding of Southern DPS subadults and adults. A substantial amount of evidence indicates a relatively high frequency of occurrence of Southern DPS fish. Very important for multiple year classes.
Lower Columbia River (RKM 74 to 146)		2	5	**L**		**L**		Data indicate lower use by green sturgeon in this area compared to the lower Columbia River estuary.
Willapa Bay, WA	7	1		**H**		**H**		Identified as an important area for summer rearing, feeding, aggregations, and holding of Southern DPS subadults and adults. A substantial amount of evidence indicates a relatively high frequency of occurrence of Southern DPS fish. Very important for multiple year classes.
Grays Harbor, WA	6	2		**H**		**H**		Identified as an important area for summer rearing, feeding, aggregations, and holding of Southern DPS subadults and adults. A substantial amount of evidence indicates a relatively high frequency of occurrence of Southern DPS fish. Very important for multiple year classes.
Puget Sound, WA		5	3	**M**		**M**	**No**	Southern DPS presence (subadults/adults) has been confirmed. The relatively few detections of Southern DPS fish indicate a low frequency of occurrence, but also suggest lengthy use and/or residence time.

Table 7 (continued)

Specific area	H	M	L	Conservation value (CV) rating	Benefit of designating migratory corridor	Benefit of designation (final CV rating)	Would exclusion impede conservation?	Comments
Coastal marine waters within 60 fm contour line								
US-CA/Mexico border to Monterey Bay, CA *			8	**L**		**U**	**No**	Very little data on green sturgeon use. Appears to be used minimally by green sturgeon. Southern DPS presence likely.
Monterey Bay, CA, to San Francisco Bay, CA	3	3	2	**H**	**H**	**H**		An important component of the primary connectivity corridor for Southern DPS subadults and adults (from San Francisco Bay, CA, to Vancouver Island, BC). Most Southern DPS subadults and adults exiting San Francisco Bay are believed to migrate north, but some portion also migrates south as far as Monterey Bay, primarily in winter months. This area may support feeding.
San Francisco Bay, CA, to Humboldt Bay, CA	5	2	1	**H**	**H**	**H**		An important component of the primary connectivity corridor for Southern DPS subadults and adults. Noted as an especially important area for subadults making their first migration into marine waters from San Francisco Bay, CA. This area may support subadult/adult aggregations and feeding.
Humboldt Bay, CA, to Coos Bay, OR	5	2	1	**H**	**H**	**H**		An important component of the primary connectivity corridor for Southern DPS subadults and adults. This area may support feeding.
Coos Bay, OR, to Winchester Bay, OR	6	1	1	**H**	**H**	**H**		An important component of the primary connectivity corridor for Southern DPS subadults and adults. This area may support subadult/adult aggregations and feeding.

Table 7 (continued)

Specific area	H	M	L	Conservation value (CV) rating	Benefit of designating migratory corridor	Benefit of designation (final CV rating)	Would exclusion impede conservation?	Comments
Coastal marine waters within 60 fm contour line								
Winchester Bay, OR, to Columbia R. estuary	6	2		**H**	**H**	**H**		An important component of the primary connectivity corridor for Southern DPS subadults and adults, particularly to and from oversummering habitats in the Columbia R. estuary and Washington estuaries. This area may support subadult/adult aggregations and feeding.
Columbia R. estuary to Willapa Bay, WA	6	2		**H**	**H**	**H**		An important component of the primary connectivity corridor for Southern DPS subadults and adults. Telemetry data indicate a relatively high level of migration between the Columbia R. estuary and Willapa Bay, two important oversummering areas. This area may support subadult/adult aggregations and feeding.
Willapa Bay, WA, to Grays Harbor, WA	6	2		**H**	**H**	**H**		An important component of the primary connectivity corridor for Southern DPS subadults and adults, supporting migration to and from oversummering habitats in Willapa Bay and Grays Harbor. This area may support subadult/adult aggregations and feeding.

Table 7 (continued)

Specific area	H	M	L	Conservation value (CV) rating	Benefit of designating migratory corridor	Benefit of designation (final CV rating)	Would exclusion impede conservation?	Comments
Coastal marine waters within 60 fm contour line								
Grays Harbor, WA, to US-WA/Canada border	3	3	2	**M**	**H**	**H**		An important component of the primary connectivity corridor for Southern DPS subadults and adults, supporting migration to and from oversummering habitats in Oregon and Washington, and overwintering habitats off Vancouver Island, BC. This area may support subadult/adult aggregations and feeding. The CHRT rated the area as medium-value, but rated the connectivity corridor as high-value.
Strait of Juan de Fuca, WA		6	2	**M**	**H**	**H**		An important component of the primary connectivity corridor for Southern DPS subadults and adults. May support feeding. The CHRT rated the area as medium-value, but rated the connectivity corridor as high-value.
Canada/US-AK border to Yakutat Bay, AK	1	4	3	**M**	**M**	**M**	**?**	This area represents the northernmost extent of the overwintering range, but is not identified as a component of the primary connectivity corridor for green sturgeon (from Monterey Bay, CA, to Vancouver Island, BC). Little data on green sturgeon use, aside from the detection of 2 Southern DPS fish off Graves Harbor. The CHRT rated both the area and the connectivity corridor as medium-value.
Coastal marine waters northwest of Yakutat Bay, AK, including the Bering Sea, to the Bering Strait *	1	1	6	**L**		**U**	**No**	Very little data on green sturgeon use. Appears to be used minimally by green sturgeon. Southern DPS presence likely.

Table 8. Definitions and criteria for evaluation of unoccupied areas identified by the CHRT.

Factor	Criteria
Historical importance: The role the habitat may have played for green sturgeon before habitat degradation and passage impairment.	3 = likely an area of significant spawning and juvenile production
	2 = likely an area of limited spawning and juvenile production
	1 = likely not used for spawning, but perhaps used by other life stages (e.g., summer holding for adults)
	0 = not an area of significant use by any life stage
Potential for restoration : The potential condition of the habitat for green sturgeon, including accessibility and spawning, either naturally or through active conservation/ restoration, given known limiting factors, likely biophysical responses, and feasibility.	3 = there is a high potential and likelihood for restoring green sturgeon presence and spawning in the area. Restoration actions in the planning or implementation phase.
	2 = there is some potential and likelihood for restoring green sturgeon presence and spawning in the area. Not in planning, but apparent impediments are not severe or expensive to correct, or restoration planning underway but efficacy for green sturgeon uncertain.
	1 = there is some potential and likelihood for restoring green sturgeon presence in the area, but not spawning. Not in planning, but apparent impediments are not severe or expensive to correct, or restoration planning underway, but efficacy for green sturgeon uncertain. Restoration of limiting habitat conditions is uncertain.
	0 = there is a low potential and likelihood for restoring green sturgeon presence and/or spawning in the area. Impediments are severe, expensive to correct, and political support for corrections unlikely.

Table 9. Evaluation table for consideration of unoccupied areas identified by the CHRT.

Unoccupied area	Historical importance	Potential for restoration	Total score	Section 7 benefits	Comments/ justification on ratings	Comments on boundaries
Upper Sacramento River – Pit River						
Upper Sacramento River – McCloud River						
Upper Sacramento River – Upper Sacramento River						
Upper Feather River						
Upper Yuba River						
American River						
San Joaquin River (Area 1) – to Stanislaus River						
San Joaquin River (Area 2) – to Upper San Joaquin and Stanislaus rivers						

Figure 1. Map of occupied specific areas considered for designation in coastal bays and estuaries and coastal marine waters off California.

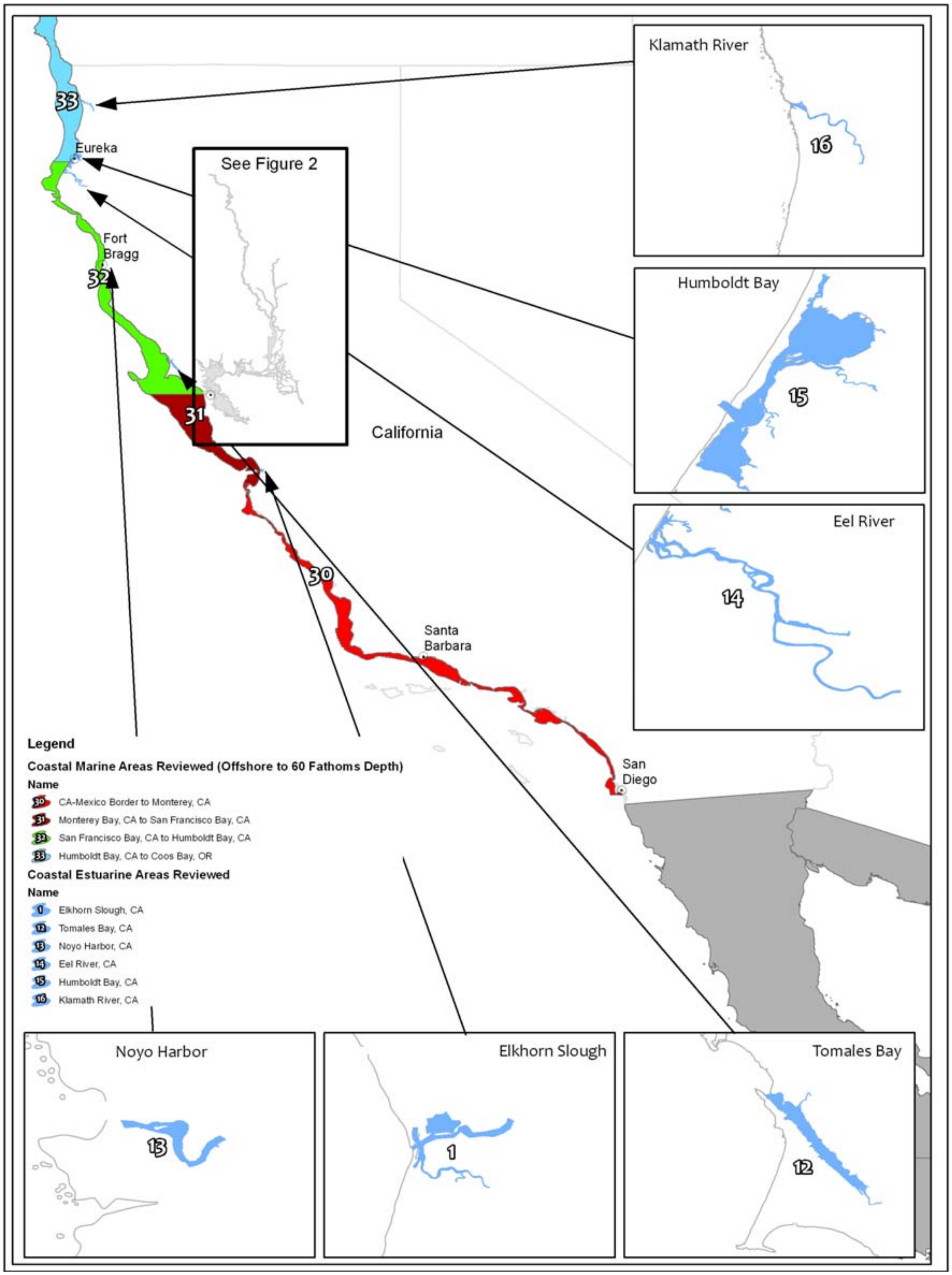


Figure 2. Map of occupied specific areas considered for designation in the Central Valley, California.

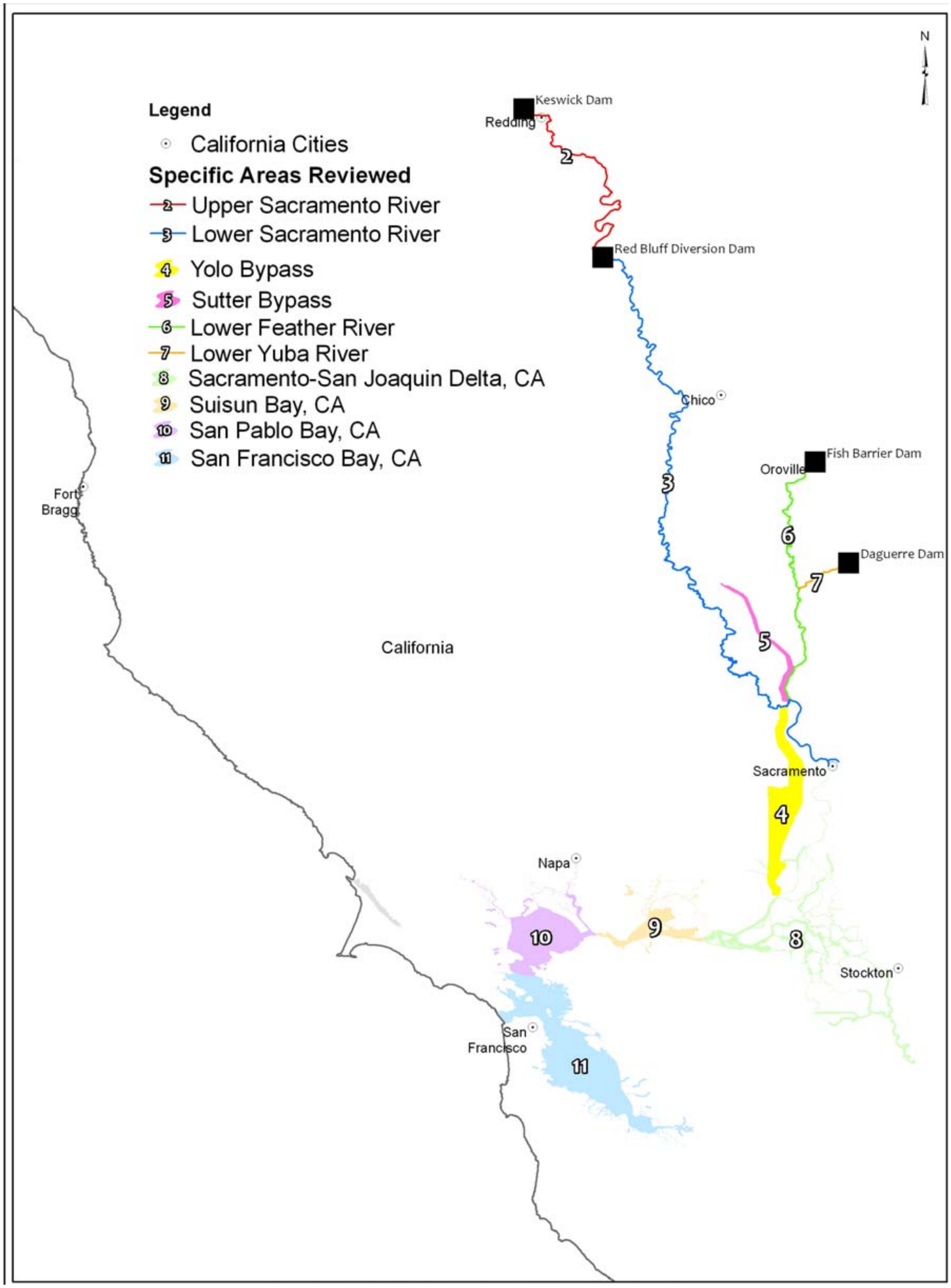


Figure 3. Map of occupied specific areas considered for designation in coastal bays and estuaries and coastal marine waters off Oregon.

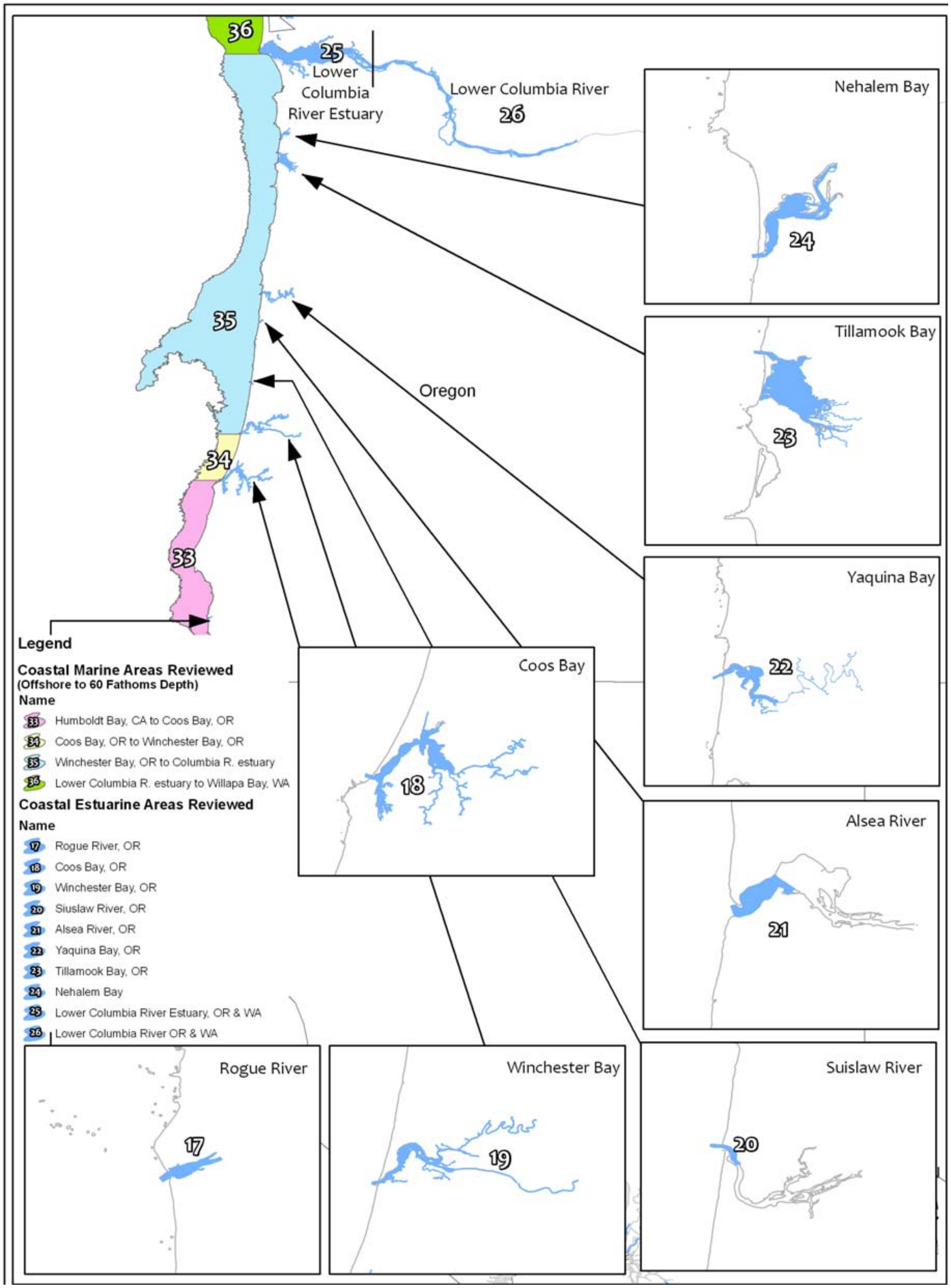


Figure 4. Map of occupied specific areas considered for designation in coastal bays and estuaries and coastal marine waters off Washington.

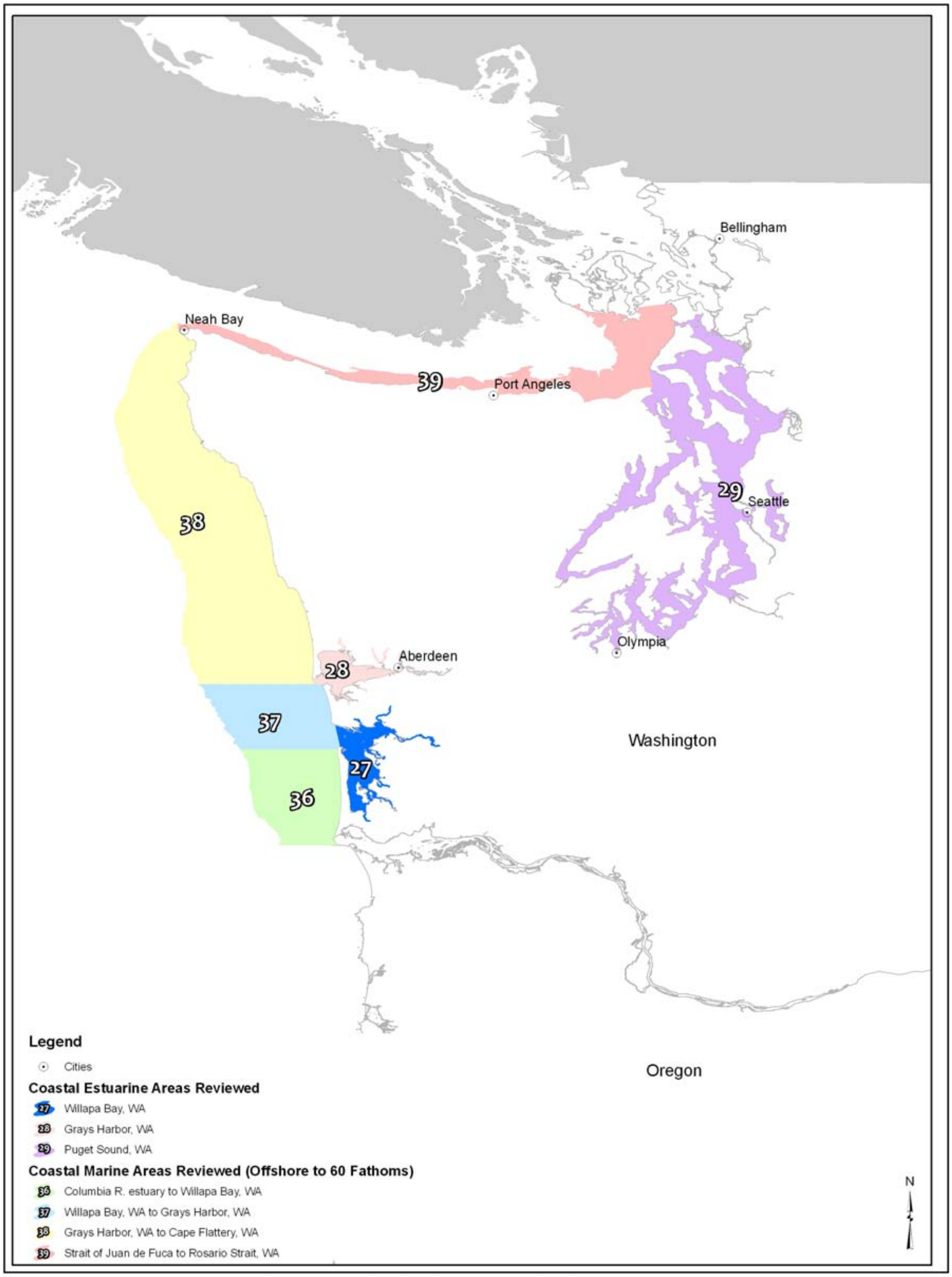
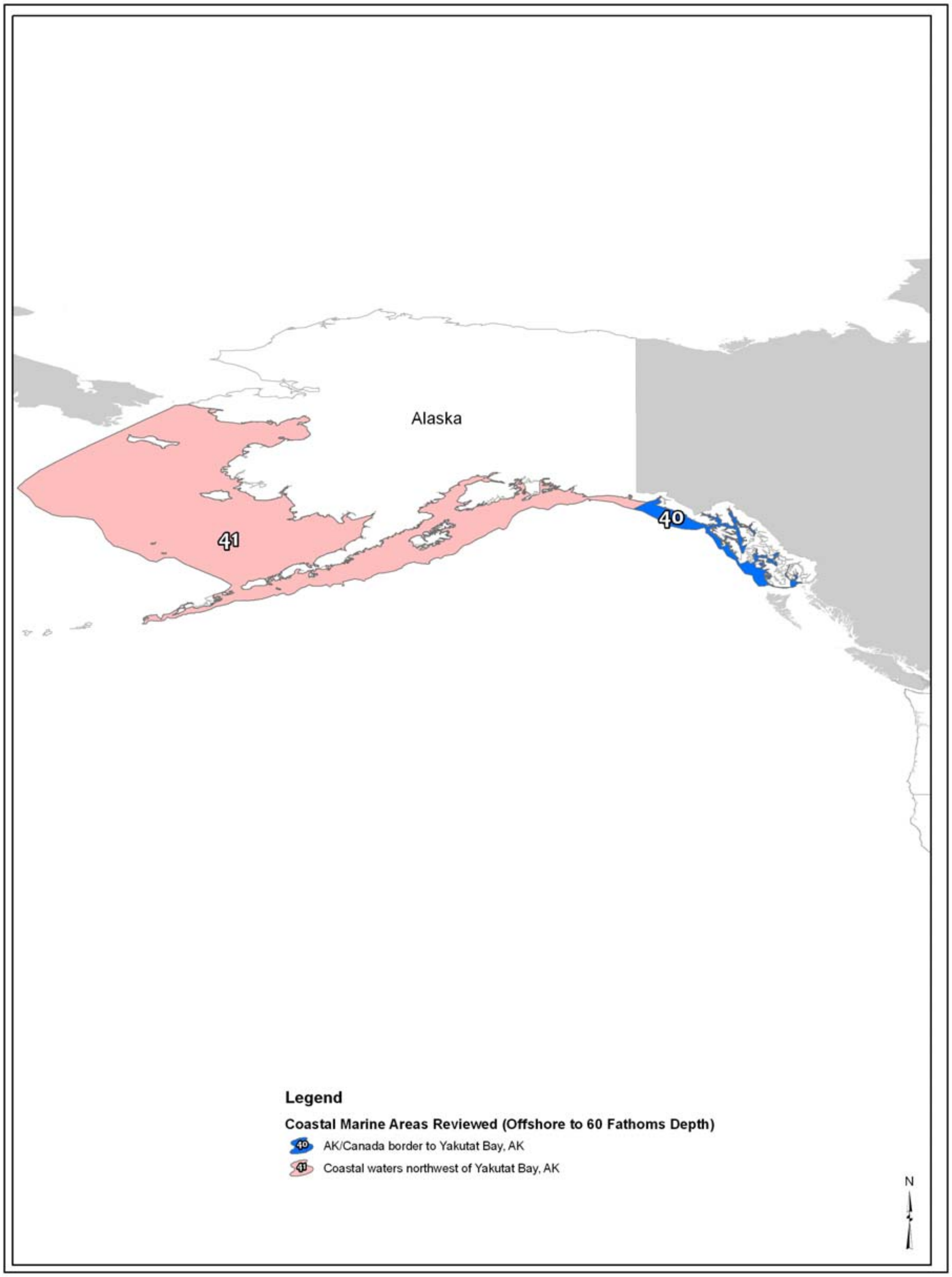


Figure 5. Map of occupied specific areas considered for designation in coastal marine waters off Alaska.



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PERSONAL COMMUNICATIONS

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APPENDIX A

MEMO July 14, 2008

TO: The Record

FROM: Melissa Neuman
Southwest Regional Office, Protected Resources Division

SUBJECT: Summary of Data Concerning Critical Habitat for the Southern Distinct Population Segment of Green Sturgeon in the Pacific Ocean.

The critical habitat review team (CHRT) assessed the biological importance of coastal marine areas to green sturgeon, and the primary constituent elements (PCEs) and special management considerations or protection that may be needed within these areas. This memo summarizes the best data available upon which the CHRT and NMFS evaluated critical habitat for the Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*; hereafter, "Southern DPS") within coastal marine areas.

Green sturgeon use of coastal marine areas

The CHRT identified coastal marine areas within 110 m depth as important migratory and feeding habitats for Southern DPS green sturgeon. Subadults enter the ocean after rearing in fresh and estuarine waters as juveniles for 1-4 years, and spend 3-20 years at sea before reaching reproductive maturity and returning to their natal river (i.e., the Sacramento River, CA) to spawn. After spawning, adults migrate out to sea and return to spawn every 2-4 years. Estimated longevity is between 60-70 years (Emmett *et al*., 1991). Thus, green sturgeon spend the majority of their lives in marine and estuarine waters outside of their natal rivers.

The CHRT considered coastal marine areas from Monterey Bay, CA, to Graves Harbor, AK, as particularly important for the Southern DPS because tagging (i.e. hydroacoustic and pop-off archival) and fisheries data confirm that green sturgeon make exclusive use of these areas for extensive migrations (i.e. 1000s of km) spanning a broad temporal range (i.e. many months) (Erickson and Hightower, 2007; Lindley *et al*., 2008; Lindley and Moser, 2008, unpublished data; WCGOP, 2008, unpublished data) (**See Figures A-1 to A-4**). Southern DPS fish migrate through this coastal marine corridor to reach oversummering habitats in bays and estuaries in northern California, Oregon, and Washington and to reach overwintering grounds in coastal waters between Vancouver Island, BC, and southeast Alaska (Lindley *et al*., 2008; Lindley and Moser, 2008, unpublished data). Southern DPS fish also migrate south after exiting San Francisco Bay and occupy marine waters off central California (as far south as Monterey Bay) in the spring, suggesting these areas contain oversummering and overwintering habitats (Lindley *et al*., 2008; Lindley and Moser, 2008, unpublished data). Although most tagged green sturgeon made rapid migrations along the coast, some individuals were observed swimming at slower speeds and spending several days within certain areas, most likely to forage (Lindley and Moser, 2008, unpublished data).

Data obtained from the West Coast Groundfish Observer Program and Erickson and Hightower (2007) on the bycatch of green sturgeon in bottom trawl fisheries off California, Oregon, and Washington support the tagging results and confirm the presence of green sturgeon from Monterey Bay, CA, to Cape Flattery, WA. CPUE was highest between Monterey and Humboldt bays, CA (WCGOP, 2008, unpublished data). The bycatch data also demonstrate that green sturgeon associate with benthic habitat in that they were collected in bottom trawls and are thus exposed to bottom disturbances.

<u>Specific areas, PCEs, and special management considerations or protection (see .pdf attachments 2 and 3 for corresponding figures)</u>

The CHRT defined 3 primary constituent elements (PCEs) for the coastal marine areas: (1) migratory corridors; (2) prey resources; and (3) water quality. Each PCE is discussed below.

Migratory corridors: Coastal marine areas provide an important migratory/connectivity corridor for the Southern DPS to access oversummering and overwintering habitats along the west coast of North America. The CHRT identified potential threats to passage involving take of green sturgeon, including incidental catch in fisheries. Alternative energy projects may hinder migration, particularly through the production of electromagnetic fields (McIsaac, 2008). A recent workshop at Oregon State University examined the potential ecological effects of wave energy development in the Pacific Northwest (http://hmsc.oregonstate.edu/waveenergy). Although the ecological effects of alternative energy projects on the marine environment remain uncertain and require further study, sturgeon were highlighted as one of the species whose migratory and feeding behavior is most likely to be affected by electromagnetic force fields because they orient themselves in the water column and forage for food using electromagnetic receptors located on their bodies (LeBreton et al. 2005). The CHRT also highlighted the potential problem of ocean "dead zones" (areas of low dissolved oxygen) and petroleum spills, in that they may block migratory routes and restrict the migratory corridor of Southern DPS fish. The link between ocean dead zones, petroleum spills and restricted passage for green sturgeon is largely unstudied. However, recent information suggests that: ocean hypoxia is a growing problem off the U.S. West coast; dissolved oxygen levels may fall below the critical threshold of 5 mg/l (necessary for maintaining fish health and behavior) for extended periods of time (months) and occur over large spatial scales (1000s of km); low dissolved oxygen zones restrict movements of fishes by narrowing the spatial extent of waters with dissolved oxygen levels above 5 mg/l; and fish disappear and have experienced massive die-offs as a result of extended hypoxic or anoxic conditions in coastal marine waters (www.krisweb.com/stream/do.htm, www.piscoweb.org/outreach/topics/hypoxia).

Water quality: Bioaccumulation of contaminants (e.g., pesticides, mercury, heavy metals) adversely affects the growth and reproductive development and success of white sturgeon (Fairey *et al*., 1997; Foster *et al*., 2001a; Foster *et al*., 2001b; Kruse and Scarnecchia, 2002; Feist *et al*., 2005; Greenfield *et al*., 2005). Green sturgeon are believed to experience similar effects. The CHRT identified commercial shipping, desalination plants, disposal of dredged materials, LNG projects, and discharge from industries as potential sources of pollution in coastal marine areas. Structures for alternative energy projects may also release chemicals into the water (McIsaac, 2008). However, in order to link the effects of these activities on water quality to impacts on green sturgeon, more information is needed on contaminant levels within coastal marine areas and their effects on green sturgeon through trophic interactions. Low dissolved oxygen zones and petroleum spills along the coast are also a water quality concern, with potential adverse effects (i.e. impeding safe passage along the migratory corridor) on green sturgeon as described above.

Prey resources: Green sturgeon feed on a variety of benthic invertebrates and fish species in estuaries, including ghost shrimp, mud shrimp, crangonid shrimp, amphipods, isopods, clams, polychaetes, Dungeness crabs, sand lances, and lingcod (Ganssle, 1966; Radtke, 1966; Dumbauld *et al*., 2008). Green sturgeon likely feed on similar species within marine waters. Seasonal migrations of green sturgeon, particularly to overwintering grounds off central California and between Vancouver Island, BC, and southeast Alaska, are likely driven by food resources. Telemetry data indicate potential feeding aggregations along the coast (Lindley and Moser, 2008, unpublished data). Many of the prey resources mentioned above are distributed over broad ranges in near coastal marine habitats along the western coast of North America (http://www.nwrc.usgs.gov/publications/specindex.htm). The CHRT identified commercial shipping activities (particularly petroleum shipping), contaminant spills, disposal of dredged material, and bottom trawling activities as potential threats to prey resources. Commercial shipping activities, particularly petroleum shipping in the event of a petroleum spill, have the potential to negatively effect macrobenthic communities. Numerous studies have shown that total petroleum hydrocarbons are strongly negatively related to macrobenthic species number, abundance and diversity (Boesch and Rabalais, 1990). Additionally, exposure of prey species to petroleum hydrocarbons and other contaminants may result in the bioaccumulation of these contaminants in green sturgeon, resulting in long-lasting effects on the health and survival of green sturgeon. Disposal of dredged material may bury prey resources and alter the macrobenthic community structure in near shore marine environments for many months to years before the natural fauna are re-established (Oliver *et al.*, 1977, Blanchard and Feder, 2003). Disturbance of the benthos from bottom trawling may also affect prey resources, but may have beneficial or adverse effects on green sturgeon foraging, depending on the prey species and characteristics of the bottom habitat (National Research Council 2002).

Based on the available data, the CHRT identified coastal marine areas, from Monterey, CA to Graves Harbor, AK out to the 110 m depth contour, that: 1) meet the definition of critical habitat as defined by the ESA (i.e. it contains at least one PCE with a possible special management concern); 2) contain confirmed Southern DPS fish; and 3) are in need of protection in order to conserve and protect the Southern DPS.

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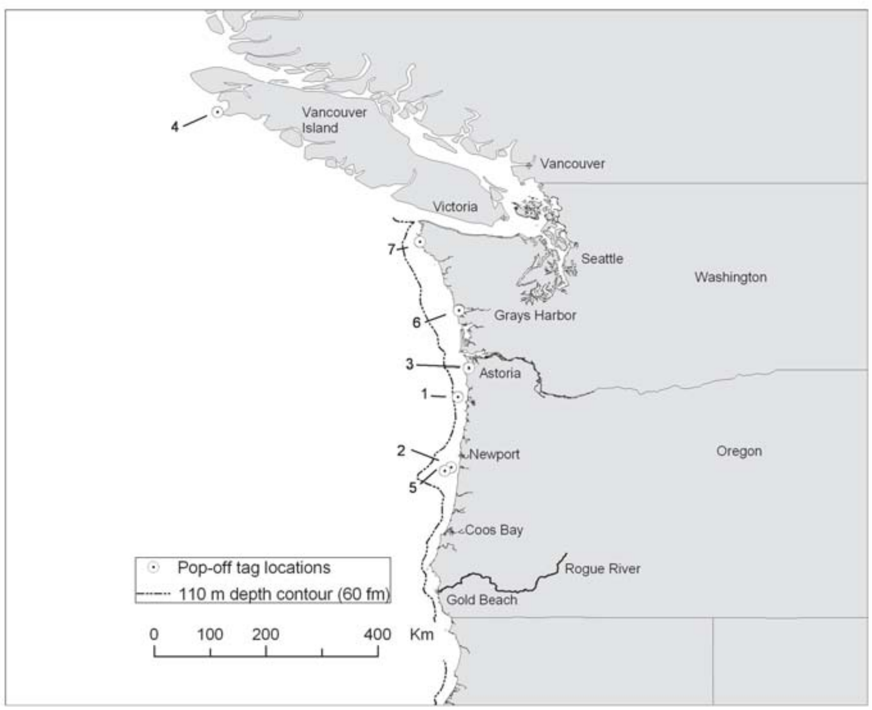


Figure A-1. Map showing the locations of the Rogue River, Oregon, where green sturgeon were tagged with pop-off archival tags (PATs), and the tag recovery sites along the coasts of Oregon, Washington, and British Columbia. The numbers refer to individual specimens; the site for specimen 3 is the point where the PAT was found on the shore after detaching prematurely. From Erickson and Hightower, 2007.

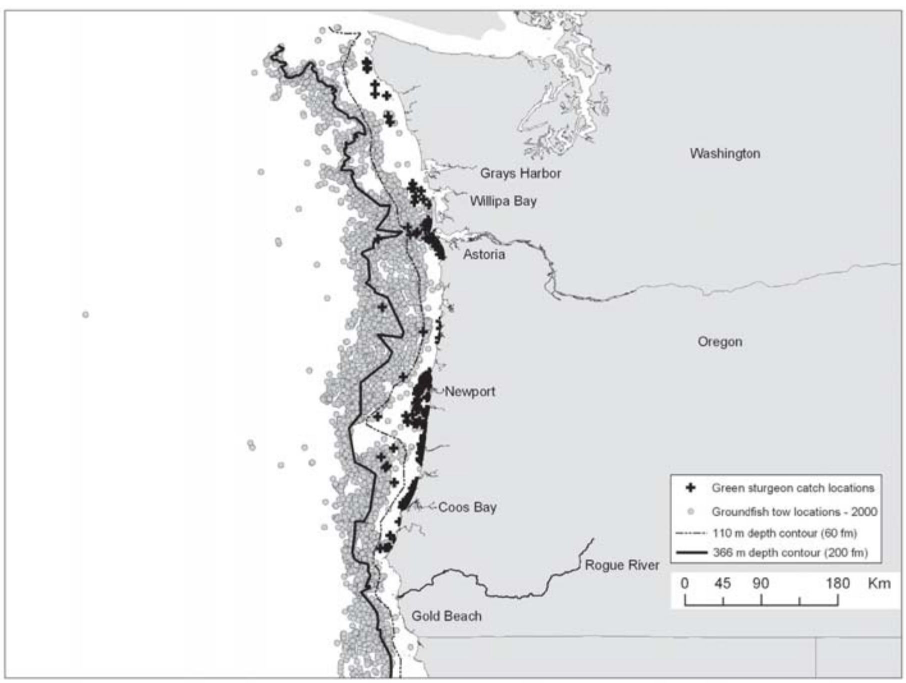


Figure A-2. Map showing the locations of bottom-trawl sets made during 2000 and bottom-trawl sets that caught green sturgeon during 1993–2000 along the Oregon and Washington coasts. The depth contours (110 and 366 m) represent the boundaries of a no-trawl zone (Rockfish Conservation Area) implemented after 2000. From Erickson and Hightower, 2007.

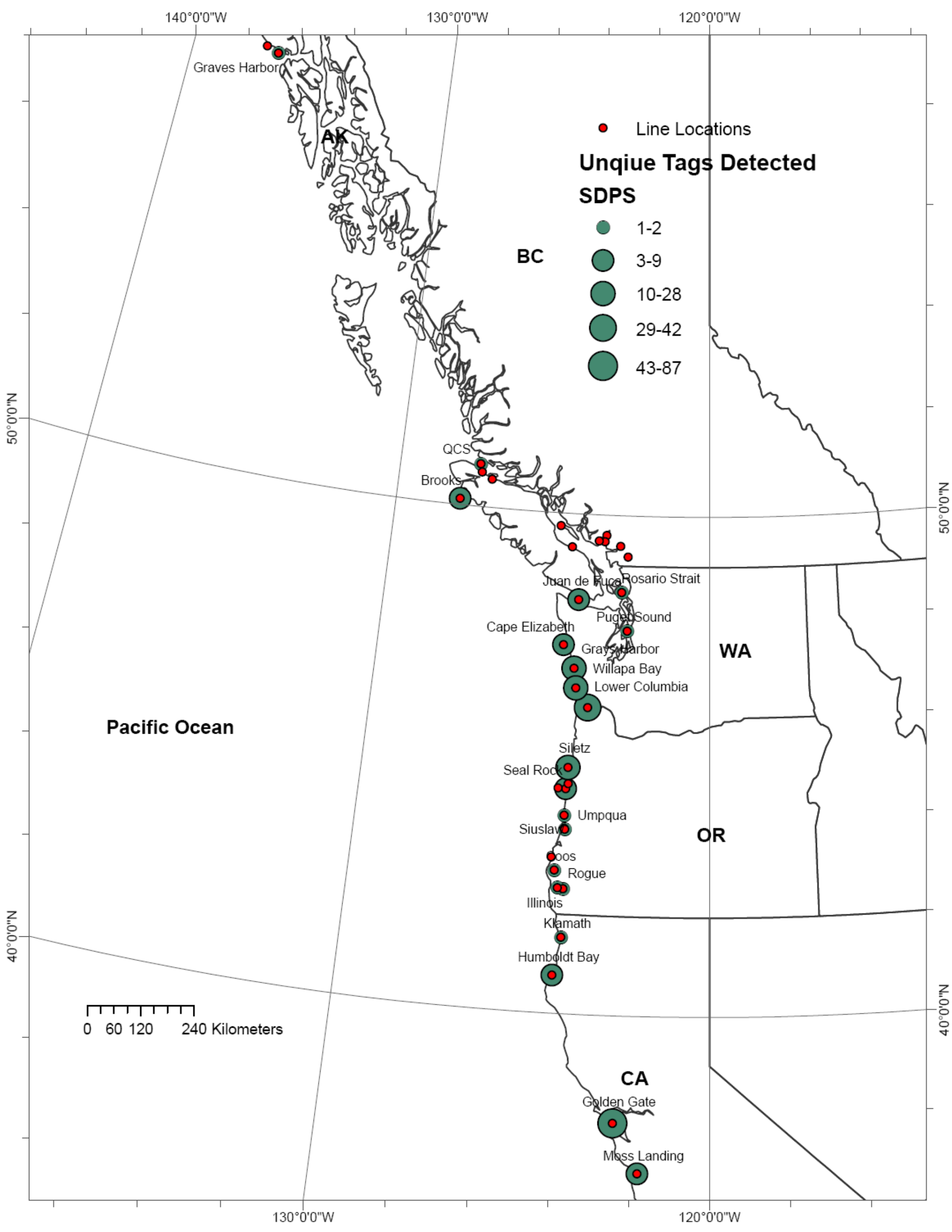
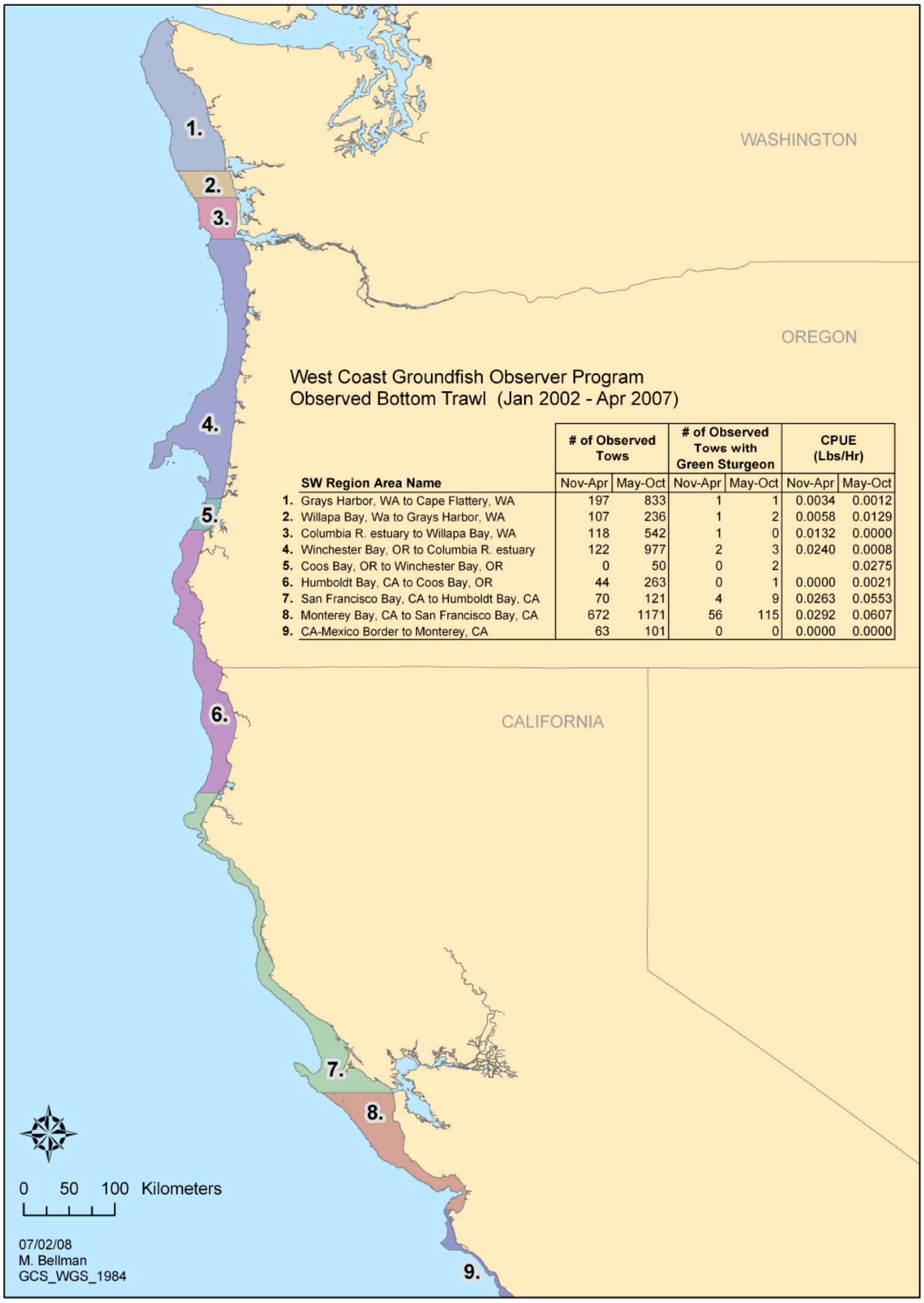


Figure A-3. Unique tag detections (n=161detections) of Southern DPS fish (n=213 total fish tagged) in coastal marine areas (n=115 detections), estuaries and rivers (n=46 detections) along the west coast of North America from 2002-2005. Adapted from Lindley et al., 2008.



	SW Region Area Name	# of Observed Tows		# of Observed Tows with Green Sturgeon		CPUE (Lbs/Hr)	
		Nov-Apr	May-Oct	Nov-Apr	May-Oct	Nov-Apr	May-Oct
1.	Grays Harbor, WA to Cape Flattery, WA	197	833	1	1	0.0034	0.0012
2.	Willapa Bay, Wa to Grays Harbor, WA	107	236	1	2	0.0058	0.0129
3.	Columbia R. estuary to Willapa Bay, WA	118	542	1	0	0.0132	0.0000
4.	Winchester Bay, OR to Columbia R. estuary	122	977	2	3	0.0240	0.0008
5.	Coos Bay, OR to Winchester Bay, OR	0	50	0	2		0.0275
6.	Humboldt Bay, CA to Coos Bay, OR	44	263	0	1	0.0000	0.0021
7.	San Francisco Bay, CA to Humboldt Bay, CA	70	121	4	9	0.0263	0.0553
8.	Monterey Bay, CA to San Francisco Bay, CA	672	1171	56	115	0.0292	0.0607
9.	CA-Mexico Border to Monterey, CA	63	101	0	0	0.0000	0.0000

Figure A-4. West Coast Groundfish Observer Program bottom trawl data 2002-2007 indicating total number of tows observed, number of observed tows containing green sturgeon, and catch per unit effort (pounds per tow hour) of green sturgeon by marine specific areas (1 through 9 described above) under consideration for proposed critical habitat designation for the Southern DPS (WCGOP, 2008, unpublished green sturgeon bycatch data).

APPENDIX B

Location data to define the extent of the critical habitat designation in the Sacramento River, the Sacramento-San Joaquin Delta, and designated coastal estuaries

Appendix B provides location data to better define the extent of the critical habitat designation within the Sacramento River, the Sacramento-San Joaquin Delta, and designated coastal estuaries in California, Oregon, and Washington. Members of the CHRT and NMFS biologists who are familiar with these specific areas were assigned to develop these location data. The CHRT members and NMFS biologists used the best available information, which varied by area and included literature references, personal communications with local experts, visual inspection of maps, and their own expertise of the specific areas and best professional judgment.

The final critical habitat designation includes the Sacramento-San Joaquin Delta and the Sacramento River in California. Table 1 defines certain areas that are not included in the critical habitat designation in the Sacramento-San Joaquin Delta, because these areas are inaccessible to green sturgeon and/or contain unsuitable habitat. Table 1 also provides one additional location that is to be included in the critical habitat designation in the Sacramento River. The final critical habitat designation also includes coastal estuaries in California, Oregon, and Washington, up to the mean higher high water (MHHW) line and including tributaries to the head-of-tide. Tables 2 and 3 provide the approximate head-of-tide locations for designated coastal estuaries, including the rationale for each head-of-tide location.

Table 1. Location data for the Sacramento River and Sacramento-San Joaquin Delta in California. The final critical habitat designation includes the Sacramento River upstream to Keswick Dam (RKM 486) and the Sacramento-San Joaquin Delta (within the legal boundaries of the Delta). This table defines an additional area to include as part of the critical habitat designation in the Sacramento River and also defines certain areas that are not part of the critical habitat designation in the Sacramento-San Joaquin Delta. These data were developed and provided by Jeffrey Stuart (Fishery biologist, NMFS Southwest Region, Sacramento, CA) and Douglas Hampton (Fishery biologist, NMFS Southwest Region, Sacramento, CA) and were based on visual inspection of maps as well as their expertise of the areas and best professional judgment.

Specific Area	Feature at point	Latitude	Longitude	Notes
Sacramento River	American River	38° 35′ 46.73" N	121° 28′ 35.64" W	Include Lower American River from mouth to Business 80 overpass at this point. Juvenile rearing potential. This point is close to the upstream influence of the Sacramento River during high flows.
Sacramento-San Joaquin Delta	Clifton Court and California Aqueduct Intake Channel	37° 49′ 46.73" N	121° 33′ 24.88" W	Cut from this point (Clifton Court Radial Gates) south and west to exclude Clifton Court and the California Aqueduct Intake Channel. Unsuitable habitat; no PCEs present
Sacramento-San Joaquin Delta	Delta Mendota Canal	37° 48′ 57.7" N	121° 33′ 30.22" W	Cut off Delta Mendota Canal west and south of this location (trash racks; close to Hammer Island). Unsuitable habitat, no suitable PCEs present. This is a shallow warm area where predators hang out. The rest of the canal leads to the pumping plant.
Sacramento-San Joaquin Delta	Fivemile Slough	38° 00′ 50" N	121° 22′ 09" W	Cut from the confluence with Fourteenmile Slough at this point (e.g., the tidal gated barrier). The tidal gated barrier isolates this slough from the rest of the Delta. Control of water flow into channels by man-made structures have made this area a "reservoir" for irrigation water delivered to surrounding farm fields.
Sacramento-San Joaquin Delta	Indian Slough and Werner Cuts	37° 55′ 7.85" N	121° 35′ 12.29" W	End point for cut from Werner Cut and Orwood - entrance to Discovery Bay.
Sacramento-San Joaquin Delta	Indian Slough and Werner Cuts	37° 58′ 13.67" N	121° 35′ 40.71" W	Junction of Werner Cut and Rock Slough.
Sacramento-San Joaquin Delta	Italian Slough	37° 51′ 38.62" N	121° 34′ 52.79" W	Cut from this point and upstream.
Sacramento-San Joaquin Delta	Rock Slough	37° 58′ 22.03" N	121° 34′ 39.81" W	Cut from Werner Cut and Orwood south to Indian Slough and Rock Slough. This point marks the Old River junction with Rock Slough.
Sacramento-San Joaquin Delta	Sacramento Deep Water Ship Channel	38° 14′ 12.67" N	121° 40′ 23.22" W	Cut the Sacramento Deep Water Ship Channel from this point north to the Port of West Sacramento. This point marks the confluence of the ship channel with Cache Slough.

Table 1 (continued)

Specific Area	Feature at point	Latitude	Longitude	Notes
Sacramento-San Joaquin Delta	Oxbow loop off San Joaquin River	37° 43′ 9.22" N	121° 16′ 35.71" W	Cut off oxbow loop north of mainstem. Fish unlikely to utilize this area, and no suitable PCEs present.
Sacramento-San Joaquin Delta	Oxbow loop off San Joaquin River	37° 46′ 9.08" N	121° 18′ 5.77" W	Cut off oxbow loop south of mainstem. Fish unlikely to utilize this area, and no suitable PCEs present.
Sacramento-San Joaquin Delta	Sand Mound Slough	37° 58′ 37.34" N	121° 37′ 19.04" W	End point for cut from Werner Cut and Orwood. Feature at this point - earthen barrier at southern end of channel.
Sacramento-San Joaquin Delta	Sevenmile Slough	38° 06′ 55" N	121° 40′ 55" W	Exclude all reaches between this point in Threemile Slough and Jackson Slough (see next point for Sevenmile Slough). A man-made barrier isolates this slough from the rest of the Delta. Man-made structures control water flow into the channels and have made this area a "reservoir" for irrigation water delivered to surrounding farm fields.
Sacramento-San Joaquin Delta	Sevenmile Slough	38° 06′ 59" N	121° 37′ 44" W	Exclude all reaches between this point in Jackson Slough and Threemile Slough (see previous point for Sevenmile Slough). A man-made barrier isolates this slough from the rest of the Delta. Man-made structures control water flow into the channels and have made this area a "reservoir" for irrigation water delivered to surrounding farm fields.
Sacramento-San Joaquin Delta	Snodgrass Slough	38° 18′ 32.98" N	121° 30′ 46.14" W	Cut from here (Lambert Road) north to exclude Snodgrass Slough. A man-made barrier isolates this slough from the rest of the Delta. Man-made structures control water flow into the channels and have made this area a "reservoir" for irrigation water delivered to surrounding farm fields.
Sacramento-San Joaquin Delta	Tom Paine Slough	37° 47′ 25" N	121° 25′ 08" W	Cut from here (confluence with Middle River) upstream to exclude Tom Paine Slough. A man-made barrier isolates this slough from the rest of the Delta. Man-made structures control water flow into the channels and have made this area a "reservoir" for irrigation water delivered to surrounding farm fields.
Sacramento-San Joaquin Delta	Trapper Slough	37° 53′ 36" N	121° 29′ 15" W	Cut from here upstream to exclude Trapper Slough. A man-made barrier isolates this slough from the rest of the Delta. Man-made structures control water flow into the channels and have made this area a "reservoir" for irrigation water delivered to surrounding farm fields.

Table 2. Head-of-tide locations for San Francisco Bay, San Pablo Bay, Suisun Bay, and Humboldt Bay in California. The final critical habitat designation includes these bays in California, including waters up to the MHHW line and the approximate head-of-tide locations listed here. The data for the San Francisco, San Pablo, and Suisun bays were developed and provided by David Woodbury (Fishery biologist, NMFS Southwest Region, Santa Rosa, CA) and Charleen Gavette (Geographer, NMFS Southwest Region, Santa Rosa, CA). The data for Humboldt Bay were developed and provided by Diane Ashton (Fishery biologist, NMFS Southwest Region, Arcata, CA) and Douglas Chow (GIS/IT Specialist, NMFS Southwest Region, Arcata, CA). The data were developed based on personal communications with local experts, visual inspection of maps, and the expertise and best professional judgment of the CHRT members and NMFS staff.

Estuary	Tributary	Latitude	Longitude	Notes
San Francisco Bay	Alameda Creek	37° 36′ 47.347" N	122° 4′ 17.504" W	Long culvert under Hwy 880 overcrossing (impassable?)
San Francisco Bay	Arroyo Corte Madera del Presidio	37° 53′ 42.994" N	122° 31′ 48.241" W	Extended MHHW to bridge over slough off Richardson Bay.
San Francisco Bay	Colma Creek	37° 39′ 6.041" N	122° 25′ 8.94" W	Some sort of structure across channel at this point. Also, concrete trapezoidal channel upstream of this point.
San Francisco Bay	Coyote Creek	37° 27′ 16.841" N	121° 55′ 35.659" W	Standish Dam on Coyote Creek
San Francisco Bay	Coyote Creek	37° 52′ 44.735" N	122° 31′ 30.612" W	Extended MHHW to end of slough off Richardson Bay.
San Francisco Bay	Coyote Creek, unnamed waterway in marsh	37° 27′ 55.688" N	121° 55′ 40.4" W	Tide gate
San Francisco Bay	Coyote Creek, unnamed waterway in marsh	37° 26′ 23.334" N	121° 57′ 29.167" W	Tidal weir
San Francisco Bay	Coyote Creek, unnamed waterway in marsh	37° 27′ 15.008" N	121° 56′ 11.544" W	Tide gate
San Francisco Bay	Coyote Hills Slough	37° 34′ 25.853" N	122° 3′ 36.288" W	BART weir
San Francisco Bay	Mt Eden Creek	37° 37′ 6.442" N	122° 7′ 22.508" W	MHHW no longer exists
San Francisco Bay	Mud Slough, unnamed waterway in marsh	37° 29′ 47.724" N	121° 57′ 14.371" W	Long culvert under Hwy 880 overcrossing (impassable?)
San Francisco Bay	Mud Slough, unnamed waterway in marsh	37° 28′ 43.144" N	121° 57′ 3.002" W	Tide gate
San Francisco Bay	Newark Slough, unnamed waterway in marsh	37° 31′ 50.635" N	122° 4′ 7.133" W	Impassable culvert

Table 2 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
San Francisco Bay	Newark Slough	37° 31′ 35.864" N	122° 3′ 24.419" W	Long culvert under Thornton Ave (impassable?)
San Francisco Bay	Richardson Bay, unnamed waterway	37° 54′ 1.847" N	122° 31′ 35.746" W	Extended MHHW to road crossing over slough off Richardson Bay.
San Francisco Bay	San Clemente Creek	37° 55′ 12.299" N	122° 30′ 25.427" W	Impassable culvert at Paradise Drive overcrossing.
San Francisco Bay	San Francisco Bay shoreline	37° 40′ 44.119" N	122° 10′ 17.623" W	Tide gate
San Francisco Bay	Seal Slough	37° 34′ 8.904" N	122° 17′ 29.504" W	Tide gate
San Pablo Bay	Adobe Creek	38° 12′ 41.534" N	122° 36′ 6.095" W	Added Adobe Creek to extent of MHHW.
San Pablo Bay	Black John Slough	38° 8′ 12.39" N	122° 33′ 42.368" W	Added to MHHW on tributary to lower Petaluma River.
San Pablo Bay	Black John Slough	38° 7′ 58.919" N	122° 32′ 54.154" W	Added to MHHW on tributary to lower Petaluma River.
San Pablo Bay	Carneros Creek	38° 13′ 52.19" N	122° 18′ 48.582" W	Added to MHHW on creek adjacent to Napa Valley Marina based on change of elevation.
San Pablo Bay	Gallinas Creek	38° 0′ 49.655" N	122° 32′ 23.845" W	End of MHHW on Miller Creek.
San Pablo Bay	Huichica Creek, unnamed tributary	38° 12′ 35.676" N	122° 21′ 35.233" W	Impassable culvert.
San Pablo Bay	Novato Creek	38° 5′ 50.024" N	122° 33′ 51.934" W	End of MHHW on Novato Creek.
San Pablo Bay	Petaluma River	38° 14′ 52.789" N	122° 38′ 16.951" W	Upper Petaluma River tidal weir.
San Pablo Bay	Petaluma River, unnamed tributary	38° 12′ 58.176" N	122° 34′ 22.537" W	Levee currently blocking waterway.
San Pablo Bay	Railroad Slough	38° 13′ 30.302" N	122° 26′ 27.794" W	Added to MHHW based on change of elevation.
San Pablo Bay	San Antonio Creek, unnamed tributary	38° 9′ 44.953" N	122° 34′ 0.592" W	Added to MHHW on San Antonio Creek.
San Pablo Bay	San Pablo Bay shoreline	38° 2′ 43.559" N	122° 15′ 44.212" W	Tidal structure
San Pablo Bay	San Pablo Creek	37° 58′ 5.992" N	122° 22′ 42.377" W	No MHHW above this point
San Pablo Bay	San Rafael Creek	37° 58′ 4.505" N	122° 31′ 35.166" W	End of MHHW on San Rafael Creek.
San Pablo Bay	South Fork Gallinas Creek	38° 0′ 3.971" N	122° 32′ 8.66" W	Impassable culvert on south Miller Creek.
San Pablo Bay	Tolay Creek	38° 9′ 41.652" N	122° 26′ 48.628" W	Added waterway to end of MHHW.
San Pablo Bay	Tolay Creek	38° 9′ 6.221" N	122° 26′ 48.592" W	Added slough on Tolay Creek, south of Hwy 37.
San Pablo Bay	Wildcat Creek	37° 57′ 26.485" N	122° 22′ 44.738" W	No MHHW above this point
Suisun Bay	Deverton Creek	38° 13′ 37.564" N	121° 53′ 47.155" W	Added waterway to end of MHHW.
Suisun Bay	Green Valley Creek	38° 12′ 48.55" N	122° 7′ 51.251" W	Added to MHHW on Green Valley Creek based on change of elevation.
Suisun Bay	Hastings Slough	38° 1′ 30.299" N	122° 3′ 34.816" W	Added waterway to end of slough.
Suisun Bay	Suisun Marsh, Grizzly Bay shoreline	38° 5′ 53.174" N	122° 0′ 34.913" W	Tide gate

Table 2 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Suisun Bay	Suisun Marsh, Grizzly Bay shoreline	38° 6′ 49.291" N	121° 58′ 53.526" W	Added waterway to impassable culvert
Suisun Bay	Suisun Marsh, Grizzly Bay shoreline	38° 8′ 18.654" N	121° 59′ 30.671" W	Added waterway to end of MHHW.
Suisun Bay	Suisun Marsh, Grizzly Bay shoreline	38° 8′ 5.816" N	121° 59′ 33.493" W	Added waterway to end of MHHW.
Suisun Bay	Suisun Marsh, unnamed waterway	38° 2′ 28.237" N	121° 57′ 55.069" W	Added waterway to end of slough.
Suisun Bay	Suisun Marsh, unnamed waterway	38° 2′ 49.816" N	121° 58′ 39.097" W	No longer tidal.
Suisun Bay	Suisun Marsh, unnamed waterway	38° 2′ 41.766" N	121° 56′ 15.889" W	No longer tidal.
Suisun Bay	Suisun Marsh, unnamed waterway	38° 2′ 29.832" N	121° 55′ 17.623" W	No longer tidal.
Suisun Bay	Walnut Creek	38° 0′ 15.887" N	122° 3′ 41.368" W	Slough added. Road crossing with no MHHW upstream.
Humboldt Bay	Elk River	40° 43′ 45.397" N	124° 11′ 15.414" W	Head of tide identified by Mike Wallace of CDFG
Humboldt Bay	Elk River	40° 45′ 8.579" N	124° 10′ 56.798" W	Tidegate
Humboldt Bay	Elk River	40° 45′ 7.25" N	124° 10′ 58.062" W	Unsuitable habitat
Humboldt Bay	Eureka Slough	40° 48′ 13.864" N	124° 7′ 14.711" W	Tidegate
Humboldt Bay	Eureka Slough	40° 48′ 17.651" N	124° 8′ 29.393" W	Unsuitable habitat
Humboldt Bay	Eureka Slough	40° 48′ 14.054" N	124° 8′ 21.923" W	Unsuitable habitat
Humboldt Bay	Eureka Slough	40° 48′ 8.849" N	124° 8′ 13.967" W	Unsuitable habitat
Humboldt Bay	Freshwater Creek	40° 46′ 43.428" N	124° 4′ 47.64" W	Head of tide identified by Mike Wallace of CDFG
Humboldt Bay	Freshwater Slough	40° 47′ 18.287" N	124° 6′ 54.176" W	Unsuitable habitat
Humboldt Bay	Freshwater Slough	40° 47′ 9.906" N	124° 6′ 15.286" W	Unsuitable habitat
Humboldt Bay	Freshwater Slough	40° 48′ 3.01" N	124° 6′ 53.496" W	Unsuitable habitat, blind slough
Humboldt Bay	Gannon Slough	40° 50′ 47.789" N	124° 4′ 53.983" W	Unsuitable habitat, blind slough
Humboldt Bay	Gannon Slough	40° 50′ 36.834" N	124° 4′ 53.209" W	Unsuitable habitat
Humboldt Bay	Jacoby Creek	40° 50′ 21.952" N	124° 4′ 16.453" W	Head of tide identified by Jeff Anderson & Diane Ashton, NMFS Arcata Office
Humboldt Bay	Jacoby Creek	40° 50′ 25.458" N	124° 4′ 56.165" W	Tidegate
Humboldt Bay	Liscom Slough	40° 52′ 34.576" N	124° 8′ 13.679" W	Unsuitable habitat, blind slough
Humboldt Bay	Mad River Slough	40° 53′ 13.535" N	124° 8′ 9.467" W	Tidegate
Humboldt Bay	Mad River Slough	40° 53′ 59.41" N	124° 8′ 0.92" W	Unsuitable habitat, blind slough
Humboldt Bay	Mad River Slough	40° 54′ 0.958" N	124° 8′ 8.592" W	Unsuitable habitat, blind slough

Table 2 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Humboldt Bay	McDaniel Slough	40° 51′ 54.194" N	124° 8′ 52.444" W	Tidegate
Humboldt Bay	McDaniel Slough	40° 51′ 54.194" N	124° 8′ 52.444" W	Tidegate
Humboldt Bay	McDaniel Slough	40° 51′ 38.632" N	124° 6′ 2.005" W	Tidegate
Humboldt Bay	Rocky Gulch/ Washington Gulch	40° 49′ 52.41" N	124° 4′ 58.238" W	Tidegate
Humboldt Bay	Salmon Creek	40° 41′ 12.448" N	124° 13′ 9.962" W	Tidegate
Humboldt Bay	Unnamed Tributary	40° 42′ 36.403" N	124° 15′ 45.295" W	Unsuitable habitat
Humboldt Bay	White Slough	40° 41′ 56.137" N	124° 12′ 17.762" W	Unsuitable habitat, blind slough

Table 3. Head-of-tide locations for designated coastal estuaries in Oregon and Washington. The final critical habitat designation includes waters within these estuaries up to the MHHW line and upstream to the approximate head-of-tide locations listed here. These data were compiled and provided by Steve Stone (Fishery biologist, NMFS Northwest Region, Portland, Oregon) and were based on visual inspection of 1:24,000 US Geological Survey topographic maps and aerial photographs, as well as various literature references as listed in the table (under “Notes”).

Estuary	Tributary	Latitude	Longitude	Notes
Coos Bay	Boone Creek	43° 16' 30.905" N	124° 9' 25.906" W	Placed endpoint at location specified in Oregon Division of State Lands (OR DSL 1989) report.
Coos Bay	Catching Creek	43° 16' 31.444" N	124° 9' 11.173" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Coalbank Slough	43° 21' 10.488" N	124° 13' 16.599" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Coos River, South Fork	43° 22' 31.744" N	123° 59' 34.469" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Cox Canyon Creek	43° 16' 13.422" N	124° 18' 51.589" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Daniels Creek	43° 21' 10.202" N	124° 5' 28.630" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Davis Creek	43° 17' 29.044" N	124° 14' 30.103" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Day Creek	43° 18' 58.529" N	124° 18' 23.982" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Delmar Creek	43° 15' 23.718" N	124° 13' 51.704" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Deton Creek	43° 24' 15.482" N	124° 3' 53.067" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Elliot Creek	43° 17' 45.000" N	124° 17' 44.697" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Goat Creek	43° 15' 41.855" N	124° 12' 58.109" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Haynes Inlet	43° 27' 56.451" N	124° 11' 22.437" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Hayward Creek	43° 19' 6.757" N	124° 19' 58.746" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Joe Ney Slough	43° 20' 12.322" N	124° 17' 39.388" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	John B Creek	43° 16' 58.813" N	124° 18' 26.637" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Kentuck Slough	43° 25' 19.203" N	124° 11' 18.580" W	Placed endpoint at location specified in OR DSL 1989 report.

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Coos Bay	Larson Slough	43° 27' 43.111" N	124° 11' 37.883" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Lillian Creek	43° 21' 41.373" N	124° 8' 41.348" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Mart Davis Creek	43° 22' 58.403" N	124° 5' 37.814" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Matson Creek	43° 18' 26.702" N	124° 8' 16.075" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Millicoma River, East Fork	43° 25' 49.890" N	124° 1' 2.161" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Millicoma River, West Fork	43° 25' 48.025" N	124° 2' 50.376" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Noble Creek	43° 15' 16.038" N	124° 12' 53.534" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	North Slough	43° 29' 25.604" N	124° 13' 14.119" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Pony Creek	43° 24' 6.210" N	124° 13' 54.592" W	Placed endpoint at river mile where Crowell Lane crosses Pony Creek. "A tide gate was installed years ago at Crowell Lane to prevent tidal waters from inundating the low-elevation areas of lower Pony Creek" (Lower Pony Creek Watershed Committee 2002).
Coos Bay	Seelander Creek	43° 17' 14.744" N	124° 8' 40.809" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Shinglehouse Slough	43° 19' 4.173" N	124° 13' 14.277" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Stock Slough	43° 19' 57.883" N	124° 8' 21.585" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Talbot Creek	43° 17' 1.468" N	124° 17' 49.475" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Theodore Johnson Creek	43° 16' 16.076" N	124° 19' 22.115" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Unnamed Creek	43° 17' 24.030" N	124° 17' 56.376" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Unnamed Creek	43° 18' 27.181" N	124° 7' 54.754" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Unnamed Creek	43° 21' 11.907" N	124° 9' 17.282" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Vogel Creek	43° 22' 10.120" N	124° 8' 49.254" W	Placed endpoint at location specified in OR DSL 1989 report.

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Coos Bay	Wasson Creek	43° 16' 3.070" N	124° 19' 23.442" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Willanch Slough	43° 24' 5.357" N	124° 11' 26.633" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Wilson Creek	43° 16' 50.669" N	124° 9' 2.010" W	Placed endpoint at location specified in OR DSL 1989 report.
Coos Bay	Winchester Creek	43° 15' 49.267" N	124° 19' 9.904" W	Placed endpoint at location specified in OR DSL 1989 report.
Grays Harbor	Andrews Creek	46° 49' 22.543" N	124° 1' 23.323" W	Placed endpoint at confluence with West Fork near end of marsh area. "South Bay is a large shallow harbor at the southwest end of Grays Harbor. It is composed of large tidal marshes and a number of small- to medium-sized sloughs" (Phinney and Bucknell 1975).
Grays Harbor	Beaver Creek	46° 54' 19.589" N	123° 58' 53.422" W	Placed endpoint upstream of bridge where creek narrows. "Johns River is influenced by tidal fluctuations to near river mile 4" (Phinney and Bucknell 1975) (Beaver Creek confluence is @ RM 1).
Grays Harbor	Campbell Creek	46° 56' 8.535" N	123° 53' 11.639" W	Placed endpoint upstream of highway bridge where first fork diverges. "O'Leary, Stafford, Indian, Campbell, and Chaplin Creeks are in "fair" condition, with impacts due to Highway 105 crossings" (Smith and Wenger 2001).
Grays Harbor	Campbell Slough	47° 2' 45.125" N	124° 3' 40.031" W	Placed endpoint upstream to where topo map shows a dam and elevation change. "The lower tributaries of the river are classified as sloughs. These sloughs - Gillis, Campbell, Jessie, and Burg - offer minor amounts of spawning area but do provide rearing for chinook and coho. Only Burg Slough is notidal and all are almost entirely pool areas ranging from 4 to 30 yards wide" (Phinney and Bucknell 1975).
Grays Harbor	Chapin Creek	46° 56' 18.284" N	123° 52' 29.940" W	Placed endpoint upstream to where topo map shows channel narrowing. "O'Leary, Stafford, Indian, Campbell, and Chaplin Creeks are in "fair" condition, with impacts due to Highway 105 crossings" (Smith and Wenger 2001).
Grays Harbor	Charley Creek	46° 56' 54.733" N	123° 49' 52.821" W	Placed endpoint slightly upstream of where topo map shows channel narrowing and a short unnamed tributary enters from the south. "The Charley Creek estuary is "poor" due to a dike protecting an auto salvage yard along the east bank" (Smith and Wenger 2001).

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Grays Harbor	Chehalis River	46° 58' 16.042" N	123° 35' 37.930" W	Placed endpoint 1 mile upstream of Wynoochee River confluence (i.e, at RM14). NOTE that this includes Blue, Elliot, Higgins, Max Chuck, Peels, and Preacher sloughs. "From Montesano to the mouth, the mainstem Chehalis River is tidally influenced with numerous sloughs and side channels (Ralph et al. 1994)" (Smith and Wenger 2001).
Grays Harbor	Chenois Creek	47° 2' 35.820" N	124° 0' 54.043" W	Placed endpoint upstream to where topo map shows channel narrowing in marsh area (Phinney and Bucknell 1975).
Grays Harbor	Elk River	46° 50' 7.801" N	123° 59' 7.631" W	Placed endpoint upstream to where topo map shows channel narrowing. "South Bay is a large shallow harbor at the southwest end of Grays Harbor. It is composed of large tidal marshes and a number of small- to medium-sized sloughs" (Phinney and Bucknell 1975).
Grays Harbor	Gillis Slough	47° 2' 34.280" N	124° 2' 29.369" W	Placed endpoint upstream to where topo map shows channel split and road crossing. "The lower tributaries of the river are classified as sloughs. These sloughs - Gillis, Campbell, Jessie, and Burg - offer minor amounts of spawning area but do provide rearing for chinook and coho. Only Burg Slough is notidal and all are almost entirely pool areas ranging from 4 to 30 yards wide" (Phinney and Bucknell 1975).
Grays Harbor	Grass Creek	47° 1' 40.940" N	124° 0' 39.754" W	Placed endpoint upstream to where topo map shows channel narrowing, approximately same distance upstream as in adjacent Chenois Creek (Phinney and Bucknell 1975).
Grays Harbor	Hoquiam River	47° 3' 2.866" N	123° 55' 34.124" W	Placed endpoint upstream to RM9, where channel narrows among marsh area on topo map. "In the lower Hoquiam River, the tidally influenced reaches have been developed, but upstream of the commercial and residential lands in the lower drainage, development is less extensive than along the Wishkah River" (Smith and Wenger 2001).
Grays Harbor	Hoquiam River, East Fork	47° 3' 7.114" N	123° 51' 24.684" W	Placed endpoint upstream at RM6 to where topo map shows channel narrowing. "The Hoquiam tributaries head in low hills and have a moderate gradient most of their length. The lower extremities of the major tributaries are affected by tide variations" (Phinney and Bucknell 1975).

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Grays Harbor	Humptulips River	47° 5' 42.296" N	124° 3' 33.642" W	Placed endpoint upstream at RM6, at confluence of trib and just downstream highway. NOTE that this includes Blue, Elliot, Higgins, Max Chuck, Peels, and Preacher sloughs. "Initial harvesting took place along the banks of the lower seven miles of the Humptulips River within the tidal zone where trees could be felled directly into the river and transported to tidewater on the ebbing tide" (Smith and Wenger 2001). "It should also be noted that the lower 6 miles of mainstem Humptulips floodplain are in "good" condition due to the relatively undisturbed tidally influenced sloughs" (Smith and Wenger 2001).
Grays Harbor	Indian Creek	46° 55' 55.212" N	123° 53' 46.755" W	Included reaches upstream to where the contours indicate constrainment. "The small independent drainages of O'Leary, Stafford, Indian, Chapin, and Charley Creeks are short basins that have minimal spawning habitat due to sedimentation from legal timber harvesting activities since the 1930s (WDFW and WWTIT 1994). All have good rearing habitat due to the low gradients, good riparian vegetation, and instream Woody debris. There is rural residential development along Highway 105, which crosses all of these creeks, but the estuaries and floodplains are mostly undisturbed" (Smith and Wenger 2001).
Grays Harbor	Jessie Slough	47° 3' 22.752" N	124° 3' 0.170" W	Placed endpoint upstream to where topo map shows channel narrowing at road crossing. "The lower tributaries of the river are classified as sloughs. These sloughs - Gillis, Campbell, Jessie, and Burg - offer minor amounts of spawning area but do provide rearing for chinook and coho. Only Burg Slough is notidal and all are almost entirely pool areas ranging from 4 to 30 yards wide" (Phinney and Bucknell 1975).
Grays Harbor	Johns River	46° 52' 28.294" N	123° 57' 1.943" W	Placed endpoint upstream to RM4 where topo map shows channel narrowing. "The Elk River and Johns River estuaries have relatively natural conditions and are rated as "good". Breaching of the dike on the eastside of the Johns River will improve conditions further by increasing the availability of estuary refuge habitat for juvenile salmon" (Smith and Wenger 2001). "Johns River is influenced by tidal fluctuations to near river mile 4" (Phinney and Bucknell 1975).
Grays Harbor	Newskah Creek	46° 56' 25.809" N	123° 50' 58.408" W	Placed endpoint upstream to where topo map shows channel narrowing near road crossing. "Newskah Creek is the third largest drainage in the South Grays Harbor region. Its diked estuary was recently breached as part of an off-site mitigation project from construction of the Stafford Creek Correctional Facility. Rural residential development and a large rock quarry are located in the lower Newskah watershed. All other land in the drainage has been managed for commercial timber" (Smith and Wenger 2001).

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Grays Harbor	O' Leary Creek	46° 54' 50.725" N	123° 57' 24.347" W	Placed endpoint at the extent of marsh area upstream of bridge. "The Highway 105 crossings at Chapin and O'Leary Creeks are currently bridges that are no longer barriers to fish habitat" (Smith and Wenger 2001).
Grays Harbor	Stafford Creek	46° 55' 50.990" N	123° 54' 28.338" W	Placed endpoint upstream of highway at next road crossing. "The small independent drainages of O'Leary, Stafford, Indian, Chapin, and Charley Creeks are short basins that have minimal spawning habitat due to sedimentation from legal timber harvesting activities since the 1930s (WDFW and WWTIT 1994). All have good rearing habitat due to the low gradients, good riparian vegetation, and instream Woody debris. There is rural residential development along Highway 105, which crosses all of these creeks, but the estuaries and floodplains are mostly undisturbed" (Smith and Wenger 2001).
Grays Harbor	Wishkah River	47° 2' 39.463" N	123° 47' 19.703" W	Placed endpoint 8 miles upstream of confluence with Chehalis. "From this point upstream to the upper end of tidal influence at RM 8, the [Wishkah] river meanders through reforested mature alder and mixed conifer that is currently undeveloped" (Smith and Wenger 2001).
Grays Harbor	Wynoochee River	46° 58' 18.831" N	123° 36' 57.498" W	Placed endpoint 1 mile upstream of confluence with Chehalis. "The lowest mile of the Wynoochee River is tidally influenced. The Wynoochee River enters the Chehalis River at RM 13.0 near the upper end of the tidal influence of Grays Harbor" (Smith and Wenger 2001).
Lower Columbia River	Bear Creek	46° 10' 0.316" N	123° 40' 6.037" W	Placed endpoint upstream to RM0.5 where topo map shows channel narrowing. "Tidewater extends about 3\4 mile up the stream from the Columbia" (E&S Environmental Chemistry, Inc. (E&S Env. Chem., Inc..) and Nicolai-Wickiup Watershed Council 2000).
Lower Columbia River	Big Creek	46° 10' 33.462" N	123° 35' 29.691" W	Placed endpoint upstream to RM 0.7 where topo map shows channel narrowing (this is consistent with HOT on orthophoto from DSL; J. Grimes, pers. comm., June 2009). "The main stream is about 11.5 miles long and has a drainage area of 37 square miles. The first 1\2 mile above the Columbia is a spruce tidal wetland" (E&S Env. Chem., Inc. and Nicolai-Wickiup Watershed Council 2000).
Lower Columbia River	Blind Slough/Gnat Creek	46° 10' 46.579" N	123° 31' 44.685" W	Placed endpoint upstream to RM 2 in Gnat Creek where topo map shows channel narrowing and marsh ending. "The creek flows into the Columbia through Blind Slough. The mile upstream of Blind Slough is a tidal swamp. For about three miles above tidewater the stream, paralleling highway 30, has spawning gravel and rearing pools" (E&S Env. Chem., Inc. and Nicolai-Wickiup Watershed Council 2000).

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Lower Columbia River	Chinook River	46° 18' 14.278" N	123° 58' 0.947" W	Placed endpoint at Hwy 101 Bridge. "TAG members thought that the tidegates on the Chinook River under Highway 101 restrict passage during certain flows. These tidegates alter water exchange rates and tidal influences that may create thermal and dissolved oxygen barriers under certain conditions (TAG)" (Wade 2002).
Lower Columbia River	Deep Creek	46° 19' 3.358" N	123° 42' 23.256" W	Placed endpoint @ RM 1 @ Swenson's Landing. "Tidal influence reaches approximately 5,000 feet upstream in Deep River" (Wade 2002).
Lower Columbia River	Driscol Slough	46° 8' 35.443" N	123° 23' 43.927" W	Placed endpoint upstream to RM0.8 where topo map shows channel narrowing.
Lower Columbia River	Ferris Creek	46° 10' 5.307" N	123° 39' 8.093" W	Placed endpoint upstream to RM0.5 where topo map shows channel narrowing and marsh ending. "Ferris Creek flows into Svensen Slough about 1\2 mile upriver from the mouth of Bear Creek. Highway 30 crosses the creek about 1\2 mile above the Columbia and the old Highway crosses about 1\4 mile above that. The area downstream of Old Highway 30 is a grassy wetland that floods at very high tides" (E&S Env. Chem., Inc. and Nicolai-Wickiup Watershed Council 2000).
Lower Columbia River	Grays River	46° 21' 33.587" N	123° 35' 5.145" W	Placed endpoint @ RM10 downstream of covered bridge site where aerial photo shows a large beach. "TAG members considered the mainstem Grays River tidally influenced up to "Badgers Beach" located about 1 mile downstream of the State Route 4 Bridge" (Wade 2002).
Lower Columbia River	Hunt Creek	46° 11' 45.668" N	123° 26' 30.231" W	Placed endpoint upstream to RM 0.6 where topo map shows channel narrowing. This is between two unnamed falls identified by ODFW, but it is unclear from the imagery and topo maps why the lower "falls" is there. "Hunt Creek is also used by Coho; however the falls located approximately 0.5 miles upstream from the mouth significantly limits the amount of the creek that can be used as habitat" and "Hunt Creek also has a falls that blocks fish passage, approximately a quarter mile above the confluence with the Columbia River" (E&S Env. Chem., Inc. and Nicolai-Wickiup Watershed Council 2000).
Lower Columbia River	Jim Crow Creek	46° 16' 18.999" N	123° 33' 26.473" W	Placed endpoint upstream to RM1 where topo map shows channel narrowing. "Jim Crow Creek is tidally influenced for the first mile" (Wade 2002).
Lower Columbia River	John Day River	46° 9' 12.766" N	123° 43' 15.865" W	Placed endpoint upstream to RM where topo map shows slough ending near Claremont Road. Used orthophotos from DSL (J. Grimes, pers. comm., June 2009) to identify HOT.

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Lower Columbia River	John Day River	46° 9' 10.382" N	123° 43' 27.458" W	Placed endpoint @ RM 4.5 where topo map shows channel ending/narrowing. "A foul weather option is to paddle up the John Day River, although it is only navigable for about 3.5 miles upstream from the boat ramp. The current is mainly tidal" (Jones 2003).
Lower Columbia River	Klaskanine River	46° 5' 32.647" N	123° 44' 51.841" W	Placed endpoint upstream to RM1 where topo map shows channel narrowing downstream from confluence of north and south forks (E&S Env. Chem., Inc. and Youngs Bay Watershed Council 2000).
Lower Columbia River	Lewis and Clark River	46° 5' 52.029" N	123° 51' 4.146" W	Placed endpoint @ RM8. "The tide head for the Youngs River is at river mile 4.3 and for the Lewis & Clark River at river mile 8" and "The river is about 25 miles long, of which the lower six miles is a tidal slough. The 7.5 miles of the river from tidewater to a deep canyon section has low banks that are usually flooded each spring" (E&S Env. Chem., Inc. and Youngs Bay Watershed Council 2000).
Lower Columbia River	Marys Creek	46° 10' 11.868" N	123° 40' 17.477" W	Similar and adjacent to Bear Creek. Placed endpoint upstream to RM0.5 where topo map shows channel narrowing (E&S Env. Chem., Inc. and Nicolai-Wickiup Watershed Council 2000).
Lower Columbia River	Seal Slough	46° 19' 19.527" N	123° 40' 14.749" W	Placed endpoint approx. 4,000 feet upstream of confluence with Grays River. "TAG members considered the mainstem Grays River tidally influenced up to “Badgers Beach” located about 1 mile downstream of the State Route 4 Bridge. The lower 4,000 feet of Seal River is tidally influenced and pool frequency rated 'poor'" (Wade 2002).
Lower Columbia River	Sisson Creek	46° 18' 24.672" N	123° 43' 46.459" W	Placed endpoint @ RM 0.7 to where topo map shows channel narrowing. "Tidal conditions influence the accumulation of silt in Sisson Creek for approximately one mile" (Wade 2002).
Lower Columbia River	Skamokawa Creek	46° 19' 11.391" N	123° 27' 19.731" W	Placed endpoint at confluence with Left Fork. "Skamokawa Creek is tidally influenced and has predominantly fine sediments from the mouth to its confluence with the Left Fork Skamokawa" (Wade 2002).

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Lower Columbia River	Skipanon River	46° 9' 30.604" N	123° 55' 34.411" W	Skipanon Watershed Assessment (SWA; E&S Env. Chem., Inc.. and Skipanon Watershed Council 2000) states that "the head of tide for the Skipanon River is at river mile 4.3". The US Coast Guard Navigable Waterway Determinations reports "Tributary of Lower Columbia River at Warrenton, OR (tidal at mile 4.5)." Orthophotos from OR DSL show HOT near Perkins Creek @ RM 5 and a recent COE application (see Klavas 2008) mentions tidal influence to this creek as well. However, the latter does not identify sturgeon presence in fish samples, and the ODFW fish barrier GIS data (ODFW 2009) shows a dam/tide gate on the mainstem Skipanon River called "8th Street Dam". The SWA also identifies this tide gate and says it and others are "fitted with fish passage facilities but still may represent partial fish passage barriers that need to be further evaluated." Confirmed this with Google maps image and placed endpoint @ 8th Steet tide gate/dam.
Lower Columbia River	Wallacut River	46° 19' 27.573" N	123° 59' 11.217" W	Placed endpoint upstream to RM2.3 where topo map shows channel narrowing. "The lower reaches of the Chinook and Wallacut Rivers are low gradient, tidally influenced reaches where rating standards for percent pool would not apply" (Wade 2002).
Lower Columbia River	Wallooskee River	46° 7' 6.978" N	123° 46' 25.040" W	Placed endpoint upstream to RM4.8 where topo map shows channel narrowing. "Extensive diking has occurred in the tidal portions of the Lewis & Clark River as well as the Wallooskee River. Many of these wetlands may have once been tidal estuarine wetlands that have been disconnected as a result of draining from tidegates and dike construction. These practices remove the tidal influence, resulting in the loss of saltwater influences and leading to changes in the structure of the wetland" and "To get to the Walluski, settlers went by boat from Astoria, up the Young's River and then to the Walluski "following this stream several miles until it narrowed considerably at a place known as the 'landing'" (E&S Env. Chem., Inc. and Youngs Bay Watershed Council 2000).
Lower Columbia River	Westport Slough/Clatskanie River	46° 8' 4.313" N	123° 13' 31.378" W	Placed endpoint upstream in Clatskanie River @ RM0.5 where topo map shows lower Clatskanie splitting around Anunde Island and heading west to Westport Slough. "While habitat enhancement within the subbasin is minimal to date, the Lower Columbia River Watershed Council has implemented a substantial project reconnecting Westport Slough with the Clatskanie River" and "Habitat improvements from the reconnection of the Westport Slough include improved hydrological conditions within the channel and with time it is expected that improved fish access and use of tributary streams will also result" (Portland State University).

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Lower Columbia River	Youngs River	46° 4' 11.402" N	123° 47' 9.464" W	Placed endpoint at RM 12.5 at bridge. "The tide head for the Youngs River is at river mile 4.3 and for the Lewis & Clark River at river mile 8." However, it also states "The water in the Young's River was Columbia River water to river mile 6, even at low tide", and "there is a falls on the Youngs River a quarter mile above tidewater" {which is @ RM 13} and "The Young's River , which has an impassable 57 foot high falls several hundred yards above the head of tide was in 1953 supporting small runs of fall chinook, silver, chum, and steelhead" (E&S Env. Chem., Inc. and Youngs Bay Watershed Council 2000).
Nehalem River	Alder Creek	45° 42' 52.355" N	123° 54' 12.141" W	Placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Anderson Creek	45° 44' 25.051" N	123° 52' 25.509" W	Placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Coal Creek	45° 44' 49.282" N	123° 51' 56.506" W	Placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Foley Creek	45° 41' 47.585" N	123° 50' 53.022" W	Placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Gallagher Slough	45° 42' 3.924" N	123° 52' 49.531" W	Placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Messhouse Creek	45° 40' 0.017" N	123° 55' 32.174" W	Placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Nehalem River	45° 41' 48.024" N	123° 49' 31.166" W	Placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Nehalem River, North Fork	45° 47' 10.782" N	123° 49' 19.235" W	Placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Unnamed Creek	45° 44' 34.627" N	123° 51' 53.228" W	A tributary to lower Coal Creek. Placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Unnamed Creek	45° 44' 53.240" N	123° 51' 12.208" W	Next tributary upstream from Coal Creek. Placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Unnamed Creek	45° 45' 5.695" N	123° 50' 55.877" W	Next tributary downstream of Gravel Creek. Placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Unnamed Creek	45° 44' 11.496" N	123° 51' 39.950" W	North fork of an unnamed tributary upstream of confluence of mainstem Nehalem & North Fork Nehalem. I placed endpoint at location specified in OR DSL 1989 report.
Nehalem River	Unnamed Creek	45° 44' 6.710" N	123° 51' 40.322" W	South fork of an unnamed tributary upstream of confluence of mainstem Nehalem & North Fork Nehalem. Placed endpoint at location specified in OR DSL 1989 report.

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Nehalem River	Unnamed Creek	45° 43' 44.299" N	123° 52' 34.839" W	Second tributary downstream of confluence of mainstem Nehalem & North Fork Nehalem. Placed endpoint at location specified in OR DSL 1989 report.
Willapa Bay	Bear River	46° 20' 5.212" N	123° 56' 8.417" W	Placed endpoint @ RM3.5 where topo map shows channel narrowing. "The lower 3.5 miles is tidally influenced, and surrounded by marsh and deciduous brush" (Smith 1999).
Willapa Bay	Bone River	46° 39' 29.307" N	123° 54' 1.982" W	Placed endpoint @ RM1.5. "Bone River is formed by four tributaries flowing from alder draws. The bottom is hard clay with virtually no gravel. The lower 1.5 miles of the river are under tidal influence" (Phinney and Bucknell 1975).
Willapa Bay	Cedar River	46° 45' 37.461" N	124° 0' 2.562" W	Placed endpoint @ RM3 where topo map shows marsh area ending and confluence with tributary to the north. "The Cedar River is the largest stream in this area, and historically produced small runs of coho and chum salmon (Phinney and Bucknell 1975; Lonnie Crumley, WDFW, personal communication). It is a low gradient stream, draining the low hill area; most of the watershed is less than 400 feet in elevation (Phinney and Bucknell 1975)" (Smith 1999).
Willapa Bay	Naselle River	46° 22' 32.104" N	123° 49' 19.190" W	Placed endpoint @ RM10.5 where topo map shows sidechannel adjacent to marsh area. NOTE that this includes Ellsworth and Teal sloughs. "Tidal influence extends from the Naselle River mouth to Dell Creek (about RM 10.5), and the width of the lower Naselle River fluctuates greatly with the tide (Phinney and Bucknell 1975)" (Smith 1999).
Willapa Bay	Nemah River, Middle	46° 28' 41.797" N	123° 51' 12.691" W	Placed endpoint @ RM3.5 where Phinney & Bucknell (1975) show a reach with cascades. "The three forks of the Nemah River flow westerly into the middle portion of Willapa Bay. All three of these streams have low gradients and extensive tidal areas in their lower reaches" (Phinney and Bucknell 1975) and "The Middle Fork Nemah is about 10.2 miles long. The lower reaches are tidally influenced, while the middle reaches have steep gradients." (Smith 1999)
Willapa Bay	Nemah River, North	46° 30' 56.469" N	123° 52' 26.878" W	Placed endpoint @ RM3.5 where topo map shows channel narrowing upstream of tidal flats. "The three forks of the Nemah River flow westerly into the middle portion of Willapa Bay. All three of these streams have low gradients and extensive tidal areas in their lower reaches" (Phinney and Bucknell 1975).
Willapa Bay	Nemah River, South	46° 28' 36.572" N	123° 53' 14.877" W	Placed endpoint @ RM3.4 where topo map shows channel narrowing. "The three forks of the Nemah River flow westerly into the middle portion of Willapa Bay. All three of these streams have low gradients and extensive tidal areas in their lower reaches" (Phinney and Bucknell 1975).

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Willapa Bay	Niawiakum River	46° 36' 38.981" N	123° 53' 33.648" W	Placed endpoint upstream to RM3 where topo map shows channel narrowing. Tidal action in the Niawiakum extends about 3 miles (Phinney and Bucknell 1975)" (Smith 1999).
Willapa Bay	North River	46° 48' 51.312" N	123° 50' 54.000" W	Placed endpoint upstream to RM7.4, at a tributary junction. "Tidal influence occurs up to river mile (RM) 7.4 of the North River (Phinney and Bucknell 1975)" (Smith 1999).
Willapa Bay	Palix River, Middle Fork	46° 35' 45.809" N	123° 52' 29.003" W	Placed endpoint upstream to RM3 where topo map shows channel narrowing. "Tidal influence extends up through the three major forks of the Palix (North Palix, Middle Palix (Canyon River), and South Palix). The South Fork Palix is extensively under tidal influence. Tidal action in the Niawiakum extends about 3 miles (Phinney and Bucknell 1975)" (Smith 1999). "The Middle Palix has a long estuarine zone that extends about 2 miles. Between RM 2-4.5, the intertidal zone changes to a low gradient flood plain zone" (Smith 1999).
Willapa Bay	Palix River, North Fork	46° 36' 9.998" N	123° 52' 25.520" W	Placed endpoint upstream to RM3 where topo map shows channel narrowing. "Tidal influence extends up through the three major forks of the Palix (North Palix, Middle Palix (Canyon River), and South Palix). The South Fork Palix is extensively under tidal influence. Tidal action in the Niawiakum extends about 3 miles (Phinney and Bucknell 1975)" (Smith 1999). "The Middle Palix has a long estuarine zone that extends about 2 miles. Between RM 2-4.5, the intertidal zone changes to a low gradient flood plain zone" (Smith 1999).
Willapa Bay	Palix River, South Fork	46° 34' 29.519" N	123° 53' 41.562" W	Placed endpoint upstream to RM4 where topo map shows channel narrowing. "Tidal influence extends up through the three major forks of the Palix (North Palix, Middle Palix (Canyon River), and South Palix). The South Fork Palix is extensively under tidal influence. Tidal action in the Niawiakum extends about 3 miles (Phinney and Bucknell 1975)" (Smith 1999). "The Middle Palix has a long estuarine zone that extends about 2 miles. Between RM 2-4.5, the intertidal zone changes to a low gradient flood plain zone" (Smith 1999).
Willapa Bay	Stuart Slough	46° 41' 8.747" N	123° 52' 16.450" W	Placed endpoint upstream to RM1.5 where topo map shows channel narrowing (Phinney and Bucknell 1975; Smith 1999).
Willapa Bay	Willapa River	46° 38' 50.200" N	123° 38' 50.100" W	Placed endpoint upstream to RM18. "Tidal influence extends to around RM 18 in the mainstem Willapa River and to the lower 5 miles of the South Fork Willapa River (Phinney and Bucknell 1975)" (Smith 1999).
Winchester Bay	Brainard Creek	43° 44' 45.609" N	124° 1' 38.596" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Butler Creek	43° 42' 49.916" N	124° 3' 0.389" W	Placed endpoint at location specified in OR DSL 1989 report.

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Winchester Bay	Eslick Creek	43° 47' 45.935" N	123° 58' 39.526" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Frantz Creek	43° 44' 49.659" N	124° 5' 25.154" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Hudson Slough	43° 44' 55.820" N	124° 4' 42.582" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Joyce Creek	43° 45' 31.565" N	124° 1' 48.624" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Noel Creek	43° 46' 20.900" N	124° 0' 5.942" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Oar Creek	43° 40' 25.624" N	124° 3' 41.475" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Otter Creek	43° 43' 27.954" N	124° 0' 3.996" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Providence Creek	43° 43' 12.882" N	124° 7' 44.329" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Scholfield Creek	43° 40' 35.594" N	124° 5' 37.516" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Silver Creek	43° 40' 37.051" N	124° 9' 21.293" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Smith River	43° 47' 47.591" N	123° 53' 2.793" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Smith River, North Fork	43° 48' 17.274" N	123° 55' 59.037" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Umpqua River	43° 40' 2.825" N	123° 48' 32.486" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Unnamed creek	43° 40' 5.759" N	124° 10' 43.792" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Unnamed creek	43° 40' 14.313" N	124° 9' 25.762" W	Placed endpoint at location specified in OR DSL 1989 report.
Winchester Bay	Winchester Creek	43° 40' 20.112" N	124° 8' 49.173" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Babcock Creek	44° 35' 33.007" N	123° 55' 42.382" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Big Elk Creek	44° 35' 22.952" N	123° 50' 43.086" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Boone Slough	44° 35' 4.924" N	123° 57' 50.276" W	Placed endpoint at location specified in OR DSL 1989 report.

Table 3 (continued)

Estuary	Tributary	Latitude	Longitude	Notes
Yaquina Bay	Depot Creek	44° 38' 30.044" N	123° 56' 53.787" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Flesher Slough	44° 34' 0.146" N	123° 58' 52.669" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Johnson Slough	44° 34' 59.786" N	123° 59' 9.918" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	King Slough	44° 35' 34.917" N	124° 1' 55.369" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	McCaffery Slough	44° 33' 56.001" N	124° 1' 9.791" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Mill Creek	44° 35' 6.914" N	123° 53' 56.802" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Montgomery Creek	44° 35' 7.996" N	123° 56' 17.975" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Nute Slough	44° 35' 18.994" N	123° 57' 29.760" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Olalla Creek	44° 36' 48.435" N	123° 55' 29.581" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Parker Slough	44° 35' 20.889" N	124° 0' 50.298" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Poole Slough	44° 33' 27.365" N	123° 58' 46.192" W	Placed endpoint at location specified in OR DSL 1989 report.
Yaquina Bay	Yaquina River	44° 39' 4.270" N	123° 51' 25.974" W	Placed endpoint at location specified in OR DSL 1989 report.

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