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GRAY WHALE (*Eschrichtius robustus*): Western North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Gray whales occur along the eastern and western margins of the North Pacific. In the western North Pacific (WNP), gray whales feed during summer and fall in the Okhotsk Sea off northeast Sakhalin Island, Russia, and off southeastern Kamchatka in the Bering Sea (Weller *et al.* 1999, 2002; Vertyankin *et al.* 2004; Tyurneva *et al.* 2010; Burdin *et al.* 2017; Figure 1). Historical evidence indicates that the coastal waters of eastern Russia, the Korean Peninsula and Japan were once part of the migratory route in the WNP and that areas in the South China Sea may have been used as wintering grounds (Weller *et al.* 2002; Weller *et al.* 2013a). Present day records of gray whales off Japan (Nambu *et al.* 2010; Nakamura *et al.* 2017a; Nakamura *et al.* 2017b) and China are infrequent (Wang 1984; Zhu 2002; Wang *et al.* 2015) and the last known record from Korea was in 1977 (Park 1995; Kim *et al.* 2013). While recent observations of gray whales off the coast of Asia remain sporadic, observations off Japan, mostly from the Pacific coast, appear to be increasing in the past two decades (Nakamura *et al.* 2017b).

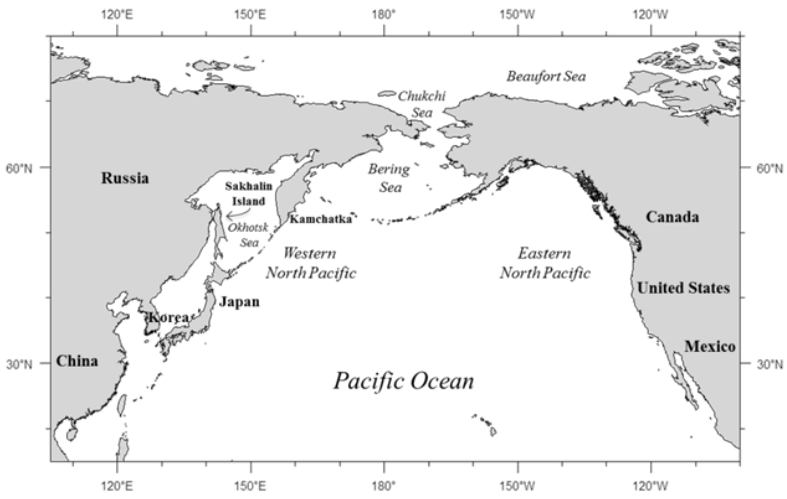

Figure 1. Range map of the Western North Pacific Stock of gray whales, including summering areas off Russia and wintering areas in the western and eastern Pacific.

Information from tagging, photo-identification and genetic studies show that some whales identified in the WNP off Russia have been observed in the eastern North Pacific (ENP), including coastal waters of Canada, the U.S. and Mexico (Lang *et al*. 2014; Weller *et al.* 2012; Mate *et al.* 2015, Urbán *et al.* 2019). Photographs of 379 individuals identified on summer feeding grounds off Russia (316 off Sakhalin; 150 off Kamchatka), were compared to 10,685 individuals identified in Mexico breeding lagoons. A total of 43 matches were found, including the following area matches: 14 Sakhalin-Kamchatka-Mexico, 25 Sakhalin-Mexico, and 4 Kamchatka-Mexico (Urban *et al.* 2019). The number of whales documented moving between the WNP and ENP represents 14% of gray whales identified off Sakhalin Island and Kamchatka according to Urban *et al.* (2019). Some whales that feed off Sakhalin Island in summer migrate east across the Pacific to the west coast of North America in winter, while others migrate south to waters off Japan and China (Weller *et al.* 2016). Cooke *et al.* (2019) note that the fraction of the WNP population that migrates to the ENP is estimated at 45-80% and note "therefore it is likely that a western breeding population that migrates through Asian waters still exists." These authors further state that at least 20% of WNP gray whales probably migrate elsewhere, likely to wintering areas in Asian waters. Despite these estimates of cross-basin movements, analysis of photo-identification data, including data on mother-calf pairs and paternity assessments, suggest that gray whales summering in the WNP may constitute a demographically self-contained subpopulation where mating occurs at least preferentially and possibly exclusively within the subpopulation (Broker *et al.* 2020, Cooke *et al.* 2017). Despite the observed movements of some gray whales between the WNP and ENP, significant differences in their mitochondrial and nuclear DNA exist (LeDuc *et al.* 2002; Lang *et al.* 2014). Taken together, these observations indicate that not all gray whales in the WNP share a common wintering ground. Brüniche-Olsen *et al.* (2018a) reassessed the genetic differentiation of gray whales feeding off Sakhalin and ENP whales from the Mexican breeding lagoons using nuclear Single Nucleotide Polymorphisms (SNPs). The degree of differentiation between these two regions was small but significant despite the existence of some admixed individuals. In conclusion, these authors suggested that gray whale population structure is not currently determined by simple geography and may be in flux as a result of emerging migratory dynamics. Contemporary gray whale genomes, both eastern and western, contain less nucleotide diversity

than most other marine mammals and evidence of inbreeding is greater in the Western Pacific than in the Eastern Pacific populations (Brüniche-Olsen et al. 2018b).

In 2012, the National Marine Fisheries Service convened a scientific task force to appraise the currently recognized and emerging stock structure of gray whales in the North Pacific (Weller *et al.* 2013b). The charge of the task force was to evaluate gray whale stock structure as defined under the Marine Mammal Protection Act (MMPA) and implemented through the National Marine Fisheries Service's Guidelines for Assessing Marine Mammal Stocks (GAMMS; NMFS 2005). Significant differences in both mitochondrial and nuclear DNA between whales sampled off Sakhalin Island (WNP) and whales sampled in the ENP provided convincing evidence that resulted in the task force advising that WNP gray whales should be recognized as a population stock under the MMPA and GAMMS guidelines. Given the interchange of some whales between the WNP and ENP, including seasonal occurrence of WNP whales in U.S. waters, the task force agreed that a stand-alone WNP gray whale population stock assessment report was warranted.

The IWC Scientific Committee completed annual (2014-2018) range-wide workshops on the status of North Pacific gray whales. The primary objectives of these meetings were to identify plausible stock structure hypotheses and create a foundation for developing range-wide conservation advice.

The Scientific Committee reported on the plausibility of various stock structure hypotheses in 2020 (IWC 2020). These hypotheses include up to three feeding groups or aggregations: the Pacific Coast Feeding Group (PCFG), the Western Feeding Group (WFG), and the North Feeding Group (NFG). The PCFG is defined above. The WFG consists of whales that feed off Sakhalin Island as documented via photo-ID. The NFG includes whales found feeding in the Bering and Chukchi Seas where photo-ID and genetic data are sparse. The IWC Scientific Committee's stock structure hypotheses also consider up to three extant breeding stocks: the Western Breeding Stock (WBS), the Eastern Breeding Stock (EBS), and a third unnamed stock that includes WFG whales that interbreed largely with each other while migrating to the Mexico wintering grounds. The IWC summarizes three 'high plausibility' hypotheses as follows:

Hypothesis 3a is characterized by maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, and random mating. Under this hypothesis, a single breeding stock (EBS) exists that includes three feeding groups: NFG, PCFG, and WFG. Areas off Southern Kamchatka and the Northern Kuril Islands are used by some whales that belong to the WFG and some whales that belong to the NFG. Although two breeding stocks (WBS and EBS) may once have existed, the WBS is assumed to have been extirpated.

Hypothesis 4a is characterized by maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, and non-random mating. Under this hypothesis, two breeding stocks exist and overwinter in Mexico. One breeding stock (EBS) includes NFG and PCFG whales, and a second, unnamed breeding stock includes WFG whales that mate largely with each other while migrating to Mexico. Areas off Southern Kamchatka and the Northern Kuril Islands are used by some whales that belong to the breeding stock comprised of WFG whales and some whales that belong to the NFG. Although a third breeding stock (the WBS) may once have existed, under this hypothesis the WBS is assumed to have been extirpated.

Hypothesis 5a is characterized by maternal feeding ground fidelity and two migratory routes/wintering grounds used by Sakhalin whales. Under this hypothesis, two breeding stocks exist: EBS and WBS. The EBS includes three feeding groups: PCFG, NFG, and the WFG that feeds off Northeastern Sakhalin Island. The WBS whales feed off Northeastern Sakhalin Island, Southern Kamchatka, the Northern Kuril Islands and other areas of the Okhotsk Sea and then migrate to the South China Sea to overwinter. Under this hypothesis, areas off Southern Kamchatka and the Northern Kuril Islands are used by the WFG, the NFG, and the feeding whales that are part of the WBS.

POPULATION SIZE

Estimated population size from photo-ID data for Sakhalin and Kamchatka in 2016 was estimated at 290 whales (90% percentile intervals = 271 – 311) (Cooke 2017, Cooke *et al.* 2018). Of these, 175-192 whales are estimated to be predominantly part of a Sakhalin feeding aggregation. These estimates represent animals in the 1-year plus age category. Cooke (2017) notes that not all of these animals belong to the Western North Pacific stock of gray whales and proposes an upper limit of approximately 100 whales from Sakhalin that could belong to the Western North Pacific breeding population.

Minimum Population Estimate

The minimum population size estimate is taken as the lower 5th percentile of the estimate from Cooke (2017), or 271 animals. This is a more conservative estimate of minimum population size than using the lower 20th percentile of a population estimate, however, Cooke (2017) did not provide such an estimate in his analysis.

Current Population Trend

The combined Sakhalin Island and Kamchatka populations were estimated to be increasing from 2005 through 2016 at an average rate between 2-5% annually (Cooke 2017).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

An analysis of the ENP gray whale population provided an estimate of R_{max} of 0.062, with a 90% probability the value was between 0.032 and 0.088 (Punt and Wade 2012). This value of R_{max} is also applied to WNP gray whales, as it is currently the best estimate of R_{max} available for any gray whale population.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (271) times one-half the estimated maximum annual growth rate for a gray whale population (½ of 6.2% for the ENP stock, Punt and Wade 2012), times a recovery factor of 0.1 (for an endangered stock with N_{min} < 1,500, Taylor *et al.* 2003), and also multiplied by estimates for the proportion of the stock that uses U.S. EEZ waters (0.575), and the proportion of the year that those animals are in the U.S. EEZ (3 months, or 0.25 years) (Moore and Weller 2013), resulting in a PBR of 0.12 WNP gray whales per year, or approximately 1 whale every 8 years (if abundance and other parameters in the PBR equation remained constant over that time period).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

The decline of gray whales in the WNP is attributable to commercial hunting off Korea and Japan between the 1890s and 1960s. Pre-exploitation abundance of WNP gray whales is unknown, but has been estimated to be between 1,500 and 10,000 individuals (Yablokov and Bogoslovskaya 1984). By 1910, after some commercial exploitation had already occurred, it is estimated that only 1,000 to 1,500 gray whales remained in the WNP population (Berzin and Vladimirov 1981). The basis for how these two estimates were derived, however, is not apparent (Weller *et al.* 2002). By the 1930s, gray whales in the WNP were considered by many to be extinct (Mizue 1951; Bowen 1974).

A significant threat to gray whales in the WNP are incidental catches in coastal net fisheries (Weller *et al.* 2002; Nakamura *et al.* 2017b; Weller *et al.* 2008; Weller *et al.* 2013a; Lowry *et al.* 2018). Between 2005 and 2007, four female gray whales (including one mother-calf pair and one yearling) died in fishing nets on the Pacific coast of Japan. In addition, one adult female gray whale died as a result of a fisheries interaction in November 2011 off Pingtan County, China (Wang *et al.* 2015). An analysis of anthropogenic scarring of gray whales photographed off Sakhalin Island found that at least 18.7% (n=28) of 150 individuals identified between 1994 and 2005 had evidence of previous entanglements in fishing gear but where the scars were acquired is unknown (Bradford *et al.* 2009). Trap nets for Pacific salmon have been deployed in the feeding area off northeastern Sakhalin Island since 2013, resulting in two known entanglements and one probable entanglement mortality (Lowry *et al.* 2018).

Given that some WNP gray whales occur in U.S. waters, there is some probability of WNP gray whales being killed or injured by vessel strikes or entangled in fishing gear within U.S. waters.

Subsistence/Native Harvest Information

NMFS has proposed to grant a waiver of the Marine Mammal Protection Act's moratorium on the take of marine mammals to allow the Makah Indian Tribe to take a limited number of Eastern North Pacific gray whales (NOAA 2019, 2020b). The **proposed rule** includes a potential maximum removal of an average of 2.5 whales annually over a 10-year period (NOAA 2019). Proposed regulations include considerations of the estimated probabilities of a Makah hunt taking a WNP gray whale (Moore and Weller 2018) and safeguards to minimize the probability of taking either WNP or PCFG whales. The proposed rule states "*there is about a 6 percent probability of hunters striking one WNP gray whale over the 10 years of the regulations (Moore and Weller, 2018). This probability is the most likely point estimate; the 95 percent confidence interval ranges from 3.0 percent to 9.3 percent. Stated another way, the most likely point estimates indicate that one in 17 10-year hunt periods (i.e., one year out of 170) would result in an individual WNP gray whale being struck by Makah hunters, if the Tribe made the maximum number of strike attempts allowed in even-year hunts and if ENP and WNP population sizes and migration patterns remained constant (Moore and Weller, 2018)*". A formal hearing occurred in November 2019 and NMFS is awaiting a recommended decision from the Administrative Law Judge overseeing that hearing (NOAA 2020b). The IWC Scientific Committee reviewed the proposed U.S. management plan for the Makah hunt of gray whales and stated that "*the performance of the Management Plan was adequate to meet the Commission's conservation objectives for the Pacific Coast Feeding*

Group, Western Feeding Group and Northern Feeding Group gray whales" (IWC 2018).

HABITAT ISSUES

Near shore industrialization and shipping congestion throughout the migratory corridors of the WNP gray whale stock represent risks by increasing the likelihood of exposure to pollutants and vessel strikes as well as a general degradation of the habitat. In addition, the summer feeding area off Sakhalin Island is a region rich with offshore oil and gas reserves. Two major offshore oil and gas projects now directly overlap or are in near proximity to this important feeding area, and more development is planned in other parts of the Okhotsk Sea that include the migratory routes of these whales. Operations of this nature have introduced new sources of underwater noise, including seismic surveys, increased shipping traffic, habitat modification, and risks associated with oil spills (Weller *et al.* 2002). During the past decade, a Western Gray Whale Advisory Panel, convened by the International Union for Conservation of Nature (IUCN), has been providing scientific advice on the matter of anthropogenic threats to gray whales in the WNP. Ocean acidification could reduce the abundance of shell-forming organisms (Fabry *et al.* 2008, Hall-Spencer *et al.* 2008), many of which are important in the gray whales' diet (Nerini 1984). An **unusual mortality event (UME)** that began in 2019 and which is ongoing (NOAA 2020a), resulted in elevated levels of stranded gray whales in poor body condition, however, it is unknown if oceanographic conditions related to this UME affected WNP and ENP gray whales similarly. Annual sea ice conditions in arctic foraging grounds have been linked to variability in gray whale calf survival and production in both Western (Gailey *et al.* 2020), and Eastern (Perryman *et al.* 2002) North Pacific populations. Following years of high sea-ice coverage on foraging grounds, calf survival and production decline. Decreased spatial and temporal access to foraging grounds as a result of heavy ice cover is hypothesized as the responsible factor.

STATUS OF STOCK

The WNP stock is listed as "Endangered" under the U.S. Endangered Species Act of 1973 (ESA) and is therefore also considered "strategic" and "depleted" under the MMPA. At the time the ENP stock was delisted, the WNP stock was thought to be geographically isolated from the ENP stock. NOAA (2018) initiated a 5-yr Status Review of WNP gray whales to ensure that the listing classification is accurate. This review is ongoing. Documentation of some whales moving between the WNP and ENP indicates otherwise (Lang *et al*. 2014; Mate *et al.* 2011; Weller *et al.* 2012; Urbán *et al.* 2019). Other research findings, however, provide continued support for identifying two separate stocks of North Pacific gray whales, including: (1) significant mitochondrial and nuclear genetic differences between whales that feed in the WNP and those that feed in the ENP (LeDuc *et al.* 2002; Lang *et al.* 2014), (2) recruitment into the WNP stock is almost exclusively internal (Cooke *et al.* 2013), (3) a SNP study that indicates the gray whale gene pool is differentiated into two populations (Brüniche-Olsen *et al.* 2018a) and (4) the abundance of the WNP stock remains low while the abundance of the ENP stock grew steadily following the end of commercial whaling (Cooke *et al.*2017). As long as the WNP stock remains listed as endangered under the ESA, it continues to be considered as depleted under the MMPA.The IWC Scientific Committee stock structure hypotheses are summarized in the Stock Definition and Geographic Range section of this report. Cooke *et al.* (2017) conducted an assessment of gray whales in the WNP using an individually-based stage-structured population model with modified stock definitions that allows for the possibility of multiple feeding/breeding groups. Cooke *et al.* (2017) noted that "there is preferential, but not exclusive, mating within the Sakhalin feeding aggregation. The hypothesis of mating exclusively within the Sakhalin feeding population is just rejected ($p < 0.05$). We conclude that the Sakhalin feeding aggregation is probably not genetically closed but that the Sakhalin and Kamchatka feeding aggregations, taken together, may be genetically closed. However, genetic data from Kamchatka would be required to confirm this." In this scenario, whales identified feeding off Sakhalin represent about 2/3 of the combined Sakhalin Island-Kamchatka subpopulation. Further substructure within the subpopulation was not excluded by Cooke *et al.* (2017), including the possibility of less than 50 mature whales that breed only in the WNP. Other IWC hypotheses include the possibility that the Western Breeding stock has been extirpated (IWC 2020).

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