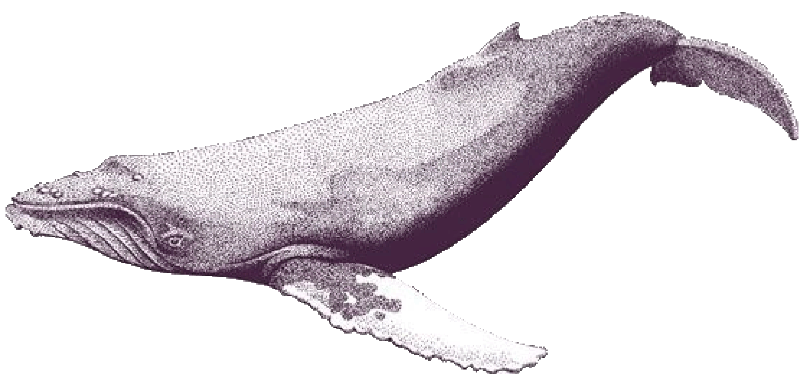
Draft Periodic Status Review for the Humpback Whale in Washington



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EXECUTIVE SUMMARY

The humpback whale is a large baleen whale found in nearly all of the world's oceans that forages on zooplankton and small fish primarily in continental shelf waters. The species undertakes long distance migrations between winter breeding grounds in tropical and subtropical waters and summer feeding grounds in high-latitude waters.

Like other large whales, humpback whales were heavily exploited worldwide by the whaling industry, including in Washington. Populations in the North Pacific were roughly estimated at 15,000 animals prior to commercial harvest. By the time the species received global protection in 1966, North Pacific populations were severely depleted, with estimates of only 1,200 to 1,400 individuals remaining. Since that time, these populations have rebounded to an estimated 16,000 to 21,000 animals, although some stocks have recovered more successfully than others.

Humpback whales have been listed as a state endangered species in Washington since 1981. In 2016, the National Marine Fisheries Service revised the federal Endangered Species Act listing for the humpback whale to identify 14 Distinct Population Segments (DPSs) worldwide, three of which visit Washington's waters. These include (1) the Mexico DPS, which comprises the largest percentage (72 percent) of humpback whales present in the state and is federally threatened, (2) the Central America DPS, which contributes the fewest animals (8 percent) among Washington's humpbacks and is federally endangered, and (3) the Hawaii DPS, which comprises about 19 percent of the humpbacks visiting Washington and is not federally listed.

Humpback whales in the North Pacific remain vulnerable to a number of threats, including entanglement in fishing gear and marine debris, ship strikes, human-generated marine sound, the effects of climate change, and for the Central America DPS, possible issues related to small population size.

Although the humpback whale as a species has rebounded since the cessation of whaling activity, the Central America DPS and the Mexico DPS, which comprise about 80 percent of the humpback whales that visit Washington waters, remain below sustainable numbers and continue to be federally listed as endangered and threatened, respectively. Due to their federal status and the threats and uncertainties described in this report, it is recommended that this species be retained as a state endangered species in Washington.

INTRODUCTION

This periodic status review summarizes the biology, population status, threats, and recent management actions directed at the three humpback whale (*Megaptera novaeangliae*) Distinct Population Segments (DPSs) that occur in the marine waters of Washington. This review also assesses whether this species should retain its current endangered status under state law or be reclassified. The Washington Department of Fish and Wildlife (WDFW) has not previously published a status report for humpback whales.

SPECIES BACKGROUND

The humpback whale is a large baleen whale (Figure 1). Adult females average 12 m but may reach up to 18 m and weigh up to 40,000 kg; adult males may be 1 to 1.5 m shorter than females (Shirihai and Jarrett 2006, Ford 2014). Newborn calves average 4 to 4.6 m in length, weigh about 900 kg at birth, and are born a dark gray color (Shirihai and Jarrett 2006, Ford 2014). Adults have a black or dark gray head and body with variable, marbled patterns of white on the throat, belly sides, flippers and flukes. In some populations, humpbacks may have nearly white pectoral flippers (Clapham and Mead 1999, Shirihai and Jarrett 2006, Ford 2014). Characteristics include long, almost wing-like flippers and tubercles on the head and flippers. Humpback whale flippers are the longest of all cetaceans, roughly a third the total length of the body, and are easily visible underwater. Flukes and the leading edge of flippers have a serrated edge and unique pattern, making it possible to use photo identification to identify individuals. The species has a flat, slender head covered by rounded knobs. Barnacles populate the chin, rostrum, lips, throat, and flipper and fluke edges of adults (Scammon 1874, Clapham and Mead 1999, Shirihai and Jarrett 2006, Ford 2014). Humpback whales have 14 to 35 throat pleats (Scammon 1874, Clapham and Mead 1999, Ford 2014). Baleen plates number 270 to 400. The baleen is black shading to brownish-white on the front plates and roughly 85 cm long (Scammon 1874, Clapham and Mead 1999, Ford 2014).

Figure 1. Humpback whale mother and calf (photo courtesy NOAA).

Taxonomy, populations, and distribution. Humpback whales are a member of the rorqual family Balaenopteridae (i.e., baleen whales with expandable throat pleats) and are found in oceans worldwide, excluding most of the Arctic Ocean. They are the only species in the genus *Megaptera*. Three subspecies are recognized, with *M. n. kuzira* present in the North Pacific and the subject of this review (Jackson et al. 2014, Committee on Taxonomy 2017).

In 2016, the National Marine Fisheries Service (NMFS) revised the federal Endangered Species Act listing for the humpback whale to identify 14 DPSs (Figure 2; NMFS 2016). Each DPS has a unique genetic structure, resulting from the strong influence of maternal fidelity to particular breeding and feeding grounds (Baker et al. 1990, 2013, Bettridge et al. 2015). Three of the four DPSs present in the North Pacific occur in Washington: the Mexico DPS, Central America DPS, and Hawaii DPS (NMFS 2016). Descriptions of these follow. A fourth DPS, the Western North Pacific DPS, has been detected only once in or near Washington and is not discussed in this report.

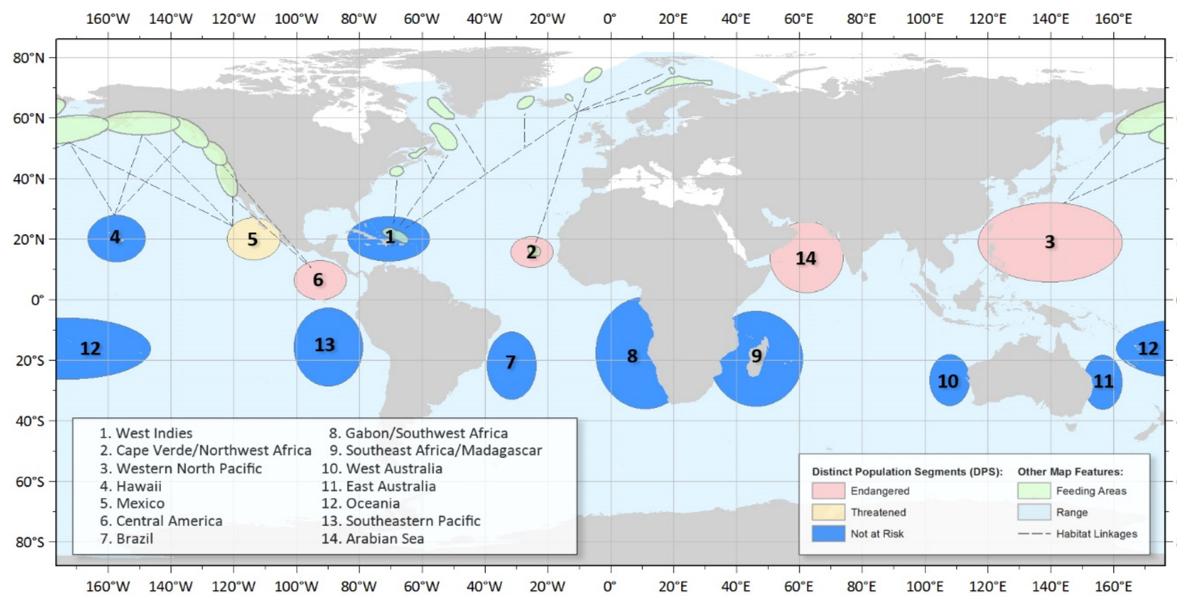

Figure 2. Humpback whale Distinct Population Segments (map courtesy NMFS).

Mexico DPS. Members of this DPS winter and breed off the Pacific coast of Baja Mexico, mainland Mexico and the Revillagigedos Islands. During migration and the summer feeding season, they range northward to California, Oregon, Washington, British Columbia, southeastern Alaska, the Gulf of Alaska, the Aleutian Islands, the Bering Sea, and the Russian Far East (Calambokidis et al. 2000, 2008, Barlow et al. 2011, Titova et al. 2018). This DPS is federally designated as threatened (NMFS 2016).

Central America DPS. This DPS consists of humpback whales that winter and breed along the Pacific coasts of Panama, Costa Rica, Nicaragua, Honduras, El Salvador, and Guatemala, and feed in the summer primarily in the coastal waters of California and Oregon, with a small number reaching Washington and southern British Columbia (Calambokidis et al. 2008, Barlow et al. 2011). This DPS is federally listed as endangered (NMFS 2016).

Hawaii DPS. These whales breed during the winter in waters of the Hawaiian Islands. The main summer feeding grounds of this DPS are located in coastal waters of northern British Columbia, southeastern Alaska, and the Gulf of Alaska, with some individuals reaching southern British Columbia and northern Washington to the south, and the Aleutian Islands, Bering Sea, and Russian

Far East to the northwest (Calambokidis et al. 2008, Barlow et al. 2011 Titova et al. 2018). This DPS is not federally listed (NMFS 2016).

Additionally, under the Marine Mammal Protection Act (MMPA), NMFS recognizes three separate humpback whale stocks in the North Pacific, which do not currently align with the designated DPSs (Carretta et al. 2019a, Muto et al. 2019). These are (1) the California/Oregon/Washington stock, which includes animals that feed off these states, (2) the Central North Pacific stock, which is includes whales that winter around Hawaii and migrate primarily to northern British Columbia/southeast Alaska, the Gulf of Alaska, the Aleutian Islands, and the Bering Sea, and (3) the Western North Pacific stock, which includes animals mainly present off eastern Asia to central Alaska and rarely visits the vicinity of Washington. The California/Oregon/Washington stock includes two separate feeding groups, one of which occurs in California and Oregon and the other in northern Washington and southern British Columbia (Calambokidis et al. 2008, Barlow et al. 2011). Interchange between these two feeding groups occurs, but at low rates (Calambokidis et al. 2004, 2008).

Sources of humpback whales visiting Washington. Photo-identification indicates that a large proportion of humpback whales feeding along the coasts of northern Washington and southern British Columbia are from the Mexico DPS (72 percent), with fewer animals from the Hawaii (19 percent) and Central America (8 percent) DPSs (Table 1; Calambokidis et al. 2017). Only a single animal from the Western North Pacific DPS has been sighted in this area. DPS membership of individuals visiting the Salish Sea roughly reflects these proportions, albeit with a greater representation of the Hawaii DPS and no detections yet of whales from the Central America DPS (Table 1).

Table 1. Percentage (%) of humpback whale identification matches between the Washington-southern British Columbia (WA-SBC) and Salish Sea feeding areas and wintering areas (from Calambokidis et al. 2017).

Area	N[1]	WNP DPS[2] (Ogasawara Islands)	Hawaii DPS	Mexico DPS				C. Am DPS[7]
				Rev Mx[3]	B Mx[4]	M Mx[5]	S Mx[6]	
WA-SBC Outer Coast	115	1	19	11	17	40	4	8
Salish Sea	18	0	33	11	6	44	0	6

[1] Number of matches, [2] Western North Pacific DPS, [3] Revillagigedos Islands, [4] Baja Mexico, [5] mainland Mexico, [6] southern Mexico, [7] Central America DPS

NATURAL HISTORY

Habitat requirements. Humpback whales breed in warm temperate and tropical waters, often near islands or reefs (Scammon 1874, Clapham and Mead 1999, Clapham 2002). Because of their diverse diet, humpbacks are able to exploit a variety of habitats, including nearshore, continental shelf and offshore waters along the U.S. Pacific Coast and British Columbia (Gregr et al. 2000, Rambeau 2008, Ford 2014). Nearshore habitat can include sheltered bays and straits (Gregr and Trites 2001). In coastal British Columbia, foraging humpback whales may be attracted to areas of higher salinity in feeding grounds, a possible indication of prey abundance (Gregr and Trites 2001). Humpbacks in

Washington have been observed in deeper water farther offshore in winter and spring than in summer and fall (Calambokidis et al. 2015). Calambokidis et al. (2015) have identified the outer coastal waters of northwestern Washington as biologically important. Migration occurs in both coastal and offshore waters (Calambokidis et al. 2001, 2008).

Foraging and diet. Humpback whales are filter feeders but are unique among baleen whales for their ability to exploit a wide range of prey, including euphausiids (krill), crab, squid, and schooling fish (Witteveen et al. 2005, 2008, Ford 2014). Fish eaten in the northeastern Pacific include juvenile walleye pollock (*Gadus chalcogrammus*), Pacific herring (*Clupea pallasii*), Pacific sand lance (*Ammodytes personatus*), and Pacific sardines (*Sardinops sagax coerulea*), which are important prey off Vancouver Island (Witteveen et al. 2005, 2008, Ford 2014). Whales foraging off California, Oregon and Washington may consume larger amounts of fish than other populations (Witteveen et al. 2009). Foraging animals eat an estimated 338 to 370 kg of prey per day (Witteveen et al. 2005). Feeding takes place in the North Pacific from May to December. Similar to other rorquals, humpbacks fast during migration and the breeding season (Witteveen et al. 2009).

Humpback whales commonly forage where dense prey patches are available (Dolphin 1987, Witteveen et al. 2008). Feeding occurs either at or below the surface to depths of 150 m. Dive duration during foraging usually lasts 3 to 15 minutes but may reach up to 40 minutes (Dolphin 1987, Shirihai and Jarrett 2006, Kavanagh et al. 2017). Surface feeding techniques include horizontal lunging, circular swimming, and “flick feeding,” in which the flukes are used to stun or concentrate prey. Humpback whales are creative predators able to take advantage of novel feeding opportunities (Johnson and Wolman 1984, Ford 2014). For example, individuals have learned to feed using docks and net pens to trap juvenile salmon released from hatcheries in Southeast Alaska (Chenowith et al. 2017). Humpback whales are also known for a unique cooperative behavior called bubble-net feeding, which concentrates large numbers of prey for easier capture (D’Vincent et al. 1985, Shirihai and Jarrett 2006, Ford 2014).

Movements. Humpback whales migrate in spring and fall between high-latitude feeding areas and tropical or subtropical wintering and breeding areas (Rice 1978, Calambokidis et al. 2008, Ford 2014). These are some of the longest migrations of any mammal, regularly extending up to 16,000 km roundtrip (Clapham and Mead 1999, Shirihai and Jarrett 2006). The longest recorded humpback migration is 18,840 km roundtrip from the Antarctic Peninsula to American Samoa and back (Robbins et al. 2011). Humpback whales swim at speeds of 2.7 to 4.7 km per hour during migration (Gabriele et al. 1996, Calambokidis et al. 2000).

In the North Pacific, the migration period is protracted, with the last individuals heading south from high-latitude feeding areas in late January or February, which overlaps with early arrivals from the breeding grounds (Calambokidis et al. 2015). Males spend longer on breeding grounds than newly pregnant females, who are the first to return to feeding grounds. Mothers and calves remain longest on the breeding grounds (Johnson and Wolman 1984, Shirihai and Jarrett 2006, Ford 2014). Some individuals may remain on feeding grounds year-round and apparently do not migrate (Johnson and Wolman 1984, Craig and Herman 1997, Shelden et al. 2000, Calambokidis et al. 2015).

Individuals often show fidelity to certain feeding areas, and interchange between feeding areas is relatively uncommon (Rambeau 2008, Baker et al. 2013, Calambokidis et al. 2015). Calambokidis et al. (2008) found that humpbacks in the northern Washington-southern British Columbia feeding group rarely used other foraging areas. In British Columbia, Rambeau (2008) resighted 57 percent of feeding humpbacks within 100 km of where they were seen in previous years, and 25 percent within 25 km. Whales feeding at any one location along the Pacific Coast may include individuals from multiple breeding grounds (Zerbini et al. 2006, Witteveen et al. 2009).

Social organization and behavior. Humpback whales occur singly, in mother and calf pairs, or in groups of up to 15 or more individuals (Clapham 2000, Shirihai and Jarrett 2006). Group membership may be short- or long-term. Individuals may stay together longer in summer to forage cooperatively. On breeding grounds, males accompany cow and calf pairs (Ford 2014).

Humpbacks are known for a wide range of surface behaviors, including breaching, pectoral flipper and tail slapping, and spy-hopping. They are famous for their aerial breaching displays, in which they sometimes leap clear of the water. These displays are especially common on breeding grounds (Whitehead 1985, Ford 2014).

Males produce a complex song lasting 10 to 20 minutes, which they repeat for hours at a time. These songs can be heard more than 30 km away, and the low-frequency sections of the song carry much farther in deep water. The song's purpose is not clear, though it appears to play a role in courtship and mating (Tyack 1981, Smith et al. 2008). The songs may also be used between males to establish dominance (Darling et al. 2006). Both sexes emit vocalizations when feeding, and other "social sounds" such as grunts, moans, "pulse trains," blowhole-associated sounds, and surface splashes (Thompson et al. 1986, Stimpert et al. 2011).

Reproduction. Humpback whales attain sexual maturity at 5 to 11 years of age upon reaching 11.5 to 12 m in body length (Clapham 1992, Gabriele et al. 2007, Zerbini et al. 2010). Reproduction is strongly seasonal. Females come into estrus during winter, and energetic courtship rituals take place with a variety of surface activities and song (see Social organization and behavior). Males typically outnumber females by more than two to one on the breeding grounds, and competition for females can be fierce (Ford 2014). Multiple males will surround a female and fight for the right to mate with her. Females typically breed every two to three years, with a gestation period of 11 to 12 months (Johnson and Wolman 1984, Clapham et al. 2003). In the North Pacific, mothers usually bear a single calf from January through March (November through March in Hawaii). Calves stay with their mother for 1 to 2 years, during which they nurse for about a year, and begin feeding on their own at about 6 months (Johnson and Wolman 1984, Shirihai and Jarrett 2006). Mothers and calves reside in significantly shallower coastal waters compared to other individuals (Ersts and Rosenbaum 2003). Mothers may use shallower waters to avoid harassment and injury to calves from breeding males, turbulent ocean conditions, or predators (Smultea 1994).

Mortality. Life span is believed to average up to 80 years, with the oldest individuals perhaps reaching 95 years old (Chittleborough 1965, Ford 2014). In the North Pacific, estimates of annual survival average between 0.95 and 0.985 in adults (Mizroch et al. 2004, Zerbini et al. 2010) and 0.818 in calves at 6 months of age (Gabriele et al. 2001, Zerbini et al. 2010). Robbins (2007) calculated a survival rate of 0.664 for calves from 6 to 18 months old for humpbacks in the Gulf of Maine population.

Natural predators of humpback whales include sharks that take calves on breeding grounds, and killer whales, which also generally target calves aged one year or younger (Mehta et al. 2007, Steiger et al. 2008, Pitman et al. 2016). Scars left by killer whale attacks are visible on the flukes of approximately 30 to 40 percent of humpback whales off Mexico (Steiger et al. 2008, Ford 2014). Humpback whales are known to defend against or attack killer whales and other predators targeting calves or juveniles (Ford and Reeves 2008, Pitman et al. 2016).

POPULATION STATUS AND TRENDS

The pre-whaling global population of humpback whales has been estimated at more than 125,000 animals, most of which inhabited the Southern Hemisphere (Baker et al. 1993). Heavy exploitation during the whaling era reduced the abundance of humpback whales by more than 90 percent to perhaps fewer than 5,000 individuals by the 1960s (Baker et al. 1993). The cessation of whaling has allowed numbers to recover in many regions of the world, with total abundance reaching 80,000 or more whales during the 2000s (Fleming and Jackson 2011).

In the North Pacific, humpback whale abundance declined from a pre-whaling estimate of roughly 15,000 animals (Rice 1978) to just 1,200 to 1,400 animals by the 1960s (Gambell 1976, Johnson and Wolman 1984). In the following decades, numbers in the region showed significant progress toward recovery, reaching an estimated 6,010 (CV = 0.08) whales by the early 1990s (Calambokidis et al. 1997), and depending on the analysis used, estimates of 21,063 (CV = 0.04) whales (Barlow et al. 2011) or 15,805 to 16,132 whales (Wade et al. 2016) by the mid-2000s. The increase between the early 1990s and mid-2000s corresponded to an estimated average annual growth rate of 8.1 percent for the entire North Pacific (Barlow et al. 2011). Much of the recent data on humpback whale abundance in the region comes from the "Structure of Populations, Levels of Abundance and Status of Humpbacks" (SPLASH) program conducted from 2004 to 2006 (Calambokidis et al. 2008). This project used photo-identification of the species' unique fluke markings and tissue sampling to catalog large numbers of individuals throughout known summering and wintering areas in the North Pacific. This information has been supplemented by data from line transects and additional photo-identification studies along the U.S. West Coast (Barlow 2016, Calambokidis et al. 2017, Carretta et al. 2019a). Carretta et al. (2019a) estimated 2,900 whales in the California/Oregon/Washington stock using data from 2011 to 2014. Growth of this stock appears to have leveled off since about 2008 (Calambokidis et al. 2017).

Status summaries of the three DPSs covered in this report are given below. Pre- and post-whaling estimates of abundance are not available for these DPSs.

Mexico DPS. During the early 1990s, two estimates placed the population's size between about 2,200 and 2,800 whales (Calambokidis et al. 1997, Urbán et al. 1999). Wade et al. (2016) analyzed SPLASH data to derive an estimate of 3,264 (CV = 0.06) whales for 2004 to 2006. This estimate superseded two earlier estimates exceeding 6,000 individuals (Calambokidis et al. 2008, Barlow et al. 2011), which used the same data, but are now considered unreliable (NMFS and USFWS 2016). More recent estimates of DPS size are not available. Comparison of estimates from the 1990s and mid-2000s indicate an increasing trend in the DPS during this period. This trend is supported by data from the California/Oregon/Washington stock, which also showed growth from 1979 to 2014 (Barlow 2016, Carretta et al. 2019a).

Central America DPS. Two initial estimates of DPS size were based on SPLASH data and put numbers at about 500 to 600 whales during 2004 to 2006 (Calambokidis et al. 2008, Barlow et al.

2011). However, Wade et al. (2016) employed an improved method of analysis of the same data to derive an estimate of 411 (CV = 0.30) whales in the population, which is considered a more accurate measure of abundance (NMFS and USFWS 2016). More recent estimates of DPS size are not available. The absence of other population estimates for this DPS means that trend information is currently lacking (Bettridge et al. 2015, NMFS and USFWS 2016).

Hawaii DPS. This is the largest DPS in the North Pacific, containing at least half of the region's humpback whales. Pre- and post-whaling estimates of abundance are unavailable for this DPS. Older surveys put numbers at 1,407 (95% CI = 1,113 to 1,701) whales in 1981 (Baker et al. 1987) and at about 3,000 to 5,000 animals during the late 1980s to 1990s (Calambokidis et al. 1997, Cerchio 1998, Mobley et al. 1999, 2001). Wade et al. (2016) analyzed SPLASH data and estimated the DPS at 11,398 (CV = 0.04) whales from 2004 to 2006. This estimate is considered more accurate than two earlier estimates of about 10,000 individuals (Calambokidis et al. 2008, Barlow et al. 2011) based on the same data (see NMFS and USFWS 2016). More recent estimates of DPS size are not available. The DPS has clearly shown an increasing trend since the early 1980s, with Calambokidis et al. (2008) estimating an average annual growth rate of 5.5 to 6.0 percent from the 1990s to mid-2000s.

Past and present status in Washington. Humpback whales were considered common off the outer coast of Washington in the 1800s and early 1900s (Scheffer and Slipp 1948) and were by far the most frequently harvested species by Bay City whalers (see **Commercial and subsistence harvest**). However, numbers became greatly depleted by the 1920s because of whaling along the North American west coast, and sightings apparently remained infrequent off Washington until perhaps as late as the 1980s (e.g., Fiscus and Niggol 1965, Wahl 1977). Calambokidis et al. (2004) documented an increase in abundance from 1995 to 2002 and estimated that several hundred individuals visited the waters off the state's northern coast each year, but considered this estimate substantially below historical levels. Stranding records for humpback whales in Washington stand at 24 from 1980 through early 2020. All but four were calves or subadults (K. Wilkinson pers. comm. 20).

Although no set of surveys has specifically measured humpback abundance and trends for Washington alone, two regional surveys in somewhat larger geographic areas provide insight into the species' recent occurrence in Washington. Barlow (2016) reported estimates for Washington and Oregon combined based on five ship-based line transect surveys from 1996 to 2014. These indicate a substantial increasing trend in humpback abundance off the two states, with estimates expanding from 28 (CV = 1.20) in 1991 to 2,480 (CV = 0.96) in 2014 (Barlow 2016). Using mark-recapture analyses, Calambokidis et al. (2017) presented estimates for the same area from 1991 to 2014 and detected strong initial growth followed by stabilization in numbers, with the most recent estimates ranging from 1,399 (CV = 0.03) to 2,374 (CV = 0.03). The majority of animals in this region typically occur in Oregon (e.g., Barlow 2016). For Washington and southern British Columbia (south of 50°N) combined, the most recent analysis of photo-identification data indicates that humpback whale abundance has increased from an estimated 100 individuals in 1995-1997 to approximately 500-720 individuals in 2012-2014 (Calambokidis et al. 2017). Deeper waters off northwestern Washington are predicted to have the highest densities of humpback whales along the state's outer coast (Calambokidis et al. 2015, Menza et al. 2016).

Humpback whales once frequented the Salish Sea before being eliminated by whaling activity in the early 20th century (see **Commercial and subsistence harvest**). Small numbers of individuals began to return to these waters during the 1970s and 1980s (Merilees 1985), with sightings continuing to be relatively rare through the 1990s (Figure 3; Everitt et al. 1980, Osborne et al. 1988, Calambokidis and Steiger 1990, Jeffries 1990). Sightings have increased greatly since the mid-2000s (perhaps due to increased prey availability), reaching 500 or more annually in 2014 and 2015 (Figure 3; McMillan et al. 2014, Calambokidis et al. 2017). Washington Salish Sea sightings have been concentrated in the Strait of Juan de Fuca and near the San Juan Islands, but are also reported throughout Puget Sound, including Hood Canal and as far south as Olympia (Calambokidis and Steiger 1990, Calambokidis et al. 2017).

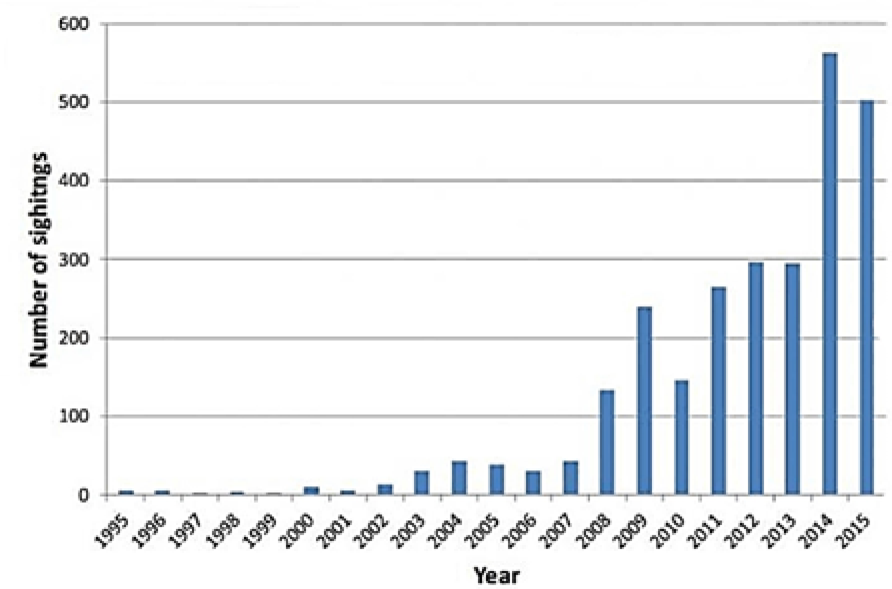

Figure 3. Sighting reports of humpback whales in the Salish Sea. Graph courtesy Cascadia Research Collective.

FACTORS AFFECTING CONTINUED EXISTENCE

Adequacy of existing regulatory mechanisms. Humpback whales have benefited from the protections afforded under a variety of national, international, and state laws. The species is protected under the U.S. federal MMPA, which prevents the taking (defined as harassing, hunting, capturing, killing, or attempting to harass, hunt, capture, or kill) and importation of these animals and products derived from them. The MMPA allows some incidental take during commercial fishing operations and limited other circumstances, as well as directed take for purposes of scientific research. Under the MMPA, the California/Oregon/Washington, Central North Pacific, and Western North Pacific stocks are considered "depleted" and are designated as "strategic stocks." The species was federally listed as endangered in 1970 under the Endangered Species Conservation Act of 1969, which preceded the Endangered Species Act of 1973. This listing was revised in 2016, when NMFS divided the species into 14 DPSs and determined that four of these (Central America, Western North Pacific, Arabian Sea, and Cape Verde Islands/Northwest Africa) should be listed as endangered, one (Mexico) should be listed as threatened, and the others should not be listed (NMFS

2016). Federal listed status includes prohibitions on take of listed species similar to those under the MMPA. In October 2019, NMFS proposed the designation of critical habitat for the listed DPSs of humpback whales along the U.S. west coast and Alaska (NMFS 2019). In Washington, the proposal includes all outer coastal waters from 50 to 1,200 m deep, with the exception of those in the large Quinault Range Site operated by the U.S. Department of Defense. The U.S. portion of the Strait of Juan de Fuca east to Angeles Point is also included in the proposal.

National marine sanctuary regulations (15 CFR 922 Subpart O, 152(a)), which apply to the Olympic Coast National Marine Sanctuary off the northwest coast of Washington, the Hawaiian Islands Humpback Whale National Marine Sanctuary in Hawaii, and other national marine sanctuaries, contain prohibitions on the taking and possessing of any marine mammal, except as authorized by the MMPA and ESA, or as allowed through tribal treaty rights.

Under Washington state law (WAC 220-610-010), humpback whales were listed as endangered in 1981. This prohibits the hunting, possession, malicious harassment, and killing of the species (RCW 77.15.120). Humpback whales are considered a priority species under WDFW's Priority Habitats and Species program, but specific management recommendations for them have not been developed under this program.

Canada's federal Species at Risk Act classifies the North Pacific population of humpback whales as being of special concern. The species is on the British Columbia Blue List, meaning that it is especially sensitive to natural events or human impacts. Mexico has established several marine protected areas, whale-watching regulations, and other protections that benefit all large whale species, including humpback whales (Bettridge et al. 2015). Full protection from commercial harvest was extended to humpback whales by the International Whaling Commission (IWC) in 1966. The International Union for the Conservation of Nature (IUCN) categorizes the entire species of humpback whale as Least Concern, but considers two populations not found in the eastern North Pacific as endangered. Humpback whales are also listed in Appendix I of the Convention on the International Trade of Endangered Species of Wild Fauna and Flora (CITES), which bans international commercial trade in products from this species.

Commercial and subsistence harvest. Commercial whaling during the 19th and 20th centuries decimated many populations of whales worldwide, including humpback whales (Roman and Palumbi 2003, Rocha et al. 2014). The species was widely hunted by the 1800s and was a favorite target of whalers because of its coastal distribution and relatively slow swimming speed. Global harvest of humpback whales peaked in the 20th century, during which nearly 250,000 individuals were caught, more than 85 percent of which were taken in the southern hemisphere (Rocha et al. 2014). A total of 29,131 humpbacks were killed in the North Pacific during the 20th century (Rocha et al. 2014), including at least 14,207 individuals in the eastern North Pacific (Rice 1978).

In Washington, humpback whales were the primary species taken by the shore-based whaling station at Bay City from 1911 to 1925, with 1,933 individuals caught compared to 764 other whales (Scheffer and Slipp 1948). Humpback whales were also a major component of the shore whaling harvest in British Columbia from 1908 to 1967, when 5,638 individuals were killed (Gregr et al. 2000). Most (3,768) of these animals were taken between 1908 and 1913, causing the depletion of the population (Gregr et al. 2000, Nichol et al. 2002). Although the vast majority in Washington and British Columbia were captured in continental shelf waters, a small number were also harvested in the Salish Sea (at least 81 whales, 1866-1873; 112 whales, 1907-1908; Merilees 1985, Ford 2014). Historically, humpback whales were hunted for subsistence purposes by the coastal native peoples of Washington and British Columbia (Huelsbeck 1988, 1994, Ford 2014), but these harvests probably had relatively little impact on species abundance. Archaeological evidence dating back at least 1,500 years indicates that humpback and gray whales (*Eschrichtius robustus*) were major food items for the Makah tribe along Washington's northwest coast (Huelsbeck 1988, 1994).

Entanglement in fishing gear and marine debris. A growing but poorly understood concern is the level of threat that entanglements pose to whale populations (IWC 2010, Williams et al. 2011b, Reeves et al. 2013). Large whales can become entangled in active fishing gear (such as gillnets and vertical lines used to mark trap/pot fisheries) or in discarded netting and other marine debris. Death, injury, or eventual starvation may result when entangled animals fail to free themselves of gear or debris. Risk of entanglement varies with species, the amount of overlap with various fisheries, and the type of gear used in those fisheries. Most entanglements occur in coastal waters, where fishing activity is highest (Saez et al. 2013).

Humpback whales are especially vulnerable to entanglement because of their frequent use of shallower waters, combined with their large knobby pectoral fins and large flukes that make them prone to snagging lines and nets (Saez et al. 2013). Entanglements are the most commonly identified cause of death and injury among humpback whales along California, Oregon, and Washington (Carretta et al. 2013, 2019b), and probably cause a modest reduction in the size or growth rate of the Central America and Mexico DPSs (Bettridge et al. 2015). Humpbacks were the second most frequently entangled whale species (after gray whales) in this region from 1982 to 2013, averaging 2.1 reports per year (NMFS, unpublished data). However, actual numbers of entanglements were likely much higher, as indicated by photographic data showing scarring from past incidents on half or more of the humpback whales occurring off these states (Robbins et al. 2007). Numbers of reported entanglements increased dramatically from 2014 to 2018 (average = 31.8 whales/year), making humpback whales by far the most frequently reported entangled species in the region (NMFS, unpublished data). Much of this change has been linked to substantially increased coastal foraging by the whales due to a marine heatwave from 2014 to 2016 and a delayed opening of the Dungeness crab fishery in 2016 that coincided with the whales' migration (Santora et al. 2020).

The vast majority of entanglement reports since 1982 are documented off California, but this is due in part to California's larger number of observers on the water and longer coastline relative to Washington and Oregon (Carretta et al. 2013, 2019b, Saez et al. 2013, NOAA Fisheries 2017). Most humpback entanglements in the region involve trap/pot gear, especially from commercial Dungeness crab fisheries (Saez et al 2013, NOAA Fisheries 2017). Eighty-one percent of entanglement reports since 1982 were received between May and October (NMFS, unpublished data), which coincides with the species' migration and summer feeding seasons (Saez et al. 2013).

Table 2. Numbers of humpback whale entanglements documented in Washington by location and time period, 1990–2018 (NMFS, unpublished data).

	Location		Time period		
Total	Outer coast	Salish Sea	1990-1999	2000-2009	2010-2018
10	15	8	0	2	21

In Washington, 23 of the 51 large whale entanglements reported since 1990 have involved humpback whales. Incidents have increased since 2010 (Table 2) and now outnumber those involving gray whales. More incidents were reported along the outer coast than in the Salish Sea (Table 2). The location where the entanglement is observed or reported may not necessarily reflect the location of the initial entanglement. To illustrate the potential risk for entanglements off Washington, upwards of 78,000 crab pots are deployed annually off the outer coast at the start of the commercial Dungeness crab fishery in December and January (D. Ayres, pers. comm. 2017). Pot numbers decline as the season progresses, falling to 7,300 pots by the end of the fishery on September 15.

Members of the Hawaii DPS are also vulnerable to entanglement in Alaskan, Hawaiian, and British Columbian waters, mainly from gillnet, longline, pot fisheries, and marine debris (Muto et al. 2019). More than 50 percent of the animals in Southeast Alaska possess entanglement scars (Neilson et al. 2009), suggesting that the current average yearly estimate of mortality and serious injuries from fisheries and other entanglements for this DPS (26 or more incidents, Muto et al. 2019) is likely a substantial underestimate. Entanglements are likely responsible for moderate reductions in the size or growth rate of this population (Bettridge et al. 2015).

Vessel strikes. Whales swimming or resting near the ocean surface can be vulnerable to injury or death from collisions with large and small vessels, especially in areas of frequent vessel traffic such as the U.S. west coast. Collisions can involve either blunt force trauma or propeller strikes. Ship strikes of whales have become more common in recent decades due to increases in shipping traffic, ship speeds, and whale abundance (Laist et al. 2001, Calambokidis 2011, Neilson et al. 2012). Documented collisions and resulting mortalities likely represent just a small fraction of the total number (Jensen and Silber 2004, Williams et al. 2011a, Rockwood et al. 2017). For some small populations of whales, ship strikes may be frequent enough to slow or prevent recovery (Kraus et al. 2005, Redfern et al. 2013).

Humpback whales are one of the most commonly vessel-struck whale species in some areas of the world (Jensen and Silber 2004, Neilson et al. 2012, Hill et al. 2017). For example, in Alaskan and Hawaiian waters, members of the Hawaii DPS experienced an average of at least 4.0 deaths and serious injuries per year because of collisions from 2012 to 2016 (Muto et al. 2019). In comparison, fewer strikes resulting in deaths and serious injuries are typically reported off California, Oregon, and Washington (e.g., a minimum yearly average = 2.1 for 2012-2016; Carretta et al. 2019a). However, actual deaths from ship strikes along the U.S. West Coast are considered much higher than this figure, with a best estimate of 28 animals killed annually (Rockwood et al. 2017). This indicates that ship strikes are a major source of mortality among humpback whales from California to Washington. Humpbacks are also the most commonly reported whale struck by vessels in British Columbia (Ford 2014).

In Washington, just two humpback whales were reported killed by vessel strikes from 1980 to 2017 (Douglas et al. 2008, Carretta et al. 2013, 2019b). The state has several areas where heavy vessel traffic poses a higher collision risk for humpback whales. These include the mouths of the Strait of Juan de Fuca and Columbia River, the north-south shipping lane leading to California, and the Strait of Juan de Fuca and other parts of the Salish Sea (Williams and O'Hara 2010, Nichol et al. 2017, Rockwood et al. 2017). Ship strike risk may expand in these areas as shipping traffic intensifies in the future and humpback numbers increase.

Disturbance from sound and vessels. Marine mammals in all oceans are exposed to increasing levels of underwater sound from vessels, seismic surveys, sonar, marine construction, and other human-related sources (Nowacek et al. 2007, 2015). Marine ambient noise levels at frequencies below 500 Hz, which overlap with the low-frequency calls of baleen whales, have increased by at least 20 dB (re 1 µPa) since pre-industrial conditions (Hildebrand 2009, Andrew et al. 2011, Redfern et al. 2017). Baleen whales rely on their acoustic sensory system for communicating with other individuals, sometimes at distances of hundreds of kilometers. Significant levels of anthropogenic sound can therefore interfere with communication by masking vocalizations (Erbe et al. 2016). Intense sound can also cause changes in surface, foraging, and vocal behavior, displace animals from occupied areas, and produce temporary or permanent hearing damage and physiological stress (e.g., Nowacek et al. 2007, Castellote et al. 2012, Risch et al. 2012, Rolland et al. 2012). Nevertheless, responses by whales can vary depending on localized circumstances, sometimes with no observable reactions recorded. Where sound-related impacts are severe, reproduction and survival of animals may be affected (Clark et al. 2009).

In response to different human-generated sound, humpback whales have been found to move away from noise sources (Dunlop et al. 2016), reduce male singing activity (Sousa-Lima and Clark 2008, Risch et al. 2012), reduce feeding activity (Sivle et al. 2016), and alter their migration path and speed (Dunlop et al. 2015, 2016). Williams et al. (2014) found coastal marine noise levels high enough to potentially cause significant communication problems for humpback whales at several locations in British Columbia, including Haro Strait in the Salish Sea adjacent to Washington. Members of the Mexico, Central America, and Hawaii DPSs are expected to face increasing sound levels in the future due to expanding vessel traffic, oil and gas exploration and development, offshore wind farm construction, coastal development, and military training and testing (Bettridge et al. 2015).

The tremendous growth in whale watching in recent decades (O'Connor et al. 2009) has elevated concerns that cetaceans are being disturbed by the physical presence and sound of whale-watching vessels (Parsons 2012, Hoyt and Parsons 2014). Boat-based whale watching has been documented to cause changes in the behavior of humpback whales in some locations (e.g., Stamation et al. 2010), but overall the activity is not known to cause significant harmful impacts to the species. Humpback whales in the Mexico, Central America, and Hawaii DPSs experience low to moderate levels of viewing pressure from whale watchers; as a result, this activity does not appear to be an important conservation concern for these populations (Bettridge et al. 2015).

Climate change. The effects of global climate change will likely become one of the greatest threats to many species of marine mammals in the coming decades because of its alteration of marine ecosystems and food webs through changes in ocean temperatures, currents, stratification, and nutrient cycling, and by causing higher sea levels and increased occurrence of unusual and extreme ocean conditions such as strong El Niño events (e.g., Doney et al. 2012). Climate change effects on oceans will probably occur unevenly, with some areas affected more severely than others. Humpback whales are perhaps most likely to be affected through changes in prey abundance and availability. However, this concern may be somewhat alleviated among northern hemisphere humpback whales, which have greater foraging flexibility resulting from diets comprised of both invertebrates and forage fish (Bettridge et al. 2015, Fleming et al. 2015). Increased exposure to novel diseases throughout the species' range is another possible outcome of climate change (Simmonds and Eliott 2009). Marshall et al. (2017) modelled ocean acidification impacts due to climate change and concluded that pelagic species (including humpbacks and other marine mammals) may be much less influenced by future pH levels than other species, especially epibenthic invertebrates and demersal fishes.

Environmental contaminants. A number of studies have described contaminant loads in humpback whales (Ryan et al. 2013, Dorneles et al. 2015, Das et al. 2017), with Elfes et al. (2010) measuring levels in animals from Washington and elsewhere off western North America. As with most other baleen whales, humpback whales possess relatively low toxicant concentrations that are less than those associated with health disorders in other species. Contaminants are therefore not considered an important threat to the Central America, Mexico, and Hawaii DPSs (Bettridge et al. 2015).

Oil spills. When exposed to oil, individual whales can experience baleen fouling, ingestion of oil, respiratory distress from inhalation of vapors at the water's surface, and contaminated food sources (Geraci 1990, Takeshita et al. 2017), all of which may produce physiological effects that remain poorly understood. Major spills may cause lingering reproductive and health impacts (Kellar et al. 2017, Smith et al. 2017), as well as direct mortality of prey and displacement from feeding areas. At the population level, marine oil spills are generally considered a relatively minor threat for large whales.

It is unknown whether any of the seven major oil spills in Washington from 1964 to 1991 (Neel et al. 2007) harmed humpback whales. Increased safety measures and prevention programs since the 1990s have helped reduce the number and scale of vessel spills in Washington, where no spills exceeding 100,000 gallons have occurred since 1991 (Etkin and Neel 2001, Neel et al. 2007). However, the sheer volume of shipping traffic (i.e., about 6,800 vessel transits in 2019; WSDOE 2020) makes oil spills a persistent threat in the state. Shipping routes serving major ports in Seattle, Tacoma, and Vancouver, B.C., as well as several major oil refineries and the third largest naval base in the U.S., all traverse waters used by humpback whales in Washington. A 2015 risk assessment of oil spills from vessels transiting the Salish Sea and northern outer coast of Washington found that the region remains at risk of a large spill (Van Dorp and Merrick 2017). This risk is expected to grow substantially in the future as tanker traffic from ports in British Columbia and possibly Washington increases due to expanded oil and natural gas production in the interior of North America and the TransMountain pipeline expansion to Burnaby, BC. Spill risk could also expand elsewhere in the ranges of the Central America, Mexico, and Hawaii DPSs wherever offshore oil production is approved in the future (Bettridge et al. 2015).

Harmful algal blooms. Harmful algal blooms, also known as "red tides," result from rapid, temporary increases in local populations of particular dinoflagellates, protists, or other phytoplankton. Two of the most common toxins produced by algal blooms along the west coast of North America are the neurotoxins saxitoxin and domoic acid, both of which can be toxic to marine mammals, especially pinnipeds (Torres de la Riva et al. 2009, Lewitus et al. 2012). Of the few known cases of acute algal poisoning confirmed in large whales (e.g., Fire et al. 2010, Lewitus et al. 2012), one involved 14 humpback whales dying from saxitoxin poisoning in Massachusetts (Geraci et al. 1989). During the past decade, there have been increasing reports of saxitoxin and domoic acid being detected in whales and blooms coinciding with whale mortalities (Lefebvre et al. 2016, Wilson et al. 2016). In one recent study, saxitoxin and domoic acid were found in 50 percent and 38 percent, respectively, of a small sample of humpback whales from southern Alaska (Lefebvre et al. 2016). Harmful algal blooms are projected to become increasingly common in the future with warming ocean conditions (McKibben et al. 2017) and therefore could represent a possible emerging concern for humpback whales.

Small population size. The small size of the Central America DPS could impart a higher risk of inbreeding, loss of genetic variability, and occurrence of chance events such as demographic fluctuations and population-level impacts from ship strikes and entanglements, all of which could negatively affect this population.

MANAGEMENT ACTIVITIES

Management of whaling. International prohibitions on the commercial harvest of humpback whales (in 1966) and all large whales (in 1986) were established by the IWC and remain in effect as a primary conservation tool for protecting humpbacks.

Species management and recovery planning. In addition to the IWC responsibilities noted above, NMFS manages all humpback whale stocks in U.S. waters under the MMPA and regularly assesses population sizes, trends, and sources of mortality to guide conservation of the species (Carretta et al. 2019a, Muto et al. 2019). Animals from the five listed humpback DPSs, including the Mexican and Central America DPSs, are also managed under the ESA. A recovery strategy for humpback whales in British Columbia describes needed conservation actions (DFO 2013). It also designated four areas of critical habitat that are of high value to the species.

Entanglement in fishing gear and marine debris. NMFS, in collaboration with stakeholders, has led national efforts to mitigate the problem of whale entanglements (NOAA Fisheries 2017). On the U.S. East Coast, this has led to the development and implementation of restrictions on when and how fishing gear can be set, including closures and gear modifications. Restrictions have not been implemented in fisheries off the U.S. West Coast, but NMFS is working with partners to conduct outreach to commercial and recreational fishing communities promoting consideration of changes in fisheries and gear along with other best practices for avoiding entanglements. Outreach has also targeted the broader marine community to encourage the prompt reporting of entangled animals and to improve report quality. These efforts together with expanding the response capabilities of permitted organizations and response teams may result in more successful rescue attempts to disentangle whales. Ongoing research and improved documentation of entanglements will also help inform future management efforts. In Washington, NMFS has held disentanglement training workshops and cached disentanglement equipment at various sites in the state to enhance response efforts. The Cascadia Research Collective and other entities have participated in many of the disentanglement attempts made in the state. Various projects to remove derelict crab pots and lines have also been conducted, including ones by the Quileute Nation, Quinault Indian Nation, and The Nature Conservancy along sections of the outer coast (e.g., Antonelis 2014; WDFW, no date).

To help in the recovery of lost Dungeness crab pots, WDFW allows fishers 45 days after the crabbing season closes to collect and keep any pots they find.

A multi-stakeholder Washington Whale Entanglement Working Group has regularly met since November 2017 to examine possible methods for reducing the risk of entanglements in state waters. In January 2020, the Washington Fish and Wildlife Commission approved new rules for the 2020 Dungeness crab season to reduce the potential for humpback whale entanglements. The rule changes included requiring only the amount of line reasonably necessary, reducing the pot limit and requiring a summer buoy tag, replacing buoy tags, and requiring line marking specific to Washington.

Ship strikes. NMFS, the International Maritime Organization, and others have implemented various measures in specific locations to reduce the risk of vessel collisions with large whales. These include the re-routing of shipping lanes, creation of areas to be avoided by ships, mandatory or voluntary speed restrictions for ships, using ship crew as lookouts for whales, and increasing the awareness of ship crews about whale strikes (Calambokidis 2013, Ritter and Panigada 2014). Several of these actions have been undertaken in areas of California and Alaska, but none have yet been implemented in Washington. Regulations prohibit approaching within 100 yards of a humpback whale in Alaska and Hawaii, but similar regulations have not been implemented in Washington or other areas of the U.S. West Coast. However, whale-watching guidelines, if followed, help keep vessels at reasonable distances from humpback whales, thus reducing the risk of collisions. NMFS has also expanded its efforts to document vessel strikes of all large whales in the eastern North Pacific.

Reduction of marine noise. There is growing recognition that current levels of human-generated noise in oceans require mitigation to reduce impacts on marine fauna. Implementing noise-reduction actions requires government engagement with industry, the military, and other stakeholders. The National Oceanic and Atmospheric Administration (NOAA) has recently completed an ocean noise reduction strategy to help address concerns in U.S. waters (NOAA 2016). Existing mitigation actions can include steps to (1) detect and limit impacts to animals (e.g., closing areas to certain technology, avoiding use during specified seasons or times of day, discontinued use if animals are detected, and gradual powering up of equipment to warn animals away) and (2) reduce sound levels at the source (e.g., applying noise abatement measures and reducing vessel speeds). One example of such mitigation are the measures agreed upon by the U.S. Navy and NMFS to reduce naval training impacts on marine mammals in the Northwest Training and Testing Offshore Area along the Washington, Oregon, and northern California coasts (NMFS 2015). Internationally, efforts are underway to design and implement quieting technologies in shipping, oil and gas exploration, and marine construction (IMO 2014, Hatch et al. 2016). Existing laws (e.g., MMPA) and viewing guidelines help keep whale-watching vessels at reasonable distances from humpback whales, thus reducing the effects of vessel presence and sound.

Monitoring and research. Ongoing surveys performed by NMFS, Fisheries and Oceans Canada, and partner groups in North America and Hawaii help monitor the population size, trend, and distribution of the humpback whale DPSs covered in this report (e.g., Carretta et al. 2019a). NMFS and others also monitor humpback injuries and mortalities from entanglements, ship strikes, and other causes. Numerous research projects have been conducted in recent years or are underway, including analyses of population structure, life history and ecology, genetics, as well as the impact and extent of different threats.

Stranding responses. NMFS coordinates responses to strandings of humpback whales through the West Coast Marine Mammal Stranding Network, which is comprised of cooperating scientific investigators, institutions, organizations, and state and federal agencies. Cascadia Research, SR3, WDFW, and other collaborators sample or necropsy many of these animals to determine cause of death, animal condition and health, and other traits. Stranding data are maintained in a national database.

Oil spill prevention and response. State and federal agencies, industry, and other stakeholders continue their efforts to prevent oil spills from occurring in Washington. In 2010, a rescue tug was permanently deployed at Neah Bay with funding provided by the petroleum and shipping industries under a new state law. Year-round access to the tug improves our response to oil spills associated with impaired vessels and barges in whale habitat near the entrance of the Strait of Juan de Fuca and along a portion of the outer coast. Establishment of an Area to Be Avoided off the northwestern coast encourages large vessels to stay well offshore during transit (WSDOE 2017). Spill response planning, participation in oil spill drills, and outreach are ongoing. Improved regulations have been enacted in both the U.S. and Canada to minimize the risk of accidental spills.

CONCLUSIONS AND RECOMMENDATION

Although the humpback whale as a species has rebounded since the cessation of whaling activity in the mid-20th century, the Central America DPS and the Mexico DPS, which comprise about 80 percent of the humpback whales that visit Washington waters, remain below sustainable numbers and continue to be federally listed as endangered and threatened, respectively. In order to align with federal listings and support the conservation efforts of other agencies and organizations, it is recommended that the humpback whale be retained as a state endangered species.

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Table A. Key to 34.05.271 RCW Categories:

34.05.271(1)(c) RCW	Category Code
(i) Independent peer review: review is overseen by an independent third party.	i
(ii) Internal peer review: review by staff internal to the department of fish and wildlife.	ii
(iii) External peer review: review by persons that are external to and selected by the department of fish and wildlife.	iii
(iv) Open review: documented open public review process that is not limited to invited organizations or individuals.	iv
(v) Legal and policy document: documents related to the legal framework for the significant agency action including but not limited to: (A) federal and state statutes; (B) court and hearings board decisions; (C) federal and state administrative rules and regulations; and (D) policy and regulatory documents adopted by local governments.	v
(vi) Data from primary research, monitoring activities, or other sources, but that has not been incorporated as part of documents reviewed under the processes described in (c)(i), (ii), (iii), and (iv) of this subsection.	vi
(vii) Records of the best professional judgment of department of fish and wildlife employees or other individuals.	vii
(viii) Other: Sources of information that do not fit into one of the categories identified in this subsection (1)(c).	viii

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