Draft Periodic Status Review for the Gray Whale in Washington

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EXECUTIVE SUMMARY

The gray whale is a medium-sized baleen whale that feeds in shallow continental shelf waters and at offshore banks, where benthic (i.e., bottom-dwelling) invertebrate communities are concentrated. Gray whales are the only whale species known to feed extensively on benthic animals. They undertake the longest migration of any mammal, sometimes traveling more than 20,000 km round-trip annually in coastal waters.

Gray whales in the North Pacific are divided into two populations (or stocks) known as the Eastern North Pacific (ENP) and Western North Pacific (WNP) populations. Both populations were severely depleted prior to the mid-20th century by harvest during the whaling era. The ENP population migrates along the Pacific coast of North America between summer feeding grounds in the Bering, Beaufort and Chukchi Seas and wintering sites along western Baja California and the southern Gulf of California, where mating and calving occur. This stock has recovered from the impacts of whaling, and was estimated at about 26,960 whales in 2016, when it was believed to exist at or near carrying capacity. This population was federally delisted by the U.S. in 1994.

Within the ENP population, a small aggregation of about 243 individuals known as the Pacific Coast Feeding Group (PCFG) has been identified. These whales show regular fidelity during the summer and fall feeding season to waters along the coasts of northern California, Oregon, Washington, and Vancouver Island, British Columbia, and occasionally as far north as Kodiak Island, Alaska. Genetic testing indicates some differentiation from the greater ENP population, but PCFG whales likely interbreed with other ENP whales and the PCFG is still considered a feeding aggregation of the ENP population.

The WNP population, which is federally classified as endangered by the U.S., primarily feeds in summer in the Sea of Okhotsk (mainly near the northeastern coast of Sakhalin Island, Russia) and off the southeastern coast of the Kamchatka Peninsula in the Bering Sea. Although historic records indicate that WNP gray whales migrated through the coastal waters of Japan and the Korean Peninsula to presumed wintering grounds off the coast of China, contemporary records of gray whales off Asia are rare. Abundance, calculated in 2016 at roughly 271 to 311 individuals one year and older, remains far below pre-whaling numbers. Although genetically distinct from the ENP population, research since 2004 has detected some members of this population migrating to the Pacific coast of North America to feeding and wintering grounds traditionally used by the ENP population, and stock identity research is ongoing.

Gray whales face a number of known or potential threats such as entanglement in fishing gear and marine debris, ship strikes, human-generated marine sound, and climate change. These could adversely impact the WNP population because of its small size and precarious conservation status. The PCFG is also a concern due to its small size and the substantial level of uncertainty pertaining to its possible status as a separate stock under the Marine Mammal Protection Act.

Due to the presence of PCFG and WNP gray whales in Washington and the threats and uncertainties described in this report, it is recommended that this species be retained as a state sensitive species in Washington.

INTRODUCTION

This periodic status review summarizes the biology, population status, threats, and recent management actions directed at gray whales (*Eschrichtius robustus*) in Washington and elsewhere in the species' range. This review also assesses whether this species should retain its current sensitive status under state law or be reclassified. The Washington Department of Fish and Wildlife (WDFW) published a status report for the gray whale in 1997 (Richardson 1997). That report resulted in downlisting the gray whale from state endangered to state sensitive.

SPECIES BACKGROUND


Figure 1. Gray whale mother with calf (photo courtesy NOAA).

This species is a medium-sized baleen whale. Adult males reach 15 meters and weigh 16,600 kg. Adult females reach 15 m in length and may weigh as much as 34,000 kg when pregnant (Rice and Wolman 1971, Shirihai and Jarrett 2006). Adult gray whales are slate gray and are covered by gray/white patterns (Figure 1), allowing identification of individuals. This mottled coloring occurs naturally as the animal reaches adulthood and is further enhanced as a result of crustaceans ('whale lice', i.e. Cyamidae) and barnacles accumulating on the skin. Newborn calves average 5 meters in length and are born a dark gray color. They gradually attain the patchy gray pattern characteristic of adults. Gray whales lack a dorsal fin but have a series of 6 to 12 small humps along the dorsal ridge of the tail stock. Flippers are short and broad. When viewed from above, the head is V-shaped, with a two-nostril blowhole. Gray whales have only 2 to 5 throat pleats, distinguishing them from other baleen whale species. The baleen is white to yellow, and roughly 5 to 25 cm long (Leatherwood and Reeves 1983, Nowak 1991). During the era of commercial whaling, gray whales gained a reputation as aggressive fighters when attacked, earning the nickname "devilfish" (Scammon 1874).

Taxonomy, populations, and distribution. The gray whale is the sole living member of the family Eschrichtiidae and is the most primitive of extant baleen whale species (Rice and Wolman 1971, Sumich 2014, ITIS 2017, Kimura et al. 2018). It is descended from filter-feeding whales that appeared at the beginning of the Oligocene, over 3 million years ago. Gray whales once occurred in both the North Pacific and the North Atlantic, but the Atlantic population was extinct by the early 18th century (Rice 1998, Swartz 2014). Since 2010, there have been several unexpected sightings of individuals off Israel, Spain, and Namibia, and a pair in the Laptov Sea off Russia's Arctic coast (Scheinin et al. 2011, Shpak et al. 2013, Sumich 2014).

Historically, gray whales in the North Pacific were recognized as two geographically and genetically distinct populations (or stocks) known as the Eastern North Pacific (ENP) and Western North Pacific (WNP) populations (Figure 2; LeDuc et al. 2002, Lang et al. 2011, Weller et al. 2013a, 2013b, Carretta et al. 2019). The ENP population occurs in Washington and migrates along the Pacific coast of North America between summer feeding grounds in the Bering, Beaufort and Chukchi Seas and wintering sites along western Baja

California and the southern Gulf of California, where mating and calving occur in three primary lagoons (Rice and Wolman 1971, Ford 2014, Sumich 2014). Animals are occasionally sighted south of the Baja peninsula along Mexico's west-central coastline and near Isla Clarion (Sumich 2014).

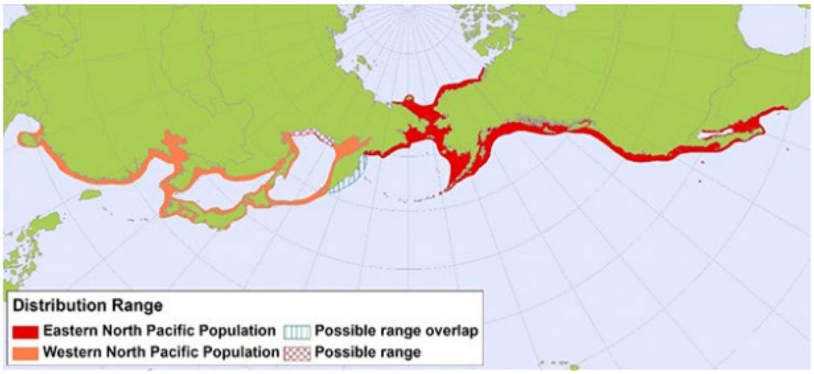

Figure 2. Hypotheses of gray whale population structure prior to recent information on movements across the Pacific (IUCN/IWC Conservation Management Plan).

Within the ENP population, a small group of gray whales known as the Pacific Coast Feeding Group (PCFG) shows regular fidelity during the feeding season to waters from northern California to northern Vancouver Island; they are also occasionally seen as far north as at least Kodiak Island, Alaska (Darling 1984, Gosho et al. 2011, Calambokidis et al. 2015, 2017, Ford 2014). PCFG members are defined as animals seen within this area in more than one year during the months of June through November between 41°N and 52°N, excluding sightings within the Salish Sea (IWC 2012, Carretta et al. 2019). In contrast to the main ENP stock, the PCFG does not rely on the dynamics of a sub-arctic ecosystem, and this uniqueness may provide important flexibility to the species as a whole. The PCFG is recognized as a distinct feeding group, but its status as separate from the ENP population remains unresolved (Weller et al. 2013b). Recent genetic data indicate that while some matrilineally driven structure exists between the PCFG and other ENP whales, PCFG whales likely interbreed with other ENP whales (Frasier et al. 2011, D'Intino et al. 2013, Lang et al. 2014, Lang et al. 2019). Calambokidis et al. (2015) identified nine survey regions within the PCFG summer range, six of which are located along the coasts of northern California, Oregon and Washington where PCFG whales are frequently observed. These include areas in Washington off the outer northwest coast and Strait of Juan de Fuca and another area off Grays Harbor.

Small numbers of gray whales visit the inland waters of the Salish Sea in Washington and British Columbia for 2 to 3 months, typically arriving from January to March and departing by the end of May (Calambokidis et al. 1991, 1992, 2015). These individuals belong to the main ENP population and are not considered part of the PCFG (IWC 2012). Most are males and some are annual visitors (J. Calambokidis, pers. comm.).

Within the WNP population, the primary summer feeding grounds for gray whales are located in the Sea of Okhotsk (mainly near the northeastern coast of Sakhalin Island, Russia) and off the southeastern coast of the Kamchatka Peninsula in the Bering Sea (Weller et al. 1999, 2002, 2013a, Vertyankin et al. 2004, Tyurneva et al. 2010, Burdin et al. 2013, Lowry et al. 2018). Although historic records indicate that WNP gray whales migrated through the coastal waters of Japan and the Korean Peninsula to presumed wintering grounds off the coast of China, contemporary records of gray whales off Asia are rare (Weller et al. 2002, 2013a). Most of these records, including sightings as recent as 2017, are from Japanese waters (Nambu et al. 2010, Nakamura et al. 2017). Only two records of gray whales in Chinese waters have been documented since the mid-1990s (Zhao 1997, Wang et al. 2015, Zhao et al. 2017), and gray whales have not been recorded in Korean waters since 1977 (Park 1995, Kim et al. 2013).

Genetic comparisons of the whales feeding off Sakhalin Island with whales considered part of the ENP population revealed significant genetic differences, although a limited degree of genetic exchange between these populations may take place (Lang et al. 2010, 2011). To date, 27 gray whales, including both males and females, known to feed in the WNP have been detected on ENP migratory routes and wintering grounds (Lang 2010, Mate et al. 2011, 2015, Weller et al. 2012, Urbán et al. 2013). However, other whales known to feed off Sakhalin Island have been recorded in Japanese waters during months when they would presumably be migrating (Weller et al. 2008, 2016), suggesting that not all gray whales in the WNP population share a common wintering ground (Weller et al. 2012). These data call into question whether the gray whales that currently feed in the WNP are surviving members from a population previously thought to be extinct (Bowen 1974) or are whales born in the ENP that have expanded their feeding range (Mate et al. 2015). Currently most authorities consider the two populations as distinct (Lang et al. 2010, 2011, Weller et al. 2013b, Mate et al. 2015) and the National Marine Fisheries Service (NMFS) classifies them as separate stocks under the Marine Mammal Protection Act (MMPA; Carretta et al. 2019), but further research on gray whale population structure in the North Pacific is required.

NATURAL HISTORY

Habitat requirements. Gray whales feed in shallow continental shelf waters and at offshore banks in the sub-Arctic and Arctic, where benthic (i.e., bottom-dwelling) invertebrate communities are concentrated (Rice and Wolman 1971, Nerini 1984, Brower et al. 2016). Abundance of prey is a strong factor influencing summer distribution and habitat use of the whales (Brower et al. 2016). Gray whales are unique from other baleen whales in that they migrate mainly through coastal and shallow shelf waters, although deeper oceanic waters are sometimes crossed (Weller et al. 2002, Sumich 2014, Mate et al. 2015). Both summering and migrating whales are often observed foraging or resting in forests of bull kelp (*Nereocystis luetkeana*) and other giant kelp (*Macrocystis* spp.) in waters 5 to 15 m deep and are also commonly seen near offshore rocks (Ford 2014, Sumich 2014, Scordino et al. 2017). Mating and calving occur in shallow lagoons and bays that provide warm, protected waters (Rice and Wolman 1971, Rice et al. 1981, Ford 2014, Sumich 2014).

Foraging and diet. All or nearly all feeding occurs during the summer and fall (Akmajian et al. 2012, Swartz 2014). Gray whales have the heaviest baleen of all the baleen whales, and they are the only whale species known to feed extensively on benthic animals (Rice and Wolman 1971, Ford 2014). They typically forage on mud, sand, silt or gravel bottoms at depths from the tidal zone to less than 50 m (Rice and Wolman 1971, Darling et al. 1998, Nelson et al. 2008, Brower et al. 2016). Gray whales feed by rolling on their side, swimming slowly forward while sucking sediment into the side of their mouth and filtering out prey through their baleen by pushing out water and mud with their powerful tongues. As they swim, they dislodge streams of sediment called mud plumes. This method of feeding produces shallow feeding pits in the ocean floor up to 3 m long and 1.5 m wide that can be seen from aerial photos (Ford 2014, Sumich 2014, Brower et al. 2016). Skim feeding for free-swimming prey at or near the surface is also practiced.

Ninety genera of prey have been found in the stomachs of gray whales (Nerini 1984). Favored prey are typically infaunal benthic species found at densities of 100 to 30,000/m^3, and up to 440,000/m^3 depending on species (Feyrer and Duffus 2011, Ford 2014, Sumich 2014). Gray whales feed on a variety of amphipods, as well as mysids (small shrimp-like crustaceans), mollusks, bivalves, polychaete worms, shrimp, krill and hydroids (Nerini 1984, Darling et al. 1998, Nelson et al. 2008, Brower et al. 2016). They are also known to feed on herring eggs and larvae (Darling et al. 1998, Ford 2014). Gray whales have been found to consume 250 to 1,100 kg of prey every day, depending on their age and size (Feyrer and Duffus 2011). Fasting whales lose 11 to 29 percent of their body weight during migration and the winter (Rice and Wolman 1971).

In Washington, PCFG whales prey mostly upon mysids and cumaceans (small shrimp-like crustaceans) during periods of intense coastal upwelling from early summer to late fall (Brodeur and Ware 1992, Hickey and Banas 2003, Marchetti et al. 2004, Scordino et al. 2013, 2017). Two favored locations for prey in Washington are the coast of northwest Washington and the Grays Harbor area (Calambokidis et al. 2015). In the Salish Sea, gray whales have been observed foraging on ghost shrimp (*Callianassa californiensis*) on sand flats near the shore off Whidbey and Camano Islands (Weitkamp et al. 1992, Calambokidis et al. 2015).

Movements. Gray whales undertake the longest migration of any mammal, with most ENP whales traveling 15,000 to 20,000 km round-trip (Rice and Wolman 1971, Ford 2014, Sumich 2014). The longest recorded round-trip was made by a WNP female that migrated 22,511 km to Mexico before returning to Sakhalin Island the next spring (Figure 3; Mate et al. 2015). ENP and some WNP whales begin to leave their summer feeding grounds in October and start arriving at their Mexican breeding sites in December (Rice and Wolman 1971, Rice et al. 1981, Rugh et al. 2001). Southward migration is concentrated in December and January. Swimming around the clock, animals on their southbound migration swim at 7 to 9 km per hour and cover 144 to 185 km per day (Ford 2014). Northward migration extends from late January to July, with a peak in April to July (Calambokidis et al. 2015). At this time of year, the whales move steadily at 4 to 5 km per hour, or 88 and 127 km per day. Most ENP gray whales migrate within 10 km of shore, with northbound travel being closer to land (Calambokidis et al. 2015). Migrating animals pass through Washington waters mainly during November and December and again from March through May (Rice and Wolman 1971, Ford 2014). Migration occurs somewhat farther offshore in Washington than in Oregon (Green et al. 1995). Some whales enter Willapa Bay, Grays Harbor, the Strait of Juan de Fuca, and Puget Sound during migration. Females, especially those who are pregnant, generally migrate south earlier than males, and those with calves remain longer in breeding/birthing areas before starting northward in March (Rice and Wolman 1971, Sumich 2014). Northbound females with calves remain close to the coastline, navigating through particularly shallow waters and kelp beds to avoid killer whale (*Orcinus orca*) attacks (Rice and Wolman 1971, Sumich 2014). The primary lagoons used by wintering ENP and suspected WNP gray whales are Laguna

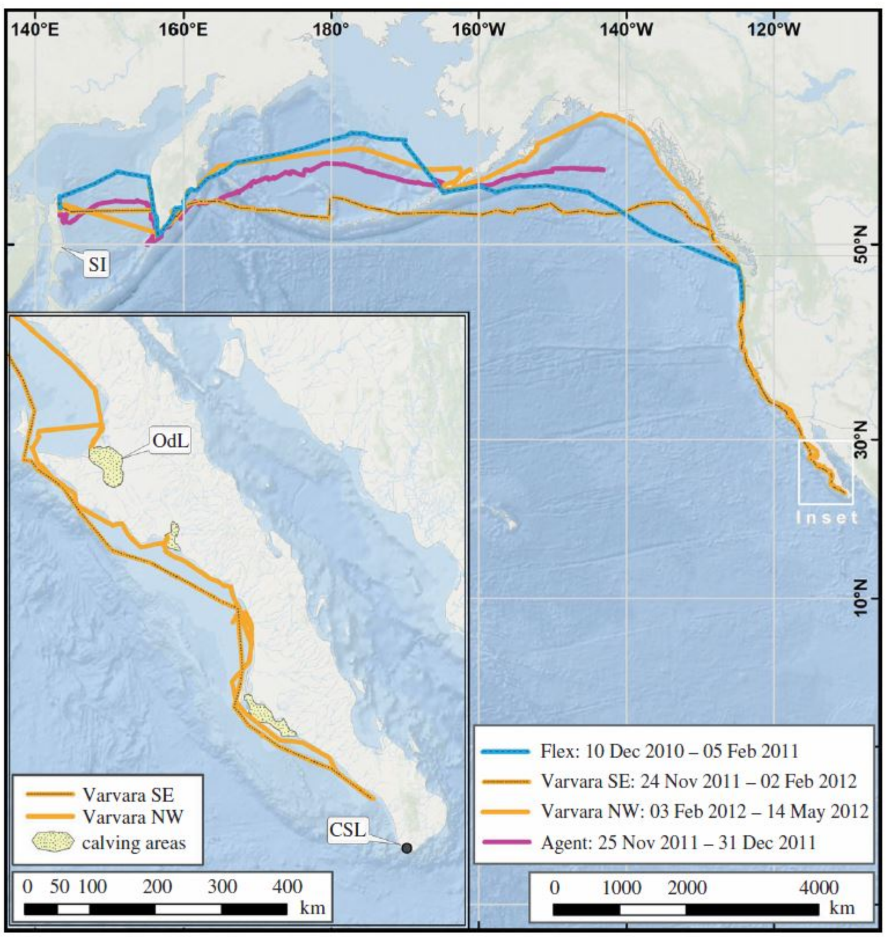

Figure 3. Routes of 3 WNP whales migrating from Sakhalin Island, Russia, to the eastern North Pacific. The legend depicts departure and arrival/end dates (Mate et al. 2015).

Ojo de Liebre (Scammon's Lagoon), Laguna San Ignacio, and the Bahia Magdalena complex (Rice and Wolman 1971, Jones 1990, Sumich 2014). Although not well documented, most WNP gray whales are believed to migrate south to winter breeding grounds off Japan, Korea and China (Andrews 1914, Weller et al. 2002, 2008). However, some individuals (possibly 37 percent or more of the WNP population; Cooke 2015) migrate to the west coast of North America, which requires a 22,000 km roundtrip to and from Mexico (Mate et al. 2011, 2015, Weller et al. 2012, Urbán et al. 2013). These movements coincide with the annual migration of ENP whales and bring WNP animals through Washington's waters (see **Distribution**).

Social organization. Gray whales are usually solitary or occur in small groups of two or three (Ford 2014). Larger aggregations of as many as 400 individuals may gather at concentrated food sources, but aside from mother-calf pairs, social bonds are not apparent (Shirihai and Jarrett 2006, Ford 2014, Sumich 2014). Calves leave their mothers upon weaning at 7 to 9 months of age (Swartz 2014).

Reproduction. Mating activity occurs between November and January during the southward migration and at the winter breeding and calving grounds (Ford 2014, Sumich 2014), and involves multiple males competing for females. Sexual maturity occurs between 5 and 11 years of age, with an average of 8 years (Rice and Wolman 1971, Rice et al. 1981, Ford 2014). After roughly 13 months of gestation, females give birth to a single calf, which nurses for 6 to 9 months on milk with a particularly high fat content of 53 percent (Rice et al. 1981, Ford 2014). Pregnant females are dependent on their summer fat reserves and do not feed between foraging seasons. Thus, they must rely on their fat stores from the previous summer to provide nourishment to their offspring. During years of limited prey availability, females may reproduce at a slower rate (Rice and Wolman 1971). Gray whale mothers often hold newborn calves to the surface to help them breathe and are fiercely protective of their young, particularly against predators such as killer whales and human whalers (Sumich 2014). Calves are born roughly every 2 years between December and February; however, some may be born during the southward migration (Rice and Wolman 1971). About 5 percent of the total ENP population is comprised of calves (Perryman et al. 2017).

Mortality. Mortality rates are highest for young animals, with an average first-year survival rate of about 71 percent (Punt and Wade 2012). About 75 percent of first-year mortalities occur during the first 2 weeks after birth. Mortality records for the ENP indicate that calves represent about 91 percent of deaths at winter breeding and calving grounds, followed by yearlings (0 to 19.5 percent) and adults (0 to 5 percent) (Jones and Swartz 1984). Annual adult mortality is estimated to be between 0.1 and 5 percent per year (Punt and Butterworth 2002, Wade 2002). Information on the lifespan of gray whales is limited, but estimates range from 25 to 80 years (Rice and Wolman 1971, COSEWIC 2004, Ford 2014).

Killer whales and humans are the only known predators of gray whales. Killer whales have been observed attacking individual gray whales both during migration and on feeding grounds (Goley and Straley 1994, George and Suydam 1998), and are a significant cause of calf mortality (Barrett-Lennard et al. 2011).

In 1999 and 2000, the ENP population suffered a major population decline, termed an "unusual mortality event", or UME. Gray whale strandings along the west coast of North America increased to approximately seven times the annual mean for 1995-1998, with 283 reported in 1999 and 368 reported in 2000 (LeBoeuf et al. 2000, Moore et al. 2001, Gulland et al. 2005). Most strandings occurred along the Mexican coast, but increased strandings were noted in all areas north to Alaska. An unusual aspect of this mortality event was that most mortalities were adults and juveniles rather than calves; as a consequence of the UME, calf production was unusually low for 1999 through 2001. The emaciated condition of many whales in 1999 and 2000 suggested that starvation caused most deaths, resulting from either a decreased availability of prey

(Moore et al. 2003) or a disease interfering with foraging. Ultimately, the cause of this UME was undetermined (LeBoeuf et al. 2000, Moore et al. 2001, Gulland et al. 2005; see **Population Status**.)

In June 2019, the National Oceanic and Atmospheric Administration (NOAA) declared another UME for the ENP population, spurred by another sharp rise in strandings along the west coast of North America. During 2019, there were 123 strandings along the U.S. coast (including 34 in Washington), 81 strandings in Mexico, and 11 strandings in Canada (NOAA Fisheries 2019). Although lower than in the 1999-2000 UME, these mortalities provide a stark contrast to the average annual number of strandings from 2001 to 2018. Conditions of the 2019 UME are similar to those of the earlier event, with some stranded whales showing evidence of starvation and lower calf production in Mexico. In 2019, 23.6% of live adult and juvenile whales in two Mexican breeding locations showed signs of emaciation, compared to 4.9% to 7.6% during 2008-2011 (Swartz et al. 2019). Mother-and-calf pairs in 2019 numbered about 28 in Bahia Magdalena and Laguna San Ignacio, contrasting with the 75 to 100 pairs found in these areas in most years (Swartz et al. 2019). Together, these observations suggest that ENP gray whales have recently experienced poor summer feeding conditions in the North Pacific and Arctic or may be suffering from the effects of a combination of environmental factors including disease (Swartz et al. 2019).

Stranding records for gray whales in Washington stand at 265 from 1980 through September 5, 2019 (K. Wilkinson pers. comm. 2019). Of these, by far the largest number of records per year occurred during the UMEs in 1999 (28 strandings), 2000 (23 strandings), and 2019 (34 strandings as of early September).

POPULATION STATUS AND TRENDS

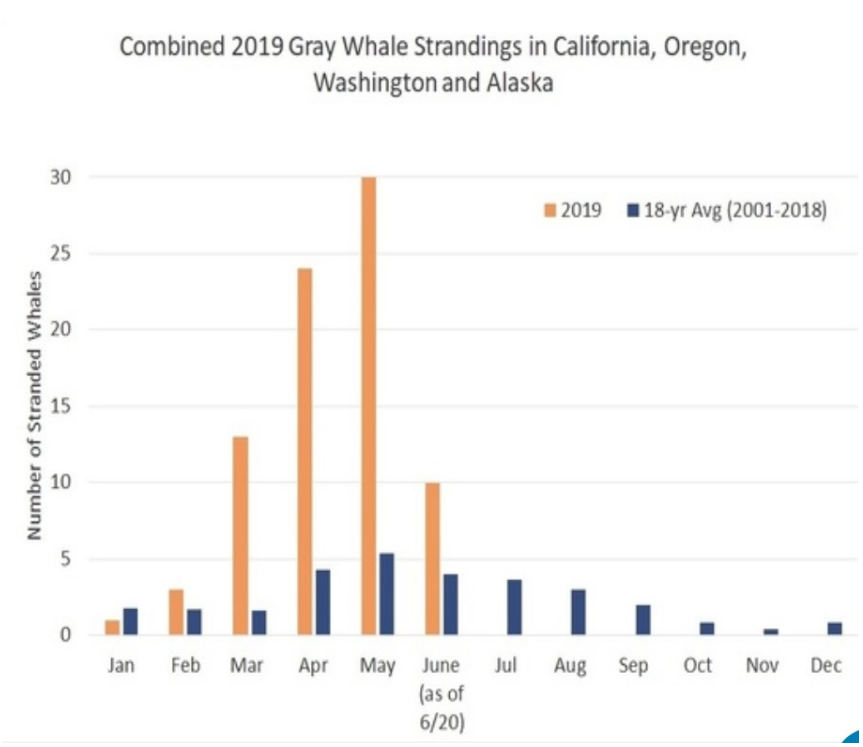

Figure 4. Combined 2019 gray whale strandings in California, Oregon, Washington and Alaska.

ENP population. This population declined from an estimated 12,000 to 24,000 animals before whaling (Ford 2014) to perhaps just a few thousand animals by the 1930s following intense commercial harvest (see **Commercial and Subsistence Harvest**). Genetic research by Alter et al. (2012) suggests a much larger pre-whaling population of 76,000 to 118,000 whales, but this estimate is not supported by historical harvest records nor the North American west coast's probable carrying capacity for the population in recent decades (Reeves et al. 2010).

Counts made at Granite Canyon south of Carmel, California, since 1967 have produced rigorous estimates of population size. These indicate that numbers grew from about 10,000 to 13,000 whales between 1967 and 1972 (Reilly et al.

1983) to about 25,000 whales in the mid-1980s, then stabilized at about 20,000 whales through most of the 1990s (Figure 4). Large numbers of animals died during the UME in 1999 and 2000 (see **Mortality**), which caused the size of the stock to decline to about 15,000 to 16,000 whales (Laake et al. 2012, Punt and Wade 2012). However, numbers began to recover immediately and stood at an estimated 20,990 (95% probability that the number of whales was between 19,230 and 22,900) whales in 2011 (Durban et al. 2013). Numbers further grew to a population estimate of 26,960 animals (95% probability that the number of whales was between 24,420 and 29,830) in 2016 (Durban et al. 2017). Population size has undoubtedly declined during the 2019 UME, but the extent of the decline has not yet been determined.

The ENP population is thought to have existed at or near carrying capacity during most years since the mid-1980s (Moore et al. 2001, Punt and Wade 2012, Carretta et al. 2019). The increase in numbers from 2011 to 2016 may be due to improved feeding conditions caused by warming Arctic waters that have resulted in higher primary productivity and expansion of ice-free habitat, which has been linked to increases in calf production in the ENP population (Perryman et al. 2002, Arrigo and Dijken 2015, Moore 2016, Durban et al. 2017).

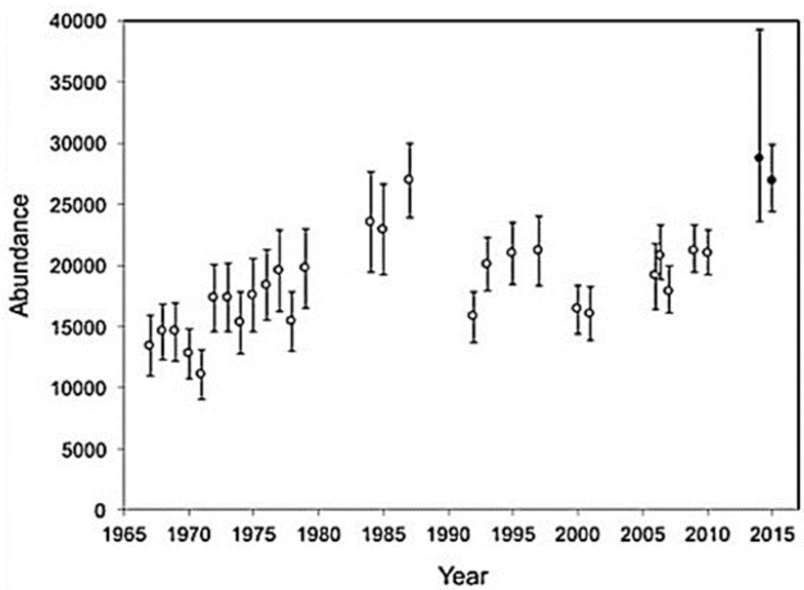

Figure 5. Abundance estimates for ENP gray whale population based on counts of whales during southbound migration off central California between 1967 and 2011 (open circles, with 95% confidence intervals) and in 2015 and 2016 (closed circles, with 95% confidence intervals) (from Durban et al. 2017).

The pre- and post-whaling sizes of the PCFG are unknown, but the subgroup has always been small since its discovery off British Columbia in the 1970s (Hatler and Darling 1974, Darling 1984, Calambokidis et al. 1994). The most recent analyses indicate that the subgroup increased rapidly from 126 (SE = 11.0) in 1998 to 216 (SE = 16.6) individuals in 2004 (Calambokidis et al. 2017). Numbers remained fairly stable between about 192 and 217 whales through 2012 but increased to an estimated 243 (SE = 18.9) whales in 2015 (Calambokidis et al. 2017).

WNP population. The pre-whaling size of this population has been estimated at between 1,500 and 10,000 individuals (Yablokov and Bokoslovskaya 1984). Extensive commercial harvest greatly depleted the stock by the 1930s, with some authors considering it extinct by this time (Bowen 1974, Berzin and Vladimirov 1981, Weller et al. 2002). Hunting continued at low levels until at least 1966 and likely further endangered the stock (Brownell and Chun 1977). Sightings in the 1980s and 1990s confirmed the continued presence of the population, but no reliable estimates of numbers were made during this period (Weller et al. 2002). The 2016 non-calf population was estimated at 271 to 311 individuals, with much of the population (175 to 192 whales) feeding off Sakhalin (Cooke et al. 2018). From 2005 to 2016, the population increased at an estimated rate of 2 to 5 percent per year (Cooke et al. 2017).

FACTORS AFFECTING CONTINUED EXISTENCE

Adequacy of existing regulatory mechanisms. Gray 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, subject to certain exceptions, prohibits 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 authorizes take under a variety of circumstances, including Alaska tribal subsistence harvest and incidental take during commercial fishing operations and some other circumstances. Under the MMPA, the WNP stock is considered "depleted" and is treated as a "strategic stock" by virtue of its listing under the Endangered Species Act (ESA); the ENP stock does not carry similar designations. Although PCFG gray whales are considered a distinct feeding group, they currently do not have formal status under the MMPA (Carretta et al. 2019). 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. The ENP population was delisted in 1994 (USFWS and NMFS 1994), but the WNP population remains listed as endangered under the ESA. Federal endangered status includes prohibitions on take of listed species similar to those under the MMPA. NMFS has not designated critical habitat for gray whales.

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

Under Washington state law (WAC 220-610-010), gray whales were listed as endangered in 1981, then downlisted to sensitive status in 1997. A sensitive classification prohibits the intentional taking, harassment, or possession of the species (RCW 77.15.130). Gray 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 ENP population of gray whales as being of special concern, but the WNP population is not listed under this law. The species is on the British Columbia Blue List, meaning that it is especially sensitive to natural events or various human impacts. Mexico initiated protections for different lagoons used by gray whales beginning in the 1970s, then declared its territorial seas and Economic Exclusion Zone as a refuge for all species of large whales in 2002. Russia, Japan, South Korea, and China also offer different levels of protection for the species in their territorial seas (Swartz 2014).

Protection from commercial harvest was extended to gray whales under the International Convention for the Regulation of Whaling in 1946 (implemented in the U.S. via the Whaling Convention Act [WCA]). The International Union for the Conservation of Nature (IUCN) categorizes the entire gray whale species as Least Concern, but considers the WNP population as Critically Endangered. Gray whales are also listed on 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 (Roman and Palumbi 2003, Rocha et al. 2014). Commercial exploitation of the ENP population began after the discovery of its winter breeding and calving grounds in

Baja California, Mexico, in 1845-1846. Harvest intensified in the ensuing years and expanded northward to California and beyond, with an estimated 6,100 to 8,300 animals taken by 1874 (Reeves et al. 2010, Punt and Wade 2012). Concentrations of females with calves were particularly vulnerable during these years, which reduced the reproductive capacity of the population. Harvests fell substantially by the mid-1870s and the stock was considered commercially extinct by 1900. Harvest increased again in the 1920s with the advent of modern factory-ship whaling, resulting in more than 1,000 additional whales being killed by 1946 (Reeves et al. 2010, Punt and Wade 2012). Some additional harvest occurred from the late 1940s to 1970s for research and from illegal Soviet whaling (Wolman 1985, Ivashchenko et al. 2013). Harvest was minimal during the shore-whaling era off Washington (1911-1925) and British Columbia (1908-1967), with perhaps just a single gray whale caught by whalers from Bay City, Washington, and about a dozen taken off British Columbia (Scheffer and Slipp 1948, Pike and MacAskie 1969). These small harvests were likely caused by a combination of factors, including the stock's reduced size, the species' lower desirability to whalers and its use of nearshore waters, and because the migration did not strongly overlap with the main whaling season (Scheffer and Slipp 1948).

Commercial hunting of the WNP population from the 1500s until 1966 nearly eliminated this population (Kato and Kasuya 2002, Weller et al. 2002). Although not well documented, commercial whaling may have played a role in the extirpation of gray whales from the North Atlantic by the early 1700s (Swartz 2014).

Gray whales have been hunted for subsistence purposes by coastal native peoples of western North American and Siberia for thousands of years (Jones and Swartz 2002, Ford 2014). Gray whales and humpback whales (*Megaptera novaeangliae*) constituted major food items for the Makah Tribe along Washington's northwest coast for at least 1,500 years, as indicated by oral and written accounts and archaeological evidence (Swan 1870, Scheffer and Slipp 1948, Huelsbeck 1988, 1994). The number of gray whales historically harvested by Native Americans in Washington is not well documented, but some reports suggest it could have been substantial (Collins 1996, Webb 2011). Subsistence hunting of the ENP population continues to the present, primarily by Chukotka Natives in northeastern Russia who have harvested approximately 125 whales per year since 1998 (IWC 2018). The current IWC Schedule for ENP gray whales establishes a 7-year catch limit of 980 whales for 2019 through 2025 (including an annual maximum of 140 whales) for the Russian Federation and the U.S. (Carretta et al. 2019); a bilateral agreement between the two countries allocates up to 135 whales per year to the Chukotka Natives and up to 5 whales per year to the Makah Tribe. This level of harvest is considered sustainable (IWC 2013). Two gray whales have been killed by Makah hunters in recent years, one during an authorized hunt in 1999 and one during an unauthorized hunt in 2007. In 2005 the Makah Tribe submitted a request to NMFS for authorization under the MMPA to resume treaty-based hunting of ENP gray whales, which received extensive NMFS review (NMFS 2015). In April 2019, NMFS published a proposed rule to allow the Makah to hunt one to three whales per year over a 10-year period, with measures included to reduce the likelihood of taking WNP and PCFG whales (NMFS 2019). In February 2020, NOAA Fisheries published a notice of intent to prepare a supplement to the Supplemental Draft Environmental Impact Statement (DEIS) issued on March 30, 2015. Upon release, NMFS will provide a 45-day public review/comment period.

Entanglement in fishing gear and marine debris. A growing concern to whale populations is the level of threat posed by entanglement in active drifting or stationary fishing gear (such as gillnets and vertical lines used to mark trap/pot fisheries) or in discarded netting and other marine debris (IWC 2010, Williams et al. 2011b, Reeves et al. 2013). 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. More entanglements occur in coastal and continental shelf waters than in waters farther offshore (Saez et al. 2013). In some whale populations, roughly half or more of all individuals show scarring from past entanglements (Neilson et al. 2009, Weller et al. 2009).

Gray whales are especially vulnerable to entanglement because of their use of nearshore coastal waters, where fishing activity is often highest. From 1982 to 2018, gray whales were the most frequently entangled whale species along California, Oregon, and Washington, averaging 6.9 entanglement reports per year (NMFS, unpublished data), although actual numbers of entanglements are likely much higher than indicated by these reports. Eighty-one percent of entanglement reports are received from January to May (NMFS, unpublished data), which coincides with the species' migration (Saez et al. 2013). The vast majority are documented off California, but this is due in part to California's larger number of observers on the water and longer coastline than in Washington and Oregon (Saez et al. 2013, Carretta et al. 2017, NOAA Fisheries 2019). Most gray whale entanglements involve trap/pot gear, especially from commercial Dungeness crab fisheries (Saez et al. 2013, NOAA Fisheries 2017). Entanglements have involved a few PCFG whales (Carretta et al. 2017).

In Washington, 25 of the 51 large whale entanglements reported since 1990 have involved gray whales. Incident reports have increased since 2000, and more incidents have occurred along the outer coast than in the Salish Sea (Table 1).

Available evidence suggests that entanglements of WNP gray whales off eastern Asia may be an important limiting factor on this population (Weller et al. 2008, 2014, Bradford et al. 2009, Carretta et al. 2017, Lowry et al. 2018) and could be slowing or preventing its recovery (Thomas et al. 2016). Extensive coastal net fisheries occur in parts of the stock's distribution (Weller et al. 2002).

Table 1. Numbers of gray whale entanglement reports 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	2010-2017
25	18	7	2	10	13

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 undoubtedly represent just a small fraction of the total number (Jensen and Silber 2004, Williams et al. 2011a).

Gray whales are one of the whale species most commonly struck by ships between California and Washington (Jensen and Silber 2004, Douglas et al. 2008, DeAngelis et al. 2011), whereas fewer collisions are known from Alaska (Neilson et al. 2012). Along Washington's outer coast, major shipping lanes converge from several directions into the mouths of the Strait of Juan de Fuca and Columbia River, and another follows a north-south route to California. Douglas et al. (2008) listed six gray whale strandings in Washington involving collisions from 1980 to 2006, and Carretta et al. (2017, 2018) reported 11 known deaths and eight injuries from vessel collisions across the full range of the ENP population from 2008 to 2016, including three possible members of the PCFG. The Salish Sea is also an area of heavy vessel traffic.

Extensive shipping traffic within portions of the range of WNP population means that ship strikes are a potentially important threat for these whales as well (Weller et al. 2002).

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), including along much of the North American west coast (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). Where sound-related impacts are severe, reproduction and survival of animals may be affected (Clark et al. 2009). Nevertheless, responses by whales can vary depending on localized circumstances, sometimes with no observable reactions recorded (Nowacek et al. 2007).

Throughout their range, gray whales face increasing sound levels associated with expanding vessel traffic, oil and gas exploration and development, wind farm construction, other coastal development, and military training (Ford 2014, Swartz 2014, Muir et al. 2016). Noise from these activities has been shown to cause avoidance behavior and changes in acoustic call characteristics of this species (Moore and Clarke 2002, Dahlheim and Castellote 2016).

The tremendous growth in whale watching in recent decades (O'Connor et al. 2009) has brought increasing concern over disturbance caused to cetaceans, which can result from the physical presence and sound of whale-watching vessels (Parsons 2012, Hoyt and Parsons 2014). Whale watchers frequently target gray whales on their Mexican breeding and calving grounds and during migration past California, but viewing pressure from Oregon to Alaska is generally limited to areas near a few ports with whale-watching companies (O'Connor et al. 2009). The small numbers of gray whales using the Salish Sea are regularly targeted, but much less so than killer whales, although viewing pressure may increase with the implementation of new regulations aimed at protecting southern resident killer whales. Vessel-based whale watching has been documented to cause changes in the species' swimming behavior (Heckel et al. 2001, Moore and Clarke 2002, Sullivan and Torres 2018), but overall the activity does not appear to be an important concern in the conservation of the species.

Climate change. Global climate change is likely to be one of the greatest threats to many species of marine mammals in the coming decades from alteration of marine ecosystems and food webs through changes in ocean temperatures, currents, stratification, and nutrient cycling, and increased frequency of unusual ocean conditions such as strong El Niño events (Doney et al. 2012). Climate change effects on oceans will probably occur unevenly, with some areas affected more severely than others. Declining summer sea ice and warming ocean temperatures may allow gray whales to expand their foraging range farther into the Arctic, but will also likely bring changes in prey abundance and availability and possibly increased competition for prey with other baleen whale species as they also expand northward (Brower et al. 2016, Moore 2016). However, the adaptable feeding strategies of gray whales may limit the negative impacts from these concerns (Swartz 2014). Reductions in sea ice are also expected to boost human activity in the Arctic (e.g., oil and gas exploration, shipping traffic, commercial fishing), resulting in increased ocean noise levels and a greater likelihood of oil spills, other forms of environmental degradation, and ship strikes (Clarke et al. 2013). Increased exposure to novel diseases throughout the species' range is an additional possible outcome of climate change (Simmonds and Eliott 2009). A concern related to climate change, increasing ocean acidification, is currently not considered an important future threat to marine mammals off western North America (Marshall et al. 2017).

Small population size. The small size of the WNP population imparts 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 the stock. The PCFG is also relatively small and could be affected in similar ways.

Environmental contaminants. Marine mammals are susceptible to a variety of environmental contaminants that bioaccumulate upward through marine food webs (O'Hara and O'Shea 2001, Buckman et al. 2011, Mongillo et al. 2016). These substances include organochlorines (e.g., polychlorinated biphenyls [PCBs], dioxins, dichloro-diphenyl trichloroethane [DDT] and its derivatives, and various other pesticides and herbicides), polybrominated diphenyl ethers (PBDEs), polycyclic aromatic hydrocarbons, trace metals (e.g., mercury, cadmium, copper), and other emerging pollutants(O'Shea 1999, O'Hara and O'Shea 2001). High contaminant levels can be harmful to the health of marine mammals, but baleen whales typically carry smaller pollutant loads than toothed whales because of their lower position in food chains. As with most other baleen whales, gray whales appear to possess relatively low toxicant loads that are beneath those associated with health disorders in other species (Wolman and Wilson 1970, Varanasi et al. 1994, Krahn et al. 2001, Tilbury et al. 2002). Contaminant concentrations can vary among individuals and may be higher in diseased or aged animals in poor nutritional health. Small numbers of gray whales harvested by Chukotka Natives in northeastern Russia are known as "stinky whales" and possess a medicinal odor to their tissues, making them inedible (NMFS 2015). This phenomenon remains under investigation but may possibly be caused by diet or exposure to hydrocarbons (NMFS 2015).

Oil spills. At the population level, marine oil spills are generally considered a relatively minor threat for large whales, with few if any harmful impacts reported in the literature. Nevertheless, 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.

As a shipping and oil-refining hub, Washington experienced seven major oil spills ranging from 0.1–2.3 million gallons along the outer coast, the Strait of Juan de Fuca, and the lower Columbia River between 1964 and 1991 (Neel et al. 2007). It is unknown whether any of these harmed gray 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., nearly 7,100 vessel transits in 2018; WSDOE 2019) makes oil spills a persistent threat in the state. Shipping routes for 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 gray 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). Spill risk in Washington's marine habitats is expected to increase 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 expansion of the TransMountain oil pipeline that terminates at Burnaby, BC.

Harmful algal blooms. Harmful algal blooms, also known as "red tides," result from rapid, temporary increases of phytoplankton. Two of the most common toxins produced by algal blooms along the west coast of North America are the neurotoxins domoic acid and saxitoxin, both of which can be toxic to marine mammals, especially pinnipeds (Torres de la Riva et al. 2009, Lewitus et al. 2012). Although few known cases of acute algal poisoning have been confirmed among gray and other large whales (Gulland et al. 2005, Fire et al. 2010, Lewitus et al. 2012), there have been increasing reports of both toxins being detected in whales and blooms coinciding with whale mortalities (Lefebvre et al. 2016, Wilson 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 gray whales.

MANAGEMENT ACTIVITIES

Management of whaling. International moratoriums on the commercial harvest of gray whales (in 1946) and all large whales (in 1986) were established by the IWC and remain in effect as a primary conservation tool. Subsistence harvest of gray whales by native peoples of the Russian Federation (Chukotkans) and the U.S. (Makah) is based on a joint request by the two countries and managed through a quota system established by the IWC for aboriginal whaling. That system relies on advice from an IWC scientific committee to establish a 6-year quota with annual catch limits. The Makah Tribe reserved the right to hunt gray whales at its usual and accustomed grounds under the Treaty of Neah Bay in 1855. A combination of factors (including the ENP population decline noted above) led to the suspension of Makah whaling in the 1920s. The Tribe resumed whaling in 1999 and 2000 but has not been authorized to hunt since 2004 due to court rulings requiring that the waiver and permit provisions of the MMPA be satisfied before NMFS can authorize a hunt. In 2005 the Tribe applied for authorization under the MMPA and WCA to harvest up to 20 ENP gray whales over a 5-year period, with no more than five taken per year and to target only whales migrating through the Tribe's usual and accustomed fishing grounds off the northwestern end of the Olympic Peninsula (NMFS 2015). Two main concerns with the proposed hunt include the possible impact on the PCFG as well as the possible taking of migrant individuals from the endangered WNP population. In 2015, NMFS released a revised draft environmental impact statement analyzing the Tribe's proposal and other alternatives (NMFS 2015) and continues to review the Tribe's request.

Species management and recovery planning. In addition to the WCA responsibilities noted above, NMFS manages both 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. 2019). NMFS also has ESA jurisdiction for WNP gray whales. A draft conservation plan for the WNP population was prepared under the auspices of the IWC and IUCN in 2010, with an update underway. The IUCN has also established a Western Gray Whale Advisory Panel to provide recommendations to a Russian energy company on steps needed to protect the stock in its summer feeding range (IUCN 2017).

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, WDFW, the Makah Tribe, 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 projects 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.

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. Existing laws (e.g., the MMPA) and whale-watching guidelines help keep vessels at reasonable distances from gray 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. 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). 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 2015b). 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 gray 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 (e.g., Cascadia Research Collective, the Makah Tribe) and eastern Asia help monitor the population size, trend, and distribution of gray whales keep stock assessments up to date (Carretta et al. 2019). NMFS also monitors gray whale injuries and mortalities from entanglements, ship strikes, and other causes (Carretta et al. 2017). Numerous research projects have been conducted in recent years or are underway. These include analyses of gray whale stock structure, genetics, life history, and ecology, as well as the impact and extent of different threats. The PCFG has been the focus of some of this research.

Stranding responses. NMFS coordinates responses to strandings of gray 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, WDFW, and other collaborators sample or necropsy many of these animals to determine cause of death, animal condition and health, emerging and re-emerging diseases, 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 greatly reduces the threat of spills associated with impaired vessels and barges 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). Use of single-hull tanker vessels and barges was phased out in the U.S. in January 2015 to reduce the risk of spills. Spill response planning, participation in oil spill drills, training of oil response volunteers, and outreach are ongoing. Measures to haze killer whales away from spills (NMFS 2012) could be extended to gray whales on a case-by-case basis (D. Noviello, pers. comm.). Improved regulations have been enacted in both the U.S. and Canada to minimize the risk of accidental spills.

CONCLUSIONS AND RECOMMENDATION

Both gray whale populations in the North Pacific became severely depleted prior to the mid-20th century by unregulated harvest during the commercial whaling era. Since that time, the ENP population has recovered and been at or near its carrying capacity for several decades, with abundance estimated at about 27,000 whales in 2016. Based on its improving status, this population was federally delisted in 1994, and the entire species was downlisted in Washington from state endangered to state sensitive in 1997. It has been maintained as a state sensitive species due to concerns about two other groups of gray whales that occur in Washington's waters. One of these is the PCFG, which is a subgroup of the ENP population and numbers approximately 250 individuals. This subgroup's summer and fall feeding range includes the area from northern California to northern British Columbia with whales occasionally sighted as far north as Kodiak Island, Alaska. The other group of concern is the WNP population, which totaled roughly 271 to 311 animals one year and older in 2016, and is classified as critically endangered by the IUCN. Recent research has shown that a portion of this population migrates into the eastern North Pacific and travels to winter breeding and calving sites off Mexico, and research on stock identity for this population is ongoing.

Throughout their range, gray whales face a number of known or potential threats such as entanglement in fishing gear and marine debris, ship strikes, human-generated marine sound, and climate change. These are most likely to adversely impact the WNP population because of its small size and precarious conservation status. The PCFG is also a concern due to its small size and the substantial level of uncertainty pertaining to its possible status as a separate stock under the MMPA.

Due to the presence of WNP and PCFG gray whales in Washington and the threats and uncertainties described in this report, it is recommended that this species be retained as a state sensitive species in Washington.

REFERENCES CITED

The references cited in the Periodic Status Review for the Gray Whale are categorized for their level of peer review pursuant to section 34.05.271 RCW, which is the codification of Substitute House Bill 2661 that passed the Washington Legislature in 2014. A key to the review categories under section 34.05.271 RCW is provided in Table A. References were categorized by the author in 2020.

Individual papers cited cover a number of topics discussed in the report, including information on: 1) the species' description, taxonomy, distribution and biology; 2) habitat requirements; 3) population status and trends; 4) conservation status and protections; 5) research, monitoring, and restoration activities; and 6) factors affecting the continued existence of the species.

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

Reference	Category
Akmajian, A.M., J. Scordino, P. Gearin, and M. Gosho. 2012. Analysis of the body condition of gray whales (Eschrichtius robustus) photographed in Northwest Washington, 2004-2010. Paper SC/65a/BRG21 presented to the International Whaling Commission Scientific Committee. [Available from http://www.iwcoffice.org/]	i
Alter, S. E., S. D. Newsome and S. R. Palumbi. 2012. Pre-whaling genetic diversity and population ecology in eastern Pacific gray whales: insights from ancient DNA and stable isotopes. PLOS One 7(5):e35039.	i
Andrew, R. K., B. M. Howe, and J. A. Mercer. 2011. Long-time trends in ship traffic noise for four sites off the North American west coast. Journal of the Acoustical Society of America 129:642–651.	i
Andrews, R.C. 1914. Monographs of the Pacific Cetacea. I. The California gray whale. Memoirs of the American Museum Nat. History. Vol 1, Part V.	i
Antonelis, K. 2014. Quinault Indian Nation and The Nature Conservancy efforts to address derelict crab pots on the Washington coast. Pages 19−21 in U.S. west coast large whale entanglement information sharing workshop report, November 13−14, 2013, Portland, Oregon. National Marine Fisheries Service, Portland, Oregon.	i
Arrigo, K. R. and G. L. Dijken. 2015. Continued increases in the Arctic Ocean primary production. Progress in Oceanography 136:60-70.	i
Barrett-Lennard, L. G., C. O. Matkin, J. W. Durban, E. L. Saulitis, D. and Ellifrit. 2011. Predation on gray whales and prolonged feeding on submerged carcasses by transient killer whales at Unimak Island, Alaska. Marine Ecology Progress Series. 421:229-241.	i
Berzin, A. A. and V. L. Vladimirov. 1981. Changes in the abundance of whalebone whales in the Pacific and the Antarctic since the cessation of their exploitation. Report to the International Whaling. Commission 31:495-9.	i
Bowen, S. L. 1974. Probable extinction of the Korean stock of the gray whale (Eschrichtius robustus). Journal of Mammalogy. 55(1):209-9.	i
Bradford, A. L., D. W. Weller, Y. V. Ivashchenko, A. M. Burdin, and R. L. Brownell, Jr. 2009. Anthropogenic scarring of western gray whales (*Eschrichtius robustus*). Marine Mammal Science. 25:161-175.	i
Brodeur, R. D. and D. M. Ware. 1992. Long-term variability in zooplankton biomass in the subarctic Pacific Ocean. Fisheries Oceanography 1:32-38. DOI: 10.1111/j.1365-2419. 1992.tb00023x	i
Brower, A. A., M. C. Ferguson, S. V. Schonberg, S. C. Jewett and J. T. Clarke. 2016. Gray whale distribution relative to benthic invertebrate biomass. Deep-Sea Research II. In press. www.elsevier.com/locate/dsr2.	i
Brownell, R. L. and C.-I. Chun. 1977. Probable existence of the Korean stock of the gray whale (Eschrichtius robustus). Journal of Mammalogy 58(2):237–239.	i
Buckland, S. T. and J. M. Breiwick. 2002. Estimated trends in abundance of eastern Pacific gray whales from shore counts (1967/68 to 1995/1996). Journal of Cetacean Research and Management 4:41-48.	i
Buckman, A. H., N. Veldhoen, G. Ellis, J. K. B. Ford, C. C. Helbing, and P. S. Ross. 2011. PCB-associated changes in mRNA expression in killer whales (Orcinus orca) from the NE Pacific Ocean. Environmental Science & Technology 45:10194−10202.	i
Burdin, A. M., O. A. Sychenko and M. M.; Sidorenko. 2013. Status of western gray whales off northeastern Sakhalin Island, Russia in 2012. Paper SC/65a/BRG3 presented to the International Whaling Commission Scientific Committee.	i
Calambokidis, J. 2011. Ship strikes of whales off the U.S. west coast. Spyhopper 2011(June):1−7.	i

Calambokidis, J. 2013. New developments dealing with ship strikes of whales off the U.S. west coast. Spyhopper 2013(June):1−5.	i
Calambokidis, J., J. D. Darling, V. Deecke, P. Gearin, M. Gosho, W. Megill, C. M. Tombach, D. Goley, C. Toropova and B. Gisborne. 2002. Abundance, range and movements of a feeding aggregation of gray whales (Eschrichtius robustus) from California to southeastern Alaska in 1998. Journal of Cetacean Resource Management 4(3):267-276.	i
Calambokidis, J., J. R. Evenson, T. Chandler and G. H. Steiger. 1992. Individual identification of gray whales in Puget Sound in 1991. Puget Sound Notes. No. 28. Puget Sound Water Quality Authority, Olympia, Washington. pp. 1-4.	i
Calambokidis, J., J. R. Evenson, G. H. Steiger, and S. J. Jeffries. 1994. Gray whales of Washington state: natural history and photographic catalog. Cascadia Research Collective, Olympia, Washington. Report to Washington Department of Fish and Wildlife, Olympia, Washington.	vi
Calambokidis, J., J. Laake, and A. Perez. 2017. Updated analysis of abundance and population structure of seasonal gray whales in the Pacific Northwest, 1996-2015. Report SC/A17/GW/05, International Whaling Commission, Impington, Cambridge, United Kingdom.	i
Calambokidis, J., G. H. Steiger, J. R. Evenson, J. C. Cubbage and R. W. Osborne. 1991. Gray whales in Puget Sound and the Strait of Juan de Fuca. Proceedings of Puget Sound Research '91, Seattle, Washington, January 4-5. Puget Sound Water Quality Authority, Olympia, Washington. pp. 414-422.	i
Calambokidis, J., G. H. Steiger, C. Curtice, J. Harrison, M. C. Ferguson, M. E. Becker, M. DeAngelis, and S. M. Van Parijs. 2015. Biologically important areas for selected cetaceans within U.S. waters – west coast region. Aquatic Mammals 41:39-53.	i
Carretta, J. V., S. M. Wilkin, M. M. Muto, and K. Wilkinson. 2013. Sources of human-related injury and mortality for U.S. Pacific west coast marine mammal stock assessments, 2007-2011. NOAA Technical Memorandum NMFS-SWFSC-514, Southwest Fisheries Science Center, La Jolla, California.	i
Carretta, J. V., M. M. Muto, J. Greenman, K. Wilkinson, D. Lawson, J. Viezbicke, and J. Jannot. 2017. Sources of human-related injury and mortality for U.S. Pacific west coast marine mammal stock assessments, 2011-2015. NOAA Technical Memorandum NMFS-SWFSC-579, Southwest Fisheries Science Center, La Jolla, California.	i
Carretta, J. V., V. Helker, M. M. Muto, J. Greenman, K. Wilkinson, D. Lawson, J. Viezbicke, and J. Jannot. 2018. Sources of human-related injury and mortality for U.S. Pacific west coast marine mammal stock assessments, 2012-2016. NOAA Technical Memorandum NMFS-SWFSC-601, Southwest Fisheries Science Center, La Jolla, California.	i
Carretta, J. V., K. A. Forney, E. M. Oleson, D. W. Weller, A. R. Lang, et al. 2019. U.S. Pacific marine mammal stock assessments: 2018. NOAA Technical Memorandum NMFS-SWFSC-617, Southwest Fisheries Science Center, La Jolla, California.	i
Castellote, M., C. W. Clark, and M. O. Lammers. 2012. Acoustic and behavioural changes by fin whales (Balaenoptera physalus) in response to shipping and airgun noise. Biological Conservation 147:115−122.	i
Clark, C. W., W. T. Ellison, B. L. Southall, L. Hatch, S. VanParijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implications. Marine Ecology Progress Series 395:201–222.	i
Clarke, J., K. Stafford, S. E. Moore, B. Rone, L. Aerts, and J. Crance. 2013. Subarctic cetaceans in the southern Chukchi Sea: evidence of recovery or response to a changing ecosystem. Oceanography 26:136–149.	i
Collins, C. C. 1996. Subsistence and survival: The Makah Indian Reservation, 1855-1933. The Pacific Northwest Quarterly, 87(4):180-193.	i

Cooke, J. G. 2015. Implications of observed whale movements on the relationship between the Sakhalin gray whale feeding aggregation and putative breeding stocks of the gray whale. Paper SC/A15/GW02 presented to the Second Workshop on the Rangewide Review of the Population Structure and Status of North Pacific Gray Whales, 1-3 April 2015, La Jolla, CA, USA [Available at: http://www.iwcoffice.org/].	i
Cooke, J. G., D. W. Weller, A. L. Bradford, O. Sychenko, A. M. Burdin, A. R. Lang and R. L. Brownell. 2017. Population assessment update for Sakhalin gray whales, with reference to stock identity. Paper SC/67A/NH11 presented to the Scientific Committee of the International Whaling Commission.	i
Cooke, J. G., B. L. Taylor, R. Reeves, and R. L. Brownell, Jr. 2018. Eschrichtius robustus (western subpopulation. IUCN Red List of Threatened Species 2018: e.T8099A50345475. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T8099A50345475.en	i
COSEWIC. 2004. COSEWIC assessment and update status report on the grey whale (Eastern North Pacific population) Eschrichtius robustus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 31 pp. (www.sararegistry.gc.ca/status/status_e.cfm).	
D'Intino A. M., J. D. Darling, R. J. Urban, and T. R. Frasier. 2013. Lack of nuclear differentiation suggests reproductive connectivity between the 'southern feeding group' and the larger population of eastern North Pacific gray whales, despite previous detection of mitochondrial differences. Journal of Cetacean Research & Management 13:97-104.	i
Dahlheim, M. and M. Castellote. 2016. Changes in the acoustic behavior of gray whales Eschrichtius robustus in response to noise. Endangered Species Research 31:227–242.	i
Darling, J. D. 1984. Gray whales off Vancouver Island, British Columbia. Pp. 267-287 in M. L. Jones, S. L. Swartz and S. Leatherwood (eds.). The gray whale, Eschrichtius robustus. Academic Press, Inc., Orlando, Florida. xxiv+600 pp.	i
Darling, J. D., K. E. Keogh and T. E. Stevens. 1998. Gray whale (Eschrichtius robustus) habitat utilization and prey species off Vancouver Island. B. C. Marine Mammal Science 14(4):692–720. http://dx.doi.org/10.1111/j.1748-7692.1998.tb00757.x.	i
DeAngelis, M., C. Fahy, and J. Cordaro. 2011. Reducing vessel strikes of large whales in California: report from a workshop held in Long Beach, California; May 19-20, 2010. National Marine Fisheries Service, Long Beach, California.i	i
Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, et al. 2012. Climate change impacts on marine ecosystems. Annual Review of Marine Science 4:11−37.	i
Douglas, A. B., J. Calambokidis, S. Raverty, S. J. Jeffries, D. M. Lambourn, and S. A. Norman. 2008. Incidence of ship strikes of large whales in Washington state. Journal of the Marine Biological Association of the United Kingdom 88:1121–1132.	i
Durban, J., D. Weller, A. Lang, and W. Perryman. 2013. Estimating gray whale abundance from shore-based counts using a multilevel Bayesian model. Report SC/65a/BRG02, International Whaling Commission, Impington, Cambridge, United Kingdom.	i
Durban, J. W., D. W. Weller, and W. L. Perryman. 2017. Gray whale abundance estimates from shore-based counts off California in 2014/15 and 2015/16. Report SC/A17/GW/06, International Whaling Commission, Impington, Cambridge, United Kingdom.	i
Erbe, C., C. Reichmuth, K. Cunningham, K. Lucke, and R. Dooling. 2016. Communication masking in marine mammals: a review and research strategy. Marine Pollution Bulletin 103:15−38.	i
Etkin, D. S. and J. Neel. 2001. Investing in spill prevention - has it reduced vessel spills and accidents in Washington state? Pages 47−56 in Proceedings of 2001 International Oil Spill Conference. American Petroleum Institute, Washington, D.C.	i

Feyrer, L. J. and D. A. Duffus. 2011. Predatory disturbance and prey species diversity: the case of gray whale (Eschrichtius robustus) foraging on a multi-species mysid (family Mysidae) community. Hydrobiologia 678(1):37-47.	i
Fire, S. E., Z. H. Wang, M. Berman, G. W. Langlois, S. L. Morton, E. Sekula-Wood, and C. R. Benitez-Nelson. 2010. Trophic transfer of the harmful algal toxin domoic acid as a cause of death in a minke whale (Balaenoptera acutorostrata) stranding in southern California. Aquatic Mammals 36:342–350.	i
Ford, J. K. B. 2014. Marine mammals of British Columbia. Royal BC Museum Handbook, Mammals of BC, Vol. 6. Royal BC Museum, Victoria, British Columbia.	i
Frasier, T. R., S. M. Koroscil, B. N. White and J. D. Darling. 2011. Assessment of population substructure in relation to summer feeding ground use in the eastern North Pacific gray whale. Endangered Species Research 14:39-48.	i
George, J.C. and Suydam, R., 1998. Observations of killer whale (Orcinus orca) predation in the northeastern Chukchi and western Beaufort Seas. Marine Mammal Science 14(2):330-332.	i
Geraci, J. R. 1990. Physiological and toxic effects on cetaceans. Pages 167–197 in J. R. Geraci and D. J. St. Aubin, editors. Sea mammals and oil: confronting the risks. Academic Press, New York, New York.	i
Goley, P. D. and Straley, J.M. 1994. Attack on gray whales (Eschrichtius robustus) in Monterey Bay, California, by killer whales (Orcinus orca) previously identified in Glacier Bay, Alaska. Canadian Journal of Zoology 72(8):1528-1530.	i
Gosho, M., P. Earin, R. Jenkinson, J. Laake, L. Mazzuca, D. Kubiak, J. Calambokidis, W. Megill, B. Gisborne, D. Goley, C. Tombach, J. Darling and V. Deeke. 2011. Movements and diet of gray whales (Eschrichtius robustus) off Kodiak Island, Alaska, 2002-2005. Paper SC/M11/AWMP2 presented to the International Whaling Commission AWMP workshop 28 March-1 April 2011.	i
Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and K. C. Balcomb, III. 1992. Cetacean distribution and abundance off Oregon and Washington. Pages 1-1 to 1-100 in J. J. Brueggeman, editor. Oregon and Washington marine mammal and seabird surveys. Pacific OCS Region, Minerals Management Service, U.S. Department of the Interior, Los Angeles, California.	i
Green, G. A., J. J. Brueggeman, R. A. Grotefendt, and C. E. Bowlby. 1995. Offshore distances of gray whales migrating along the Oregon and Washington coasts, 1990. Northwest Science 69:223-227.	i
Gulland, F. M. D., H. Pérez-Cortés M., J. Urbán R., L. Rojas-Bracho, G. Ylitalo, J. Weir, S. A. Norman, M. M. Muto, D. J. Rugh, C. Kreuder and T. Rowles. 2005. Eastern north Pacific gray whale (Eschrichtius robustus) unusual mortality event, 1999-2000. NOAA Technical Memorandum NMFS-AFSC-150, Alaska Fisheries Science Center. 33 pp.	i
Hatch, L. T., C. M. Wahle, J. Gedamke, J. Harrison, B. Laws, S. E. Moore, J. H. Stadler, and S. M. Van Parijs. 2016. Can you hear me here? Managing acoustic habitat in US waters. Endangered Species Research 30:171–186.	i
Hatler, D. F. and Darling, J. D. 1974. Recent observations of the gray whale in British Columbia. Canadian Field Naturalist 88:449-59.	i
Heckel, G., S. B. Reilly, J. L. Sumich, and I. Espejel. 2001. The influence of whalewatching on the behaviour of migrating gray whales (Eschrichtius robustus) in Todos Santos Bay and surrounding waters, Baja California, Mexico. Journal of Cetacean Research and Management 3:227–237.	i
Hickey, B. M. and N. S. Banas. 2003. Oceanography of the U.S. Pacific Northwest coastal ocean and estuaries with application to coastal ecology. Estuaries 26(4B):1010-1031.	i
Hildebrand, J. A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series 395:5–20.	i

Hoyt, E. and E. C. M. Parsons. 2014. The whale-watching industry: historical development. Pages 57–70 in J. Higham, L. Bejder, and R. Williams, editors. Whale-watching: sustainable tourism and ecological management. Cambridge University Press, Cambridge, United Kingdom.	i
Huelsbeck, D. R. 1988. Whaling in the precontact economy of the central Northwest coast. Arctic Anthropology 25:1–15.	i
Huelsbeck, D. R. 1994. The utilization of whales at Ozette. Pages 265–303 in S. R. Samuels, editor. Ozette archaeological project research reports, Volume II, fauna. Reports of Investigations 66, Department of Anthropology, Washington State University, Pullman, Washington, and National Park Service, Seattle, Washington.	i
IMO (International Maritime Organization). 2014. Marine Environmental Protection Committee annex: guidelines for the reduction of underwater noise from commercial shipping. MEPC Circular 66/17, International Maritime Organization, London, United Kingdom.	i
ITIS (Integrated Taxonomic Information System) on-line database, http://www.itis.gov. Retrieved August 8, 2017.	vi
IUCN (International Union for the Conservation of Nature). 2017. Western gray whale advisory panel. International Union for the Conservation of Nature, Gland, Switzerland. https://www.iucn.org/western-gray-whale-advisory-panel/panel Accessed on 8 September 2017.	i
Ivashchenko, Y. V., P. Clapham, and R. L. Brownell, Jr. 2013. Soviet catches of whales in the North Pacific: revised totals. Journal of Cetacean Research and Management 13:59–71.	i
IWC (International Whaling Commission). 2010. Report of the workshop on welfare issues associated with the entanglement of large whales. Report IWC/62/15, International Whaling Commission, Impington, Cambridge, United Kingdom.	i
IWC (International Whaling Commission). 2012. Report of the Scientific Committee. Journal of Cetacean Resource Management (Suppl.) 13.	i
IWC (International Whaling Commission). 2013. Report of the Scientific Committee. Journal of Cetacean Resource Management (Suppl.) 14.	i
IWC (International Whaling Commission). 2018. https:/IWC.int/table_aboriginal	vi
Jensen, A. S. and G. K. Silber. 2004. Large whale ship strike database. NOAA Technical Memorandum NMFS-OPR-25, National Marine Fisheries Service, Silver Spring, Maryland.	i
Jones, M. L. 1990. Reproductive cycle in gray whales based on photographic resightings of females on the breeding grounds from 1977 – 1982. Report to the International Whaling Commission (Special Issue 12): SC/A88/ID38.	i
Jones, M.L. and Swartz, S.L. 1984. Demography and phenology of gray whales and evaluation of whalewatching activities in Laguna San Ignacio, Baja California Sur, Mexico. pp. 309-374 in M. L. Jones, S. L. Swartz and S. Leatherwood (eds.) The Gray Whale, Academic Press, London, UK.	i
Jones, M. L. and S. L. Swartz. 2002. Gray whale Eschrichtius robustus. Pages 524-536 in W. F. Perrin, B. Wursig, and J. G. M. Thewissen, editors. Encyclopedia of marine mammals. Academic Press, San Diego, California.	i
Kato, H. and T. Kasuya. 2002. Some analyses on the modern whaling catch history of the western North Pacific stock of gray whales (Eschrichtius robustus). Journal of Cetacean Research and Management 4:277–282.	i
Kellar N. M., T. R. Speakman, C. R. Smith, S. M. Lane, B. C. Balmer, et al. 2017. Low reproductive success rates of common bottlenose dolphins Tursiops truncatus in the northern Gulf of Mexico following the Deepwater Horizon disaster (2010−2015). Endangered Species Research 33:143−158.	i

Kim H. W., H. Sohn, N. An. Yong-Rock, K. J. Park, D. N. Kim, and D. H. An. 2013. Report of gray whale sighting survey off Korean waters from 2003 to 2011. Paper SC/65a/BRG26 presented to the International Whaling Commission Scientific Committee. 7 pp.	i
Kimura, T., Hasegawa, Y. and Kohno, N., 2018. A New Species of the Genus Eschrichtius (Cetacea: Mysticeti) from the Early Pleistocene of Japan. Paleontological Research, 22(1):1-19.	i
Krahn, M. M., G. M. Ylitalo, D. G. Burrows, J. Calambokidis, S. E. Moore, et al. 2001. Organochlorine contaminant concentrations and lipid profiles in eastern North Pacific gray whales (Eschrichtius robustus). Journal of Cetacean Research and Management 3:19–29.	i
Kraus, S. D., M. W. Brown, H. Caswell, C. W. Clark, M. Fujiwara, et al. 2005. North Atlantic right whales in crisis. Science 309:561–562.	i
Laake, J. L., A. E. Punt, R. Hobbs, M. Ferguson, D. Rugh, and J. Breiwick. 2012. Gray whale southbound migration surveys 1967-2006: an integrated re-analysis. Journal of Cetacean Research and Management 12:287-306.	i
Laist, D. W., A. M. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science 17:35–75.	i
Lang, A. R. 2010. The population genetics of gray whales (Eschrichtius robustus) in the North Pacific. Ph.D. dissertation. University of California, San Diego, California. 222 pp.	i
Lang, A.R., B. L. Taylor, J. C. Calambokidis, V. L. Pease, A. Klimek, J. Scordino, K. M. Robertson, D. Litovka, V. Burkanov, P. Gearin, J. C. George, and B. Mate. 2019. Assessment of stock structure among gray whales utilizing feeding grounds in the Eastern North Pacific. Paper SC/M11/AWMP4 presented to the International Whaling Commission Scientific Committee. [Available from http://www.iwcoffice.org/]	i
Lang A. R., D. W. Weller, R. G. Leduc, A. M. Burdin, and R. L. Brownell Jr. 2010. Genetic differentiation between western and eastern (Eschrichtius robustus) gray whale populations using microsatellite markers. Paper SC/62/BRG11 presented to the International Whaling Commission's Scientific Committee. 18 pp.	i
Lang, A. R., D. W. Weller, R., LeDuc, A. M. Burdin, V. L. Pease, D. Litovka, V. Burkanov and R. L. Brownell Jr. 2011. Genetic analysis of stock structure and movements of gray whales in the eastern and western North Pacific. Paper SC/63/BRG10 presented to the IWC Scientific Committee.	i
Lang, A. R., J. Calambokidis, J. Scordino, V. L. Pease, A. Klimek, V. N. Burkanov, P. Gearin, D. I. Litovka, K. M. Robertson, B. R. Mate, J. K. Jacobsen, and B. L Taylor. 2014. Assessment of genetic structure among eastern North Pacific gray whales on their feeding grounds. Marine Mammal Science 30(4): 1473-1493.	i
LeBoeuf, B. J., H. Pérez-Cortés M., J. Urbán R., B. R. Mate and F. Ollervides U. 2000. High gray whale mortality and low recruitment in 1999: potential causes and implications. Journal of Cetacean Resource Management 2(2):85-99.	i
LeDuc, R .G., D. W. Weller, J. Hyde, J., A. M. Burdin, P. E. Rosel, R. L. Brownel2011l, B. Würsig and A. E. Dizon,. 2002. Genetic differences between western and eastern gray whales (Eschrichtius robustus). Journal of Cetacean Research and Management 4:1-5.	i
Leatherwood, S., and R. R. Reeves. 1983. The Sierra Club handbook of whales and dolphins. Sierra Club Books, San Francisco. 302 pp.	i
Lefebvre, K. A., L. Quakenbush, E. Frame, K. B. Huntington, G. Sheffield, et al. 2016. Prevalence of algal toxins in Alaskan marine mammals foraging in a changing arctic and subarctic environment. Harmful Algae 55:13–24.	i
Lewitus, A. J., R. A. Horner, D. A. Caron, E. Garcia-Mendoza, B. M. Hickey, et al. 2012. Harmful algal blooms along the North American west coast region: history, trends, causes, and impacts. Harmful Algae 19:133–159.	i

Lowry, L. F., V. N. Burkanov, A. Altukhov, D. W. Weller, and R. R. Reeves. 2018. Entanglement risk to western gray whales from commercial fisheries in the Russian Far East. Endangered Species Research 37:133-148.	i
Marchetti, A., V. L. Trainer and P. J. Harrison. 2004. Environmental conditions and phytoplankton dynamics associated with Pseudo-nitzschia abundance and domoic acid in the Juan de Fuca eddy. Marine Ecology Progress Series 281:1-12.	i
Marshall, K. N., I. C. Kaplan, E. E. Hodgson, A. Herman, D. S. Busch, et al. 2017. Risks of ocean acidification in the California Current food web and fisheries: ecosystem model projections. Global Change Biology 23:1525–1539.	i
Mate, B., A. L. Bradford, G. Tsidulko, V. Vertyankin, and V. Ilyashenko. 2011. Late-feeding season movements of a western North Pacific gray whale off Sakhalin Island, Russia and subsequent migration into the Eastern North Pacific. International Whaling Commission Scientific Committee Paper SC/63/BRG23.	i
Mate, B. R., V. Yu Ilyashenko, A. L. Bradford, V. V. Vertyankin, G. A. Tsidulko, V. V. Rozhnov and L. M. Irvine. 2015. Critically endangered western gray whales migrate to the eastern North Pacific. Biology Letters. DOI: 1098/rsbl.2015.0071.	i
McKibben, S. M., W. Peterson, A. M. Wood, V. L. Trainer, M. Hunter, and A. E. White. 2017. Climatic regulation of the neurotoxin domoic acid. Proceedings of the National Academy of Sciences 114:239–244.	i
Mongillo, T. M., G. M. Ylitalo, L. D. Rhodes, S. M. O'Neill, D. P. Noren, and M. B. Hanson. 2016. Exposure to a mixture of toxic chemicals: implications for the health of endangered southern resident killer whales. NOAA Technical Memorandum NMFS-NWFSC-135, Northwest Fisheries Science Center, Seattle, Washington.	i
Moore, S. E. 2016. Is it 'boom times' for baleen whales in the Pacific Arctic region? Biology Letters 12: 20160251. http://dx.doi.org/10.1098/rsbl.2016.0251	i
Moore, S. E. and J. T. Clarke. 2002. Potential impact of offshore human activities on gray whales (Eschrichtius robustus). Journal of Cetacean Research and Management 4:19–25.	i
Moore, S. E., J. M. Grebmeier and J. R. Davies. 2003. Gray whale distribution relative to forage habitat in the northern Bering Sea: current conditions and retrospective summary. Canadian Journal of Zoology. 81(4):734-742.	i
Moore, S. E., J. Urban, W. L. Perryman, F. Gulland, H. Perez-Cortes, P. R. Wade, L. Rojas-Bracho and T. Rowles. 2001. Are gray whales hitting "K" hard? Marine Mammal Science 17(4):954-958.	i
Muir, J. E., L. Ainsworth, R. Racca, Y. Bychkov, G. Gailey, V. Vladimirov, S. Starodymov and K. Bröker. 2016. Gray whale densities during a seismic survey off Sakhalin Island, Russia. Endangered Species Research 29:211-227.	i
Nakamura G., H. Yoshida, H. Morita, K. Ito, T. Bando, T. Mogoe, T. Miyashita, and H. Kato. 2017. Status report of conservation and researches on the western North Pacific gray whales in Japan, May 2016 - April 2017. Paper SC/67a/CMP02 presented to the International Whaling Commission's Scientific Committee. 8 pp.	i
Nambu H. H. Ishikawa and T. K. Yamada. 2010. Records of the western gray whale Eschrichtius robustus: its distribution and migration. Japan Cetology 20: 21−29.	i
Neel, J., C. Hart, D. Lynch, S. Chan, and J. Harris. 2007. Oil spills in Washington state: a historical analysis (revision of 1997 report). Publication No. 97–252, Washington State Department of Ecology, Olympia, Washington.	i
Neilson, J. L., J. M. Straley, C. M. Gabriele, and S. Hills. 2009. Nonlethal entanglement of humpback whales (Megaptera novaeangliae) in fishing gear in northern Southeast Alaska. Journal of Biogeography 36:452−464.	i

Neilson, J. L., C. M. Gabriele, A. S. Jensen, K. Jackson, and J. M. Straley. 2012. Summary of reported whale-vessel collisions in Alaskan waters. Journal of Marine Biology 2012:106282. doi:10.1155/2012/106282	i
Nelson, T. A., D. A. Duffus, C. Robertson and L. J. Feyrer. 2008. Spatial-temporal patterns in intra-annual gray whale foraging: characterizing interactions between predators and prey in Clayquot Sound, British Columbia, Canada. Marine Mammal Science 24(2): 356-370. DOI: 10.1111/j.1748-7692.2008.00190.x	i
Nerini, M., 1984. A review of gray whale feeding ecology. In: Jones, M. L., S. L. Swartz, S.L. and S. Leatherwood (Eds.) The Gray Whale Eschrichtius robustus. Academic Press. Florida, 423–450.	i
NMFS (National Marine Fisheries Service). 2012. Oil spill emergency response: killer whale-hazing implementation plan. Northwest Region, National Marine Fisheries Service, Seattle, Washington.	i
NMFS (National Marine Fisheries Service). 2015. Draft environmental impact statement on the Makah Tribe request to hunt gray whales. National Marine Fisheries Service, Seattle, Washington.	i
NMFS (National Marine Fisheries Service). 2019. Regulation governing the taking of marine mammals. Federal Register 84(66): 13604-13624.	v
NOAA Fisheries. 2019. 2018 west coast entanglement summary. National Marine Fisheries Service, Long Beach, California.	vi
Nowacek, D. P., L. H. Thorne, D. W. Johnston, and P. L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37:81–115.	i
Nowacek, D. P., C. W. Clark, D. Mann, P. J. O. Miller, H. C. Rosenbaum, et al. 2015. Marine seismic surveys and ocean noise: time for coordinated and prudent planning. Frontiers in Ecology and the Environment 13:378–386.	i
Nowak, R. M. 1991. Walker's mammals of the world. Fifth edition. Vols. I and II. Johns Hopkins University Press, Baltimore. 1629 pp.	i
O'Connor, S., R. Campbell, H. Cortez, and T. Knowles. 2009. Whale watching worldwide: tourism numbers, expenditures and expanding economic benefits. International Fund for Animal Welfare, Yarmouth, Massachusetts.	i
O'Hara, T. M. and T. J. O'Shea. 2001. Toxicology. Pages 471–520 in L. A. Dierauf and F. M. D. Gulland, editors. CRC handbook of marine mammal medicine. 2nd edition. CRC Press, Boca Raton, Florida.	i
Orca Network. 2011. Gray whale tutorial. Orca Network, Greenbank, Washington. < http://www.orcanetwork.org/nathist/graywhales.html	viii
O'Shea, T. J. 1999. Environmental contaminants and marine mammals. Pages 485–563 in J. E. Reynolds III and S. A. Rommel, editors. Biology of marine mammals. Smithsonian Institution Press, Washington, D.C.	i
O'Shea, T. J. and R. L. Brownell, Jr. 1994. Organochlorine and metal contaminants in baleen whales: a review and evaluation of conservation implications. Science of the Total Environment 154:179–200.	i
Park K.B. 1995. The history of whaling off Korean peninsula. Minjokmunhwa Press. 458 pp. [In Korean].	i
Parsons, E. C. M. 2012. The negative impacts of whale-watching. Journal of Marine Biology 2012:807294. doi:10.1155/2012/807294	i
Perryman, W. L., D. W. Weller and J. W. Durban. 2017. Estimates of eastern North Pacific gray whale calf production 1994-2016. Paper SC/67a/XX submitted to the International Whaling Commission.	i

Perryman, W. L., M. A. Donahue, P. C. Perkins, and S. B. Reilly. 2002. Gray whale calf production 1994-2000: are observed fluctuations related to changes in seasonal ice cover? Marine Mammal Science 18(l):121-144.	i
Pike, G. C. and I. B. MacAskie. 1969. Marine mammals of British Columbia. Bulletin of the Fisheries Research Board of Canada 171:1–54.	i
Punt, A. E. and D. S. Butterworth. 2002. An examination of some of the assumptions made in the Bayesian approach used to assess the eastern North Pacific stock of gray whales (Eschrichtius robustus). Journal of Cetacean Research and Management 4:99-110.	i
Punt, A. E. and P. R. Wade. 2010. Population status of the eastern North Pacific stock of gray whales in 2009. NOAA Technical Memorandum NMFS-AFSC-207, Alaska Fisheries Science Center. 43 pp.	i
Punt, A. E. and P. R. Wade. 2012. Population status of the eastern North Pacific stock of gray whales in 2009. Journal of Cetacean Research and Management 12(1):15-28.	i
Redfern, J. V., M. F. McKenna, T. J. Moore, J. Calambokidis, M. L. DeAngelis, et al. 2013. Assessing the risk of ships striking large whales in marine spatial planning. Conservation Biology 27:292–302.	i
Redfern, J. V., L. T. Hatch, C. Caldow, M. L. DeAngelis, J. Gedamke, et al. 2017. Assessing the risk of chronic shipping noise to baleen whales off southern California, USA. Endangered Species Research 32:153–167.	i
Reeves, R. R., T. D. Smith, J. N. Lund, S. A. Lebo, and E.A. Josephson. 2010. Nineteenth-century ship based catches of gray whales, Eschrichtius robustus, in the eastern North Pacific. Marine Fisheries Review 72:26−65.	i
Reeves, R. R., K. McClellan and T. B. Werner. 2013. Marine mammal bycatch in gillnet and other entangling net fisheries, 1990 to 2011. Endangered Species Research 20:71–97.	i
Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. & Zerbini, A.N. 2008. Eschrichtius robustus. The IUCN Red List of Threatened Species 2008: e.T8097A12885255. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T8097A12885255.en.	i
Reilly, S. B., D. W. Rice, and A. A. Wolman. 1983. Population assessment of the gray whale, Eschrichtius robustus, from California shore censuses, 1967-80. Fishery Bulletin 81:267-281.	i
Rice, D. W. 1998. Marine mammals of the world, systematics and distribution. Society for Marine Mammalogy Special Publications 4:1-231.	i
Rice, D. W. W. and A. A. Wolman. 1971. The life history and ecology of the gray whale (Eschrichtius robustus). Special Publication No. 3. The American Society of Mammalogists.	i
Rice, D. W., A. A. Wolman, D. E. Withrow and L. A. Fleischer. 1981. Gray whales on the winter grounds in Baja California. Report of the International Whaling Commission 31:477-493.	i
Richardson, S. 1997. Washington State status report for the gray whale. Washington Department of Fish and Wildlife. Olympia, Washington. 20 pp.	iii
Risch, D., P. J. Corkeron, W. T. Ellison, and S. M. Van Parijs. 2012. Changes in humpback whale song occurrence in response to an acoustic source 200 km away. PLoS ONE 7(1):e29741.	i
Ritter, F. and S. Panigada. 2014. IWC guidance for cruise ship operators to minimise risk of collisions with cetaceans. Report SC/65b/HIM05, International Whaling Commission, Impington, Cambridge, United Kingdom.	i
Rocha, R. C., Jr., P. J. Clapham, and Y. I. Ivashchenko. 2014. Emptying the oceans: a summary of industrial whaling catches in the 20th century. Marine Fisheries Review 76(4):37–48.	i

Rolland, R. M., S. E. Parks, K. E. Hunt, M. Castellote, P. J. Corkeron, D. P. Nowacek, S. K. Wasser, and S. D. Kraus. 2012. Evidence that ship noise increases stress in right whales. Proceedings of the Royal Society B: Biological Sciences 279:2363–2368.	i
Roman, J. and S. R. Palumbi. 2003. Whales before whaling in the North Atlantic. Science 301:508–510.	i
Rugh, D. J., K. E. W. Shelden and A. Schulman-Janiger. 2001. Timing of the southbound migration of gray whales. Journal of Cetacean Research and Management 3:31-39.	i
Saez, L., D. Lawson, M. DeAngelis, E. Petras, S.ilkin, and C. Fahy. 2013. Understanding the co-occurrence of large whales and commercial fixed gear fisheries off the west coast of the United States. NOAA Technical Memorandum NOAA-TM-NMFS-SWR-044, Southwest Regional Office, Long Beach, California.	i
Scammon, C. M. 1874. The marine mammals of the northwestern coast of North America, together with an account of the American whale-fishery. J. H. Carmany and Company, San Francisco, California.	i
Scheffer, V. B. and J. W. Slipp. 1948. The whales and dolphins of Washington state with a key to the cetaceans of the west coast of North America. American Midland Naturalist 39:257–337.	i
Scheinin, A. P., D. Kerem, C. D. MacLeod, M. Gazo, C. A. Chicote and M. Castellote. 2011. Gray whale (Eschrichtius robustus) in the Mediterranean Sea: anomalous event or early sign of climate-driven distribution change? Marine Biodiversity Records 4. Published online http://www.journals.cambridge.org/abstract_S1755267211000042.	i
Scordino, J. J., M. Gosho, P. J. Gearin, A. Akmajian, J. A. Calambokidis and N. Wright. 2013. Gray whale use of northwest Washington during the feeding season 1984-2011. Pages 30-61 in J. Scordino and A. Akmajian, editors. Research and education/outreach to benefit ESA listed and recently delisted marine mammals of northwest Washington. Final report for species recovery grant award NA10NMF4720372. Makah Fisheries Management, Neah Bay, Washington.	i
Scordino, J. J., M. Gosho, P. J. Gearin, A. Akmajian, J. Calambokidis and N. Wright. 2017. Individual gray whale use of coastal waters off northwest Washington during the feeding season 1984-2011: implications for management. Journal of Cetacean Research and Management 16:57-69.	i
Shirihai, H. and B. Jarrett. 2006. Whales, dolphins, and other marine mammals of the world. Princeton University Press, Princeton, New Jersey.	i
Shpak, O. V., D. M. Kuznetsova and V. V. Rozhnov. 2013. Observation of the gray whale (Eschrichtius robustus) in the Laptev Sea. Biology Bulletin 40:797-800.	i
Simmonds, M. P. and W. J. Eliott. 2009. Climate change and cetaceans: concerns and recent developments. Journal of the Marine Biological Association of the United Kingdom 89:203–210.	i
Smith, C. R., T. K. Rowles, L. B. Hart, F. I. Townsend, R. S. Wells, et al. 2017. Slow recovery of Barataria Bay dolphin health following the Deepwater Horizon oil spill (2013–2014), with evidence of persistent lung disease and impaired stress response. Endangered Species Research 33:127–142.	i
Sullivan, F. A. and L. G. Torres. 2018. Assessment of vessel disturbance to gray whales to inform sustainable ecotourism. Journal of Wildlife Management 82:896-905.	i
Sumich, J. 2014. E. robustus: the biology and human history of gray whales. Whale Cove Marine Education. Corvallis, Oregon. Viii+199 pp.	i
Swan, J. G. 1870. The Indians of Cape Flattery at the entrance to the Strait of Juan de Fuca, Washington Territory. Smithsonian Contributions to Knowledge 220, Smithsonian Institution, Washington, D.C.	i
Swartz, S. L. 2014. Family Eschrichtiidae (gray whale). Pages 222−241 in D. E. Wilson and R. A. Mittermeier, editors. Handbook of the mammals of the world. Volume 4. Sea mammals. Lynx Edicions, Barcelona, Spain.	i
Swartz, S. L. and M. L. Jones. 1983. Gray whale (Eschrichtius robustus) calf production and mortality in the winter range. Reports of the International Whaling Commission 33:503-507.	i

Swartz, S. L., B. L. Taylor, and D. J. Rugh. 2006. Gray whale Eschrichtius robustus population and stock identity. Mammal Review 36:66-84.	i
Swartz, S. L., J. Urbán R., S. Martínez A., L. V. Gómora and A. Gómez-Gallardo. 2019. 2019 research report for Laguna San Ignacio & Bahía Magdalena, Baja California Sur, México. Laguna San Ignacio Ecosystem Science Project, Ocean Foundation, Washington, D.C. www.sanignaciograywhales.org	i
Takeshita, R., L. Sullivan, C. Smith, T. Collier, A. Hall, T. Brosnan, T. Rowles, and L. Schwacke. 2017. The Deepwater Horizon oil spill marine mammal injury assessment. Endangered Species Research 33:95–106.	i
Thomas, P. O., R. R. Reeves, and R. L. Brownell, Jr. 2016. Status of the world's baleen whales. Marine Mammal Science 32:682–734.	i
Tilbury, K. L., J. E. Stein, C. A. Krone, R. L. Brownell Jr., S. A. Blokhin, J. L. Bolton, and D. W. Ernest. 2002. Chemical contaminants in juvenile gray whales (Eschrichtius robustus) from a subsistence harvest in Arctic feeding grounds. Chemosphere 47:555-564.	i
Torres de la Riva, G., C. K. Johnson, F. M. D. Gulland, G. W. Langlois, J. E. Heyning, T. K. Rowles, and J. A. K. Mazet. 2009. Association of an unusual marine mammal mortality event with Pseudo-nitzschia spp. blooms along the southern California coastline. Journal of Wildlife Diseases 45:109–121.	i
Tyurneva O.Y., Y. M. Yakovlev, V. V. Vertyankin, and N. I. Selin. 2010. The peculiarities of foraging migrations of the Korean-Okhotsk gray whale (Eschrichtius robustus) population in Russian waters of the Far Eastern seas. Russian Journal of Marine Biology 36(2):117-124.	i
Urbán R. J., D. Weller, O. Tyureva, S. Swartz, A. Bradford, Y. Yakovlev, O. Sychenko, N. Rosales, A. Martinez, A. Burdin and U. Gomez-Gallardo. 2013. Report on the photographic comparison of the Sakhalin Island and Kamchatka Peninsula with the Mexican gray whale catalogues. Paper SC/65a/BRG04 presented to the International Whaling Commission Scientific Committee http://www.iwcoffice.org/	i
USFWS (U.S. Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1994. Endangered and threatened wildlife and plants; final rule to remove the eastern North Pacific population of the gray whale from the list of endangered wildlife. Federal Register 59(115):31094-31095.	v
Van Dorp, J. R. and J. Merrick. 2017. VTRA 2015 final report, updating the VTRA 2010: a potential oil loss comparison of scenario analyses by four spill size categories. George Washington University, Washington, D.C., and Virginia Commonwealth University, Richmond, Virginia.	i
Varanasi, U., J. E. Stein, K. L. Tilbury, J. P. Meador, C. A. Sloan, R. C. Clark, and S.-L.Chan. 1994. Chemical contaminants in gray whales (Eschrichtius robustus) stranded along the west coast of North America. Science of the Total Environment 145:29-53.	i
Vertyankin, V. V., V. C. Nikulin, A. M. Bednykh, and A. P. Kononov. 2004. Sighting of gray whales (Eschrichtius robustus) near southern Kamchatka. Pp 126-128 in: Marine Mammals of the Holarctic. Collection of scientific papers of International Conference. Koktebel, Crimea, Ukraine, October 11-17, 2004.	i
Wade, P. R. 2002. A Bayesian stock assessment of the eastern Pacific gray whale using abundance and harvest data from 1967-1996. Journal of Cetacean Research and Management 4:85-98.	i
Wang X., M. Xu, F. Wu, D. W. Weller, X. Miao, A. R. Lang, and Q. Zhu. 2015. Insights from a gray whale (Eschrichtius robustus) bycaught in the Taiwan Strait off China in 2011. Aquatic Mammals 41:327-333.	i
WDFW (Washington Department of Fish and Wildlife). no date. Lost crab pots: a problem we can solve. Washington Department of Fish and Wildlife, Olympia, Washington. http://wdfw.wa.gov/fishing/commercial/crab/coastal/crabpots.pdf Accessed on 29 August 2017.	ii

Webb, R.L. 2011. On the Northwest: commercial whaling in the Pacific Northwest, 1790-1967. UBC Press.	i
Weitkamp, L. A., R. C. Wissmar, C. A. Simenstad, K. L. Fresh and J. G. Odell. 1992. Gray whale foraging on ghost shrimp (Callianassa californiensis) in littoral sand flats of Puget Sound, USA. Canadian Journal of Zoology 70:2275-2280.	i
Weller, D. W., B. Würsig, A. L. Bradford, A. M. Burdin, S. A. Blokhin, H. Minakuchi and R. L. Brownell, Jr. 1999. Gray whales (Eschrichtius robustus) off Sakhalin Island, Russia: seasonal and annual patterns of occurrence. Marine Mammal Science. 15:1208-1227.	i
Weller, D. W., S. Bettridge, R. L. Brownell, Jr., J. L. Laake, J. E. Moore, P.E. Rosel, B. L. Taylor, and P. R. Wade. 2013b. Report of the National Marine Fisheries Service gray whale stock identification workshop. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-507.	i
Weller, D. W., A. Burdin, B. Würsig, B. Taylor and R. Brownell, Jr. 2002. The western gray whale: a review of past exploitation, current status and potential threats. Journal of Cetacean Resource Management. 4(1):7-12.	i
Weller, D. W., A. Klimek, A. L. Bradford, J. Calambokidis, A. R. Lang, B. Gisborne, A. M. Burdin, W. Szaniszlo, J. Urbán, A. Gómez-Gallardo Unzueta, S. Swartz and R. L. Brownell, Jr. 2012. Movements of gray whales between the western and eastern North Pacific. Endangered Species Research 18:193-199.	i
Weller, D. W., A. L. Bradford, H. Kato, T. Bando, S. Ohtani, A. M. Burdin, and R. L. Brownell, Jr. 2008. Photographic match of a western gray whale between Sakhalin Island, Russia, and Honshu, Japan: first link between feeding ground and migratory corridor. Journal of Cetacean Research and Management 10:89-91.	i
Weller, D. W., A. L. Bradford, A. M. Burdin, R. L. and Brownell Jr. 2009. The Incidence of Killer Whale Tooth Rakes on Western Gray Whales off Sakhalin Island, Russia. Paper SC/61/BRG9 presented to the International Whaling Commission.	i
Weller, D. W., A. M. Burdin and R. L. Brownell, Jr. 2013a. A gray area: on the matter of gray whales in the western North Pacific. Journal of the American Cetacean Society 42(1):29-33.	i
Weller, D. W., O. A. Sychenko, A. M. Burdin, and R. L. Brownell, Jr. 2014. On the risks of salmon fishing trap-nets to gray whales summering off Sakhalin Island, Russia. Paper SC/65b/BRG16, International Whaling Commission Scientific Committee, Impington, Cambridge, United Kingdom.	i
Weller D. W., H. Ohizumi, N. Funahashi, O. Sychenko, A. M. Burdin, A. R. Lang, and R. L. Brownell Jr. 2016. Gray whale migration in the western North Pacific: further support for a Russia-Japan connection. Paper SC/66b/BRG16 presented to the International Whaling Commission's Scientific Committee. 4 pp.	i
Williams, R., S. Gero, L. Bejder, J. Calambokidis, S. D. Kraus, D. Lusseau, A. J. Read, and J. Robbins. 2011a. Underestimating the damage: interpreting cetacean carcass recoveries in the context of the Deepwater Horizon/BP incident. Conservation Letters 4:228–233.	i
Williams, R., E. Ashe, and P. D. O'Hara. 2011b. Marine mammals and debris in coastal waters of British Columbia, Canada. Marine Pollution Bulletin 62:1303–1316.	i
Wilson, C., A. V. Sastre, M. Hoffmeyer, V. J. Rowntree, S. E. Fire, et al. 2016. Southern right whale (Eubalaena australis) calf mortality at Península Valdés, Argentina: are harmful algal blooms to blame? Marine Mammal Science 32:423–451.	i
Wolman, A. A. 1985. Gray whale (Eschrichtius robustus (Lilljeborg, 1861). Pages 67−90 in S. H. Ridgway and R. Harrison, editors. Handbook of marine mammals, Vol. 3. The sirenians and baleen whales. Academic Press, London, United Kingdom.	i
Wolman, A. A. and A. J. Wilson. 1970. Occurrence of pesticides in whales. Pesticides Monitoring Journal 4:8-10.	i

WSDOE (Washington State Department of Ecology). 2017. Vessel entries and transits for Washington waters, VEAT 2016. Publication 17-08-001, Washington State Department of Ecology, Olympia, Washington.	i
WSDOE (Washington State Department of Ecology). 2019. Vessel entries and transits for Washington waters, VEAT 2018. Publication 19-08-001, Washington State Department of Ecology, Olympia, Washington.	i
Yablokov, A. V. and L. S. Bogoslovskaya. 1984. A review of Russian research on the biology and commercial whaling of the gray whale. pp. 465-85. In: M.L. Jones, S.L. Swartz and S. Leatherwood (eds.) The Gray Whale, Eschrichtius robustus. Academic Press Inc. Orlando, Florida. xxiv+600 pp.	i
Zhao Y. 1997. The grey whale stranded at the Liaoning coast in the north of the Yellow Sea. Fisheries Science 16:8-10.	i
Zhao, L., Q. Zhu, X. Miao, M. Xu, F. Wu, Y. Dai, C. Tao, J. Mou, and X. Wang. 2017. An overview of cetacean strandings, bycatches and rescues along the western coast of the Taiwan Strait, China: 2010–2015. Acta Oceanologica Sinica, 36(12):31-36.	i

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