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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).

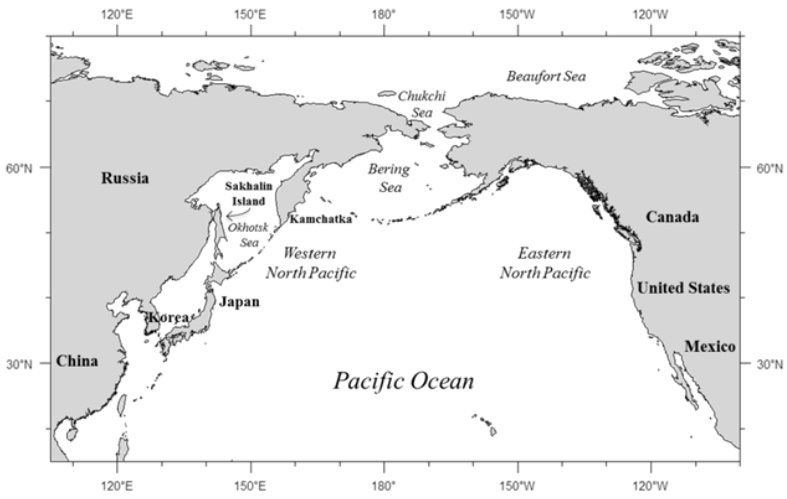

Figure 1. Range map of the Western North Pacific Stock of gray whales, including summering areas off Russia and wintering areas in the western and eastern Pacific.

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 2010; Weller *et al.* 2012; Urbán *et al.* 2013, Mate *et al.* 2015). In combination, these studies have recorded about 30 gray whales observed in both the WNP and ENP. 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 (2015) estimated that 37-100% of the whales feeding off Sakhalin Island could potentially migrate to the coast of North America or, in other words, at most 63% could migrate solely within the WNP. 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 (Cooke *et al.* 2017, IUCN 2018). 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.* 2011). Taken together, these observations indicate that not all gray whales in the WNP share a common wintering ground. Brüniche-Olsen *et al.* (2018) 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.

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 has conducted a series of annual (2014-2018) range-wide workshops on the status of North Pacific gray whales. The primary objective of these meetings was not to determine a single 'best' stock structure hypothesis (unless definitively supported by existing data) but rather to identify plausible hypotheses consistent with the suite of data available. The goal is to create a foundation for developing range-wide conservation advice. The primary hypotheses deemed as most plausible considered two separate 'breeding stocks' or biological populations (western and eastern). These hypotheses include: (a) Hypothesis 3a which assumes that while two breeding stocks (western and eastern) may once have existed, the western breeding stock is extirpated. Whales show matrilineal fidelity to feeding grounds, and the eastern breeding stock includes three feeding aggregations: Pacific Coast Feeding Group, Northern Feeding Group, and a Western Feeding Group; and (b) Hypothesis 5a which assumes that both breeding stocks are extant and that the western breeding stock feeds off both coasts of Japan and Korea and in the northern Okhotsk Sea west of the Kamchatka Peninsula. Whales feeding off Sakhalin include both whales that are part of the extant western breeding stock and remain in the western North Pacific year-round, and whales that are part of the Eastern breeding stock and migrate between Sakhalin and the eastern North Pacific.

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 Eastern North Pacific 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. The 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 ship strikes or entangled in fishing gear within U.S. waters.

Subsistence/Native Harvest Information

In 2005, the Makah Indian Tribe requested authorization from NOAA/NMFS, under the Marine Mammal Protection Act of 1972 (MMPA) and the Whaling Convention Act, to resume limited hunting of gray whales for ceremonial and subsistence purposes in the coastal portion of their usual and accustomed (U&A) fishing grounds off Washington State (NOAA 2015). Observations of gray whales moving between the WNP and ENP highlight the need to estimate the probability of a gray whale observed in the WNP being taken during a hunt by the Makah Tribe (Moore and Weller 2013). Given conservation concerns for the WNP population, the Scientific Committee of the International Whaling Commission (IWC) emphasized the need to estimate the probability of a WNP gray whale being struck during aboriginal gray whale hunts (IWC 2012). Additionally, NOAA is required by the National Environmental Policy Act (NEPA) to prepare an Environmental Impact Statement (EIS) pertaining to the Makah's request. The EIS needs to address the likelihood of a WNP whale being taken during the proposed Makah gray whale hunt.

To estimate the probability that a WNP whale might be taken during the proposed Makah gray whale hunt, four alternative models were evaluated. These models made different assumptions about the proportion of WNP whales that would be available for the hunt or utilized different types of data to inform the probability of a WNP whale being taken (Moore and Weller 2013). Based on the preferred model, the probability of striking at least one WNP whale in a single year was estimated to range from 0.006 – 0.012 across different scenarios for the annual number of total gray whales that might be struck. This corresponds to an expectation of ≥ 1 WNP whale strike in one of every 83 to 167 years. This analysis was based on a 2012 abundance estimate of 155 (95% CI 142-165) which is smaller than the 2016 abundance estimate of 290 (90% CI 271-311) whales reported by Cooke (2017).

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 ship 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).

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. Documentation of some whales moving between the WNP and ENP indicates otherwise (Lang 2010; Mate *et al.* 2011; Weller *et al.* 2012; Urbán *et al.* 2013). 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.* 2011), (2) recruitment into the WNP stock is almost

exclusively internal (Cooke *et al.* 2013), (3) a single nucleotide polymorphism (SNP) study that indicates the gray whale gene pool is differentiated into two populations (Brüniche-Olsen *et al.* 2018) 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 will continue to be considered as depleted under the MMPA.

The IWC Scientific Committee has conducted a series of annual (2014-2018) range-wide workshops on the status of North Pacific gray whales. The objective of the workshops has been to develop a series of range-wide stock structure hypotheses, using all available data sources (*e.g.* photo-id, genetics, tagging), that can be tested within a modelling framework (IWC 2017). Cooke *et al.* (2017) conducted an updated 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. The IWC analysis is ongoing and the results of Cooke *et al.* (2017) are considered provisional pending further exploration of additional gray whale stock structure hypotheses.

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