COSEWIC
Assessment and Status Report

on the

Grey Whale
Eschrichtius robustus

Northern Pacific Migratory population
Pacific Coast Feeding Group population
Western Pacific population

in Canada

Northern Pacific Migratory population - NOT AT RISK
Pacific Coast Feeding Group population - ENDANGERED
Western Pacific population - ENDANGERED
2017

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2017. COSEWIC assessment and status report on the Grey Whale *Eschrichtius robustus*, Northern Pacific Migratory population, Pacific Coast Feeding Group population and the Western Pacific population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxi + 74 pp. (http://www.registrelep-sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Previous report(s):

COSEWIC. 2009. COSEWIC status appraisal summary on the Grey Whale *Eschrichtius robustus* (Atlantic population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii pp. (www.sararegistry.gc.ca/status/status_e.cfm).

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).

Reeves, R.R. and E. Mitchell. 1987. COSEWIC status report on the grey whale (Eastern North Pacific population) *Eschrichtius robustus* in Canada. Committee on the Status of Endangered Wildlife in Canada. 36 pp.

COSEWIC. 2000. COSEWIC assessment and status report on the grey whale *Eschrichtius robustus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. v + 35 pp.

Reeves, R.R. and E. Mitchell. 1987. COSEWIC status report on the gray whale *Eschrichtius robustus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-35 pp.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la Baleine grise (*Eschrichtius robustus*), population migratrice du Pacifique Nord, population du groupe s'alimentant le long de la côte du Pacifique et la population du Pacifique Ouest, au Canada.

Cover illustration/photo:
Grey Whale, Sakhalin Island, Russia (Sea of Okhotsk), 2002. With permission from Dave Weller, NOAA.

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COSEWIC
Assessment Summary

Assessment Summary – November 2017

Common name
Grey Whale - Northern Pacific Migratory population

Scientific name
Eschrichtius robustus

Status
Not at Risk

Reason for designation
Members of this population migrate annually from wintering calving grounds in Mexico to their summer feeding areas in the Bering, Chukchi and Beaufort Seas. Despite a decline in 1999 and 2000, numbers have increased and remained well above what they were in the middle of the 20th century and have been relatively stable since the mid-1990s at about 21,000 animals.

Occurrence
Yukon, Northwest Territories, British Columbia, Pacific Ocean, Arctic Ocean

Status history
The species was considered a single unit and designated Not at Risk in April 1987. Status re-examined and designated Special Concern in May 2004. Split into two populations in November 2017; the Northern Pacific Migratory population was designated Not at Risk.

Assessment Summary – November 2017

Common name
Grey Whale - Pacific Coast Feeding Group population

Scientific name
Eschrichtius robustus

Status
Endangered

Reason for designation
Members of this small population migrate annually from their wintering grounds in Mexico to their summer feeding areas in Pacific Northwest waters, where they reside the entire summer. The population estimate is low, at about 243 individuals. Due to its small size, the population is vulnerable to stochastic events and threats including contamination from oil spills.

Occurrence
British Columbia, Pacific Ocean

Status history
The species was considered a single unit and designated Not at Risk in April 1987. Status re-examined and designated Special Concern in May 2004. Split into two populations in November 2017; the Pacific Coast Feeding Group population was designated Endangered.

Assessment Summary – November 2017

Common name
Grey Whale - Western Pacific population

Scientific name
Eschrichtius robustus

Status
Endangered

Reason for designation
Members of this population migrate annually from winter calving grounds in Mexico along the West Coast of Canada to summer feeding areas in Russia. Feeding areas in summer and autumn are located primarily in two small areas off the north-eastern coast of Sakhalin Island and off southern Kamchatka. The population is growing, but remains depleted at about 174 adults. The population faces many threats, including cumulative effects of increasing oil and gas activities in its summer range.

Occurrence
British Columbia, Pacific Ocean

Status history
This population was not part of the original assessment of the Eastern North Pacific Grey Whale that was considered a single unit and designated Not at Risk in April 1987. This new Western Pacific population was designated Endangered in November 2017.

COSEWIC
Executive Summary

Grey Whale
Eschrichtius robustus

Northern Pacific Migratory population
Pacific Coast Feeding Group population
Western Pacific population

Wildlife Species Description and Significance

The Grey Whale is a medium- to large-sized (adult length 12–14 m) baleen cetacean. It is the only living representative of the family Eschrichtiidae.

Grey Whales were historically important to Aboriginal people as subsistence and cultural resources. They are still hunted for subsistence in the eastern Russian Arctic, and the Makah tribe in Washington State, USA, is expected to resume a small, regulated subsistence hunt, as well. Grey Whales are significant to nature tourism along the west coast of North America, including British Columbia. Also, Grey Whales in the eastern North Pacific are considered an example of successful conservation, having been severely depleted by commercial whaling but then having recovered to a considerable extent under international protection.

Three designatable units (DUs) are described – a Northern Pacific Migratory population (DU1), a Pacific Coast Feeding Group population (DU2), and a Western Pacific (Sakhalin Island) population (DU3).

Distribution

Grey Whales occurred historically in both the North Atlantic and North Pacific oceans but they were extirpated from the Atlantic, probably several hundred years ago, and are now restricted to the North Pacific. Although they were common in both the eastern and western Pacific as recently as the 19th century, they were nearly extirpated in the west by the middle of the 20th century and today the vast majority of the population is in the east. The distribution is primarily coastal (depth < 60 m), although the whales move across deep ocean areas during migration. The endpoints of migration in the east are Baja California and the Mexican mainland to as far south as 21°N (winter) and the northern Bering, Chukchi and Beaufort seas (summer and autumn). Some “western” Grey Whales that spend the summer and autumn in Russia migrate across the Okhotsk and Bering seas and the Gulf of Alaska, joining the eastern migration stream in British Columbia and Washington State to overwinter in Mexico. Also, some "eastern" Grey Whales do not migrate as far north as the others and remain through the summer and autumn in waters between Alaska and northern California.

Grey Whales are present in near-shore and inshore waters of British Columbia year-round, with the numbers increasing markedly during the migration seasons as individuals moving to and from the Arctic or eastern Russia pass through the area. Small numbers of long-distance migrants reach the Canadian Beaufort Sea off Yukon and the Northwest Territories in the summer and autumn.

Habitat

Grey Whales are best known as benthic foragers that rely heavily on amphipod crustaceans and other swarming organisms found in or on soft bottom sediment. The "mud plumes" created as they filter sediments through their baleen are characteristic of feeding Grey Whales. They also forage in the water column, at least opportunistically. In British Columbia, Grey Whales forage on Ghost Shrimp in shallow (< 3 m), sheltered bays and inlets, on amphipods in somewhat deeper (< 35 m) sandy bays on the exposed outer coast, on mysids or crab larvae over rock and boulder substrates and in kelp beds (< 30 m), and on the eggs and larvae of Pacific Herring in eelgrass beds.

The principal subtropical lagoons and bays inhabited during the winter reproductive season in Mexico, where very little feeding occurs, are shallow (generally < 4 m) with sandy or muddy bottom. Winter water temperatures in these often hypersaline habitats are generally 15–20°C.

Biology

Most calves are conceived in late November and early December during the southbound migration (median birth date in late January). The gestation period is 13–14 months and females give birth to a single calf at intervals of at least two years. Lactation lasts for about six months and calves accompany their mothers on the first northward migration to the feeding grounds where they are weaned. The average age at sexual maturity is eight years and Grey Whales continue to grow until they are approximately 40. The generation time for assessment purposes is estimated as 22.9 years and it is assumed that 60% of the total eastern population and 47% of the western population are mature individuals.

The only significant predators of Grey Whales are Killer Whales, which take a particularly significant toll on young of the year during the spring northbound migration.

Population Sizes and Trends

Views differ on the size of the total North Pacific Grey Whale population prior to commercial whaling (which began in the eastern Pacific in the 1840s). Estimates range from 23,000–35,000 (eastern Pacific only) to around 96,000 (basin-wide). It is generally agreed that substantial population recovery has occurred, at least in the eastern Pacific, since the species was legally protected from commercial whaling in 1951. At present the long-distance migratory population in the eastern North Pacific numbers around 21,000, with an additional 200 whales that do not migrate any farther north than the Gulf of Alaska (and many of which forage through the summer and autumn in British Columbia and nearby waters). The Western Pacific population (here referring specifically to the group of Grey Whales that feed in the summer and autumn off Sakhalin Island, Russia; DU3) consists of 150–200 animals, some of which migrate through British Columbia waters.

Numbers of Grey Whales in the eastern Pacific (including both DU1 and DU2) are thought to be fairly stable while numbers using the Sakhalin Island feeding ground in Russia (DU3) have been increasing at around 4%/year.

Threats and Limiting Factors

Removals by subsistence whalers in Chukotka, Russia (reportedly averaging 127/year from 2008 to 2012 from what is considered the Northern Pacific Migratory population, DU1) are considered sustainable. In addition, small numbers of Grey Whales (probably tens/year) from throughout the species' range (all DUs) die or are seriously injured as a result of entanglement or entrapment in fishing gear and due to ship strikes. Other potential threats include disturbance from noise caused by human activities such as shipping and offshore industrial development (oil and gas, wind and tidal energy), degradation of prey as a result of dredging, dumping, or oiling, ocean acidification, and climate change (which could give Grey Whales greater access to foraging habitat in formerly ice-covered high-latitude areas but also put them at greater risk of Killer Whale predation, ship strikes, etc.).

Protection, Status and Ranks

Grey Whales are fully protected from commercial whaling, and Aboriginal subsistence whaling in the United States and Russia is managed under the International Convention for the Regulation of Whaling (IWC). The species is in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Its IUCN Red List status is Least Concern but the "western subpopulation" is red-listed separately as Critically Endangered. The species is on the B.C. Blue List (Special Concern) and ranked provincially as S3 (Vulnerable) and globally as G4 (Apparently Secure). The *Canadian Species at Risk Act* currently recognizes two DUs of Grey Whales: the Eastern North Pacific population listed on Schedule 1 as Special Concern and an Atlantic population listed on Schedule 1 as Extirpated. Following the COSEWIC status assessment November 2017, the previous Eastern North Pacific population was split into three populations; North Pacific Migratory population (Not at Risk), Pacific Coast Feeding Group population (Endangered), and the Western Pacific population (Endangered).

Most of the Grey Whale's habitat in the eastern Pacific (including that of some whales from western Pacific feeding grounds) lies within the exclusive economic zones of Mexico, the USA, and Canada. Several protected areas in all three countries have been designated, in part, to give special protection to Grey Whales. Three of the four major calving and nursery sites in Mexico are within a Biosphere Reserve.

TECHNICAL SUMMARY – Northern Pacific Migratory population (DU1)

Eschrichtius robustus

Grey Whale (Northern Pacific Migratory population)

Baleine grise (Population migratrice du Pacifique Nord)

Range of occurrence in Canada: British Columbia, Yukon, Northwest Territories; Pacific Ocean, Arctic Ocean, Beaufort Sea

Demographic Information

Generation time (Taylor *et al*. 2007)	23 years
Is there a continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	0 Despite the die-off in 1999 and 2000, Grey Whale numbers in the eastern North Pacific have remained well above what they were in the middle of the twentieth century and overall abundance "has been relatively stable since the mid-1990s" (Carretta *et al*. 2015).
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a.clearly reversible and b.understood and c. ceased?	Not applicable.
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (COSEWIC 2004)	250,000 km^2
Index of area of occupancy (IAO)	2,241 km^2 Based on total area of the 4 main areas (in Mexico) used by most of the population for winter calving and early stages of nursing (COSEWIC 2004)

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	Not applicable
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Not applicable
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	No
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"∗?	Not applicable
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Total	Ca. 12,350 20,990 (CV=0.05) whales of all ages estimated from 2010 to 2011 survey (Durban *et al*. 2013) [Likely includes at least parts of both other proposed DUs so need to subtract ca. 400 from total = 20,590]. Assumed 60% of the total population consists of mature individuals (Taylor *et al*. 2007)

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not applicable. Analysis has not been undertaken.

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes The Calculated Overall Threat Impact for this DU was Low to Medium based upon the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system. Concerns about the impacts of offshore oil and gas development as well as the transport of oil in the marine environment are widely recognized. Small numbers of Grey Whales from throughout the species' range die or are seriously injured as a result of entanglement or entrapment in fishing gear and due to ship strikes. Other potential threats include disturbance from noise caused by human activities such as shipping and offshore industrial development (oil and gas, wind and tidal energy), degradation of prey as a result of dredging, dumping, or oiling, ocean acidification, and climate change. Removals by subsistence whalers in Chukotka, Russia are considered sustainable.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Atlantic population is Extirpated; Western North Pacific (Sakhalin) subpopulation is IUCN red-listed as Critically Endangered; Western Pacific DU is small (ca. 200) and is already included (at least partly) in the counts in California from which abundance estimates for this DU are derived
Is immigration known or possible?	Unknown
Would immigrants be adapted to survive in Canada?	Presumably yes
Is there sufficient habitat for immigrants in Canada?	Unknown
Are conditions deteriorating in Canada?[+]	Possibly given anticipated increases in ship traffic and offshore energy development projects
Are conditions for the source population deteriorating?[+]	Unknown although yes for Western DU
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: The species was considered a single unit and designated Not at Risk in April 1987. Status re-examined and designated Special Concern in May 2004. Split into two populations in November 2017; the Northern Pacific Migratory population was designated Not at Risk.

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Status and Reasons for Designation:

Status: Not at Risk	**Alpha-numeric codes:** Not applicable
Reasons for designation: Members of this population migrate annually from wintering calving grounds in Mexico to their summer feeding areas in the Bering, Chukchi and Beaufort Seas. Despite a decline in 1999 and 2000, numbers have increased and remained well above what they were in the middle of the 20th century and have been relatively stable since the mid-1990s at about 21,000 animals.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Likely stable.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO and IAO both exceed thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable.
Criterion D (Very Small or Restricted Population): Not applicable. The number of mature individuals is 12,350.
Criterion E (Quantitative Analysis): Not applicable.

TECHNICAL SUMMARY – Pacific Coast Feeding Group population (DU2)

Eschrichtius robustus

Grey Whale (Pacific Coast Feeding Group population)

Baleine grise (Population du groupe s'alimentant le long de la côte du Pacifique)

Range of occurrence in Canada: British Columbia; Pacific Ocean

Demographic Information

Generation time (Taylor *et al*. 2007)	23 years
Is there a continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a.clearly reversible and b.understood and c. ceased?	Not applicable.
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	> 20,000 km² Not calculated but would include only the B.C. portion of the species' EOO but that would certainly exceed 20,000 km^2
Index of area of occupancy (IAO)	2,241 km² Based on total area of the 4 main areas (in Mexico) used by most of the population for winter calving and early stages of nursing (COSEWIC 2004)

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	Not applicable
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Not applicable
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	No
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"∗?	Not applicable
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Total	Ca.146 243 (SE=18.9) whales of all ages estimated in 2015. Assumed 60% of the total population consists of mature individuals (Taylor *et al*. 2007)

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not applicable.

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? [Yes] The Calculated Overall Threat Impact for this DU was Medium to High based upon the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system. Offshore oil and gas development, and renewable energy projects as well as the transport of oil in contributed to the calculated overall threat impact score. Grey Whales are also exposed to entanglement in fishing gear and collisions with boats throughout the range.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Atlantic population is Extirpated; Western North Pacific (Sakhalin) population is red-listed as Critically Endangered; the other two populations (North Pacific and Pacific Coast Feeding Group) are already included in Canadian DU(s)
Is immigration known or possible?	Unknown
Would immigrants be adapted to survive in Canada?	Presumably yes
Is there sufficient habitat for immigrants in Canada?	Unknown
Are conditions deteriorating in Canada?+	Possibly given anticipated increases in ship traffic and offshore energy development projects
Are conditions for the source population deteriorating?+	Unknown although yes for Western Pacific (Sakhalin) population
Is the Canadian population considered to be a sink?+	No
Is rescue from outside populations likely?	Unknown

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: The species was considered a single unit and designated Not at Risk in April 1987. Status re-examined and designated Special Concern in May 2004. Split into two populations in November 2017; the Pacific Coast Feeding Group population was designated Endangered.

Status and Reasons for Designation:

Status: Endangered	Alpha-numeric codes: D1
Reasons for designation: Members of this small population migrate annually from their wintering grounds in Mexico to their summer feeding areas in Pacific Northwest waters, where they reside the entire summer. The population estimate is low, at about 243 individuals. Due to its small size, the population is vulnerable to stochastic events and threats including contamination from oil spills.	

+ See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Likely stable.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO and IAO both exceed thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable.
Criterion D (Very Small or Restricted Population): Meets Endangered, D1, as population is estimated to have fewer than 250 mature individuals.
Criterion E (Quantitative Analysis): Not applicable.

TECHNICAL SUMMARY – Western Pacific population (DU3)

Eschrichtius robustus

Grey Whale (Western Pacific population)

Baleine grise (Population du Pacifique Ouest)

Range of occurrence in Canada: British Columbia; Pacific Ocean

Demographic Information

Generation time (Taylor *et al*. 2007)	23 years
Is there a continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a.clearly reversible and b.understood and c. ceased?	Not applicable.
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence Not possible to estimate from available data and information	Unknown

Index of area of occupancy (IAO)	2,241 km² (presumed calving and early stages of nursing grounds) or <1,000 km^2 (primary feeding grounds) Assuming that the sojourn of 1 satellite-tracked female to the Mexican wintering grounds is representative, the same estimate as for all of the other DUs (2,241 km) may be appropriate; alternatively, given the fidelity shown by this population to the two small primary feeding areas off northeastern Sakhalin Island, the total area of those two parcels (probably < 1,000 km²) may be appropriate (see main text).
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	Not applicable
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Not applicable
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Quality is definitely expected to decline with ongoing oil and gas development in primary feeding areas along with increased shipping
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"∗?	Not applicable
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Total	88 Mature females estimated as 44 in 2015 (WGWAP 2016). Adding an equal number of mature males = 88

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not applicable

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? [Yes]

The calculated overall threat impact for this DU was High to Very High based upon the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system.

The increasing activity of offshore oil and gas development, transport of oil in the marine environment, and potential for pipeline spills in and near the Sakhalin feeding areas all contributed to the calculated overall threat impact. Western Pacific Grey Whales are also exposed to entanglement in fishing gear and collisions with boats throughout their range.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Atlantic population is Extirpated; the other two populations (North Pacific Migratory (DU1) and Pacific Coast Feeding Group (DU2)) are already included in Canadian DU(s)
Is immigration known or possible?	Unknown
Would immigrants be adapted to survive in Canada?	Presumably yes
Is there sufficient habitat for immigrants in Canada?	Unknown but likely
Are conditions deteriorating in Canada?[+]	Possibly given anticipated increases in ship traffic and offshore energy development projects
Are conditions for the source population deteriorating?[+]	Unknown
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	Unknown

Data Sensitive Species

Is this a data sensitive species? No

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Status History

COSEWIC: This population was not part of the original assessment of the Eastern North Pacific Grey Whale that was considered a single unit and designated Not at Risk in April 1987. This new Western Pacific population was designated Endangered in November 2017.

Status and Reasons for Designation:

Status: Endangered	**Alpha-numeric codes:** D1
Reasons for designation: Members of this population migrate annually from winter calving grounds in Mexico along the West Coast of Canada to summer feeding areas in Russia. Feeding areas in summer and autumn are located primarily in two small areas off the northeastern coast of Sakhalin Island and off southern Kamchatka. The population is growing, but remains depleted at about 174 adults. The population faces many threats, including cumulative effects of increasing oil and gas activities in its summer range.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable.
Criterion D (Very Small or Restricted Population): Meets Endangered, D1, as population is estimated to have fewer than 250 mature individuals.
Criterion E (Quantitative Analysis): Not applicable.

PREFACE

Grey Whales in the Pacific Ocean were assessed by COSEWIC in 2004 as a single designatable unit – the Eastern North Pacific population. This population was designated as Special Concern.

Since the last assessment, considerable work has been conducted on Grey Whales including multiple workshops (Makah Tribal Council 2012; International Whaling Commission 2015a, 2016, 2017) dedicated to examining their population structure and status in the North Pacific. Much of the deliberation at those workshops focused on the Pacific Coast Feeding Group (PCFG). The PCFG is genetically distinct insofar as there is a consistent pattern of mtDNA differentiation (Frasier *et al*. 2011). Furthermore, recent analyses of photo-identification data through 2015 indicated a higher degree of internal recruitment into this group than had previously been suggested (Calambokidis and Pérez 2017). The genetic results and photo-identification data suggest strong maternally directed fidelity to summer feeding grounds, of which near-shore waters of British Columbia form a major part.

The Western Pacific (Sakhalin) population of Grey Whales, which is approximately the same size as the PCFG (around 200 individuals), feeds in summer and autumn primarily in two small areas off the northeastern coast of Sakhalin Island, Russia (Weller *et al*. 2002a,b) as well as off southern Kamchatka, Russia (Tyurneva *et al*. 2010). In the previous report (COSEWIC 2004), it was assumed that none of these whales occurred in Canada and therefore there was no need to include them in the assessment. However, the results of satellite-linked tagging at Sakhalin in 2010 and 2011, followed by an intensive effort to compare photographs and genetic biopsy samples between the Sakhalin whales and the Grey Whales observed off western North America, have revealed regular annual seasonal movements by at least some Sakhalin whales across the Pacific and into Canadian waters as they move toward the wintering grounds in Mexico (Weller *et al*. 2012; Mate *et al*. 2015; International Whaling Commission 2015b, 2016). The extirpation (or near-extirpation) of Grey Whales from mainland Asia and Japan by whaling has created a significant gap in the effective global distribution of the species. Even though that gap is not in Canada, it deserves consideration when assessing the “significance” of the Western Pacific DU, which probably constitutes the best, and perhaps only, prospect for enabling recolonization and recovery of Grey Whales in their full historical western North Pacific range.

The estimated total abundance of Grey Whales in the eastern North Pacific is about 21,000 and numbers have been relatively stable since the mid-1990s (Carretta *et al*. 2015). The numbers for the PCFG have also been relatively stable since the early 2000s but the PCFG population appears to have increased in 2013–2015 (Calambokidis *et al*. 2017). The Western Pacific population increased at an average rate of 3.8% per year (CI 2.8-4.8%) from 1994 through 2014.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2017)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service
Environnement et Changement climatique Canada
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Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Grey Whale
Eschrichtius robustus

Northern Pacific Migratory population
Pacific Coast Feeding Group population
Western Pacific population

in Canada

2017

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

The Grey Whale (*Eschrichtius robustus*, Lilljeborg 1861) is named for its greyish colour. English synonyms are Gray Whale (US spelling) or California Gray Whale. Antiquated (whaler-coined) names for the species include scrag, hard-head, mussel-digger, devilfish, gray-back and ripsack.

In European languages the animal is also usually named for its colour: *Baleine grise* (French), *Ballena gris* (Spanish) and *серый кит* (Russian). Indigenous names for the species include *mauk* (Nuu-chah-nulth), *balgina* (Kwakw'ala – western dialects; sometimes also applied to Minke Whales (*Balaenoptera acutorostrata*)), *gwa'yam* (Kwakw'ala – eastern dialects; generic name for any large whale), *cetuqupak* (Yup'ik), and *abvibluaq* (Iñupiaq).

The Grey Whale is generally regarded as the only extant species in the family Eschrichtiidae. However, there is some uncertainty around the taxonomy. Some studies suggest that Eschrichtiidae is closely related to the Balaenopteridae, i.e., the rorquals or groove-throated whales (Arnason and Best 1991; Milinkovitch *et al.* 1994), while others go further and suggest that the Grey Whale is actually nested within the family Balaenopteridae (Arnason *et al*. 1993; Arnason and Gullberg 1994; Dornburg *et al*. 2012; but see Gatesy *et al*. 2013). No living subspecies of the Grey Whale are recognized.

Morphological Description

The Grey Whale is a medium-sized to large baleen whale. Physically mature females typically range from 14 – 15 m in length, males 13 – 14 m (Rice and Wolman 1971). The skin colour ranges from dark to light grey with varying degrees of mottling. Nearly all adults are heavily infested with ectoparasites and epizoites including the barnacle *Cryptolepas rachianecti* and up to three species of cyamids, or whale lice (*Cyamus scammoni*, *C. ceti*, and *C. kessleri*). The Grey Whale is the only large baleen whale in which the upper jaw extends beyond the lower one. The 130 – 180 baleen plates are 5 – 25 cm long and cream to pale yellow in colour. Grey Whales have two to five longitudinal throat creases that may facilitate gular expansion during feeding. They lack a proper dorsal fin and instead have a low hump followed by a series of 6 to 15 knobs or bumps (called knuckles) along the dorsal midline.

Population Spatial Structure and Variability

Grey Whales are generally regarded today as occupants primarily of the shallow continental margins of the North Pacific and adjacent Arctic Ocean. The Grey Whales that formerly inhabited the North Atlantic were geographically disjunct from their progenitors in the North Pacific, with the species having dispersed into the Atlantic when climatic conditions (sea level and ice cover) permitted during the Pleistocene and Holocene (Alter *et al*. 2015). Grey Whales had probably disappeared from the Atlantic by the early 18th century

(Mead and Mitchell 1984; Lindquist 2000). In recent years, possibly due to lessening of ice cover in the northern passages across North America and Eurasia, a few Grey Whales have been observed in the Atlantic Ocean although no population has become re-established there (see Alter *et al*. 2015).

In the Pacific, there has been a long-standing assumption that the Grey Whales using separate migration corridors along western North America and eastern Asia constituted separate eastern and western populations, respectively (Rice and Wolman 1971). Recent evidence from satellite tagging, photo-identification, and molecular individual identification shows that some Grey Whales move seasonally between the Russian Far East and the west coast of North America (Weller *et al*. 2012; Mate *et al*. 2015). A degree of genetic structure and variability nonetheless exists in the total North Pacific population, as explained in more detail below under **Designatable Units**.

In the eastern North Pacific, a long-recognized tendency for some Grey Whales to remain "behind" when most of the population migrates to high-latitude feeding grounds has led to recognition of a group that has come to be known as the Pacific Coast Feeding Group (PCFG), which consists of whales that spend the summer and autumn feeding in temperate coastal waters of the eastern Pacific from northern California to the Gulf of Alaska rather than joining the bulk of the northbound eastern migrants into and out of the Bering and Chukchi seas. In its simulation trials to evaluate various stock identity hypotheses, the Scientific Committee of the International Whaling Commission (IWC) considered the PCFG to be one of two "plausible 'stocks'," the other being whales that migrate "north" (meaning north of Vancouver Island) (IWC 2015b, p.489). The PCFG has not been designated as either a "population stock" or a "distinct population segment" in the United States according to the criteria of the *Marine Mammal Protection Act* and the *Endangered Species Act*, respectively.

Grey Whales, much like Humpback Whales (*Megaptera novaeangliae*) (see COSEWIC 2011), have strong site fidelity, at least in regard to feeding areas. This feature is particularly evident in the whales that return year after year to the spatially restricted feeding areas off Sakhalin Island and southern Kamchatka in Russia (Tyurneva *et al*. 2010), albeit sometimes after several years of "temporary emigration" after weaning (Bradford *et al*. 2006), but also evident in the relatively well-studied PCFG (Calambokidis *et al*. 2002).

Designatable Units

The Grey Whales considered in this report are part of one or more Pacific DUs and are clearly separate from the extirpated Atlantic DU (COSEWIC 2009). Classically, Grey Whales in the North Pacific were regarded as having two geographically distinct populations, one migrating along the coast of western North America from Mexico to Alaska (USA) and into the Bering, Chukchi, and Beaufort Seas and the other along the East Asian coast from Russia to the Korean peninsula and possibly farther south (Rice and Wolman 1971). When the species was last assessed in 2004, this paradigm was adopted and the report (COSEWIC 2004) noted, "There appears to be no genetic exchange between the eastern and western Pacific populations (LeDuc *et al.* 2002)." Also at that time, although the occurrence of a "summer-resident community" of Grey Whales was known to spend the summer feeding in temperate waters between southeastern Alaska and northern California rather than migrating to the Bering Sea and northward, these whales were described as "a small part of the eastern North Pacific population" rather than as a potentially discrete population (COSEWIC 2004). In other words, the "Pacific Coast Feeding Group," as it has come to be known, was not considered a DU candidate.

Here, three putative DUs are described: (1) a Northern Pacific Migratory population (Figure 1), (2) a Pacific Coast Feeding Group (PCFG) population (Figure 2), and (3) a Western Pacific population (Figure 3). All three DUs definitely occur in Canadian waters and therefore should be included in the assessment. In evaluating the validity of the DUs, it is important to emphasize that the COSEWIC DU guidelines (as adopted in November 2014) require that for a population below the species or subspecies level to qualify, it must be shown that the population "has attributes that make it 'discrete' and evolutionarily 'significant' relative to other populations."

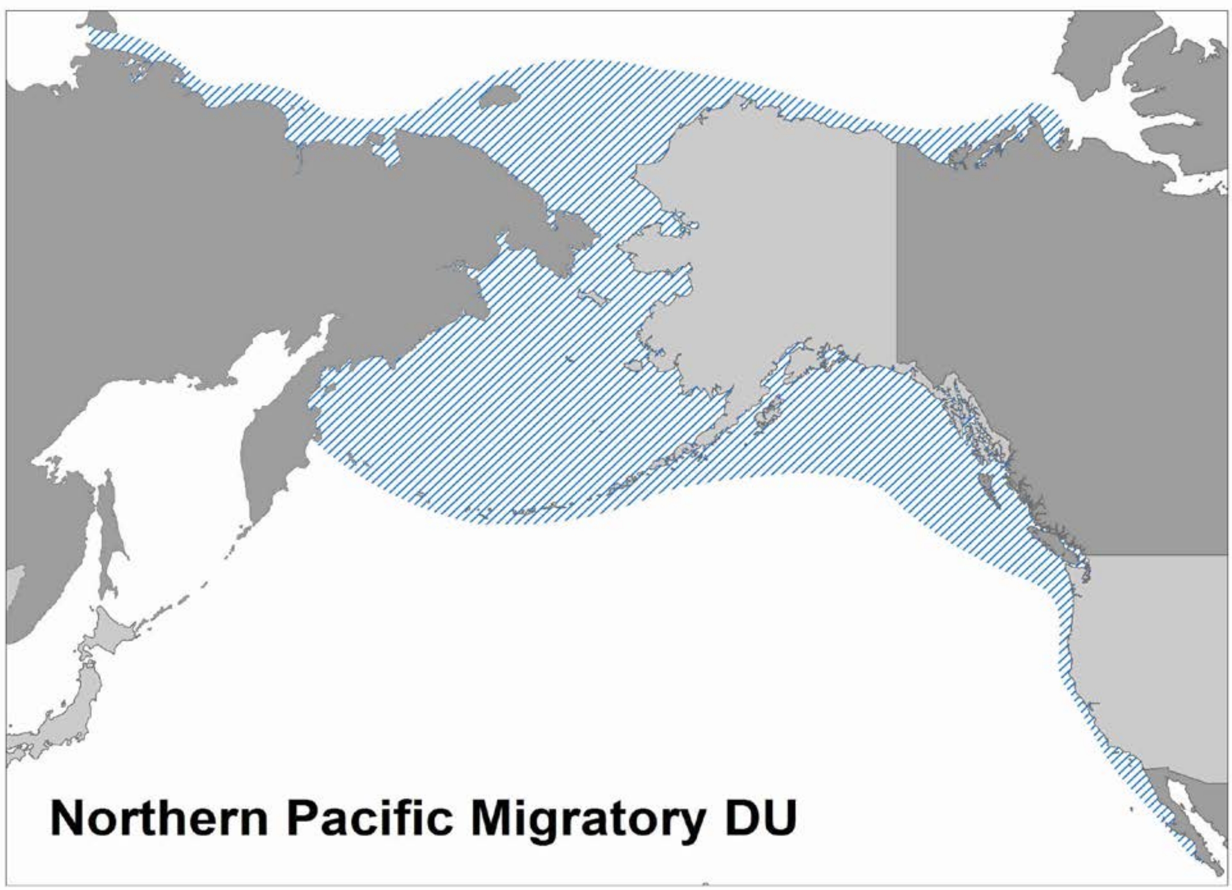

Figure 1. Approximate distribution of Northern Pacific Migratory DU (DU1) including summer and autumn feeding areas, wintering areas and migration route. Prepared by Robin Abernethy, courtesy of John Ford.

Figure 2. Approximate primary distribution of Pacific Coast Feeding Group DU (DU2) including summer and autumn feeding areas, wintering areas and migration route. Prepared by Robin Abernethy, courtesy of John Ford.

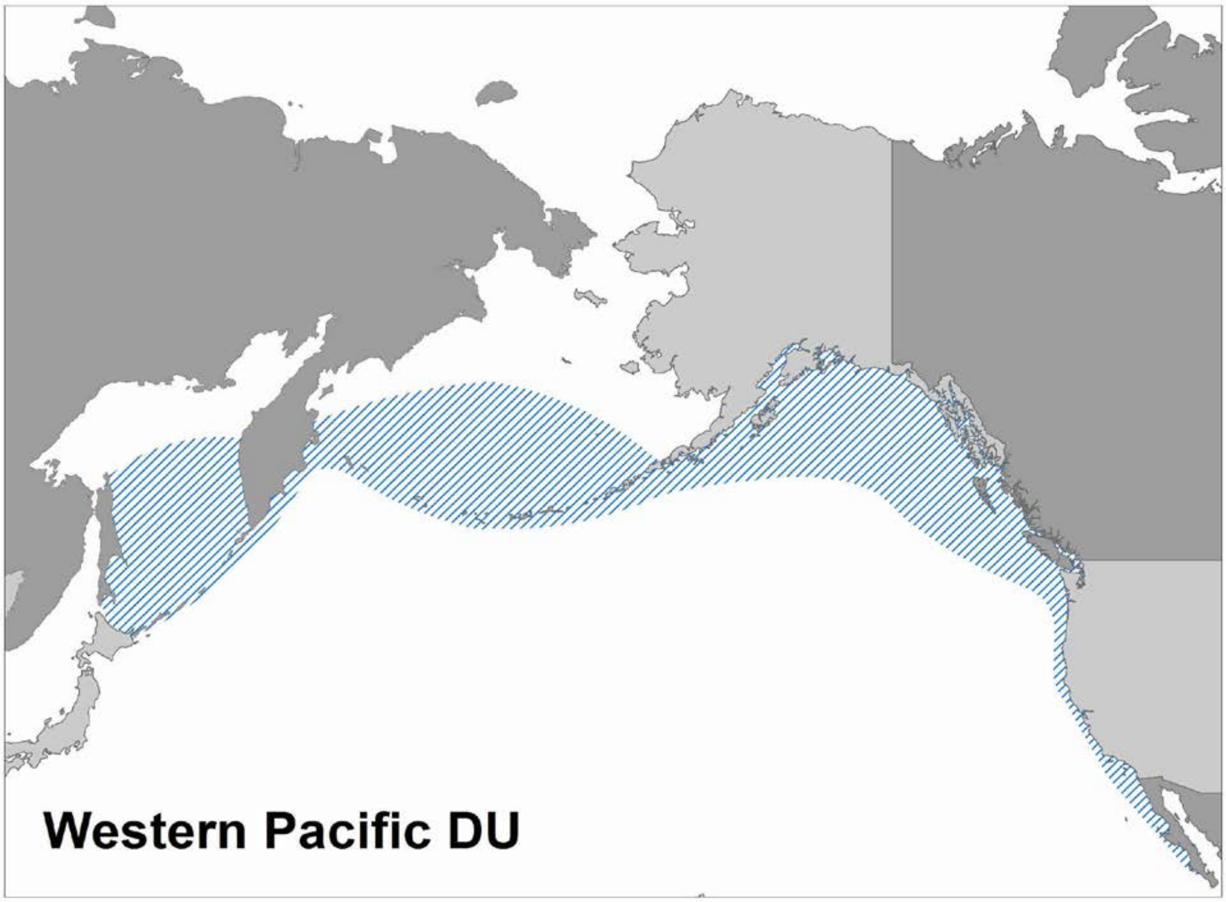

Figure 3. Approximate distribution of Western Pacific DU (DU3) including summer and autumn feeding areas, wintering areas and migration route. Prepared by Robin Abernethy, courtesy of John Ford.

<u>Northern Pacific Migratory population (DU1)</u>

The individuals that migrate between Mexico and the Bering, Chukchi, and Beaufort Seas and are not "summer-resident" in lower latitudes would constitute the Northern Pacific Migratory population. This DU either (a) would include the migrants from the western Pacific that join the migration stream in the eastern Pacific or (b) would not include them if the western animals are themselves considered to compose a separate Western Pacific DU.

<u>Pacific Coast Feeding Group population (DU2)</u>

The validity of Pacific Coast Feeding Group (PCFG) as a DU is difficult to evaluate. As mentioned above, it has long been known that some Grey Whales in the eastern North Pacific do not migrate all the way to the Bering Sea and northward in summer (Hatler and Darling 1974; Darling 1984; Calambokidis *et al*. 2002). Although the previous COSEWIC status report (COSEWIC 2004) did not attempt to describe this group of whales as a potential DU, it concluded "… factors that adversely affect summer residents or their habitat could cause local extinction due to the high degree of site-fidelity of summer resident individuals and the possibility of site-specific recruitment (Calambokidis *et al*. 2002)."

Considerable scientific work has been conducted on this population since 1996, driven primarily by the need on the part of the U.S. government to respond to an initiative by the Makah Tribe in northwestern Washington State to exercise its treaty right to resume the hunting of Grey Whales (Makah Tribal Council 2012; Lang *et al*. 2014; Carretta *et al*. 2015). Given the U.S. government's commitment to align its management of "aboriginal subsistence" whaling with the International Convention for the Regulation of Whaling, there has been extensive discussion and analyses of the PCFG within the International Whaling Commission's (IWC's) Scientific Committee, and particularly its Standing Working Group on Aboriginal Subsistence Whaling Management Procedures (e.g., International Whaling Commission 2012a,b, 2013) and its Sub-committee on Bowhead (*Balaena mysticetus*), Right and Grey Whales. Moreover, the IWC Scientific Committee has held four workshops dedicated to examining the population structure and status of North Pacific Grey Whales, and much of the deliberation at those workshops has focused on the PCFG (International Whaling Commission 2015b, 2016, 2017). In addition, the U.S. National Marine Fisheries Service carried out its own analyses to determine whether the PCFG whales qualify as a "population stock" under the *U.S. Marine Mammal Protection Act* and concluded that the information was insufficient to support an affirmative determination (Weller *et al*. 2013; Lang *et al*. 2014; Carretta *et al*. 2015).

Following is a summary of the evidence for discreteness and significance of a PCFG DU following COSEWIC's Guidelines for Recognizing Designatable Units.

Discreteness:

Genetic analyses have been used to evaluate the degree to which the proposed PCFG DU is discrete from the proposed Northern Pacific Migratory DU. Frasier *et al*. (2011) compared mitochondrial sequence data from 40 PCFG individuals to sequences from 105 individuals believed to represent the larger migratory population and found significant differences in haplotype frequencies, with an estimated exchange rate of <<1% per generation between the two maternally based groups. Moreover, estimates of the probability of a mutation occurring within the population in each generation were significantly different between the two groups. Frasier *et al*. (2011) concluded that their genetic results, in combination with photo-identification data demonstrating strong maternally directed fidelity to summer feeding grounds, demonstrated that the PCFG "qualifies as a separate MU [Management Unit, sensu Moritz 1994], and requires separate management consideration."

D'Intino *et al*. (2013) analysed 15 nuclear microsatellite loci in 59 PCFG individuals and 40 individuals from the Mexican calving lagoons (which they considered representative of the larger migratory population). They found no indication of population structure from this analysis and concluded that the combined data from mitochondrial and nuclear markers and photo-identification suggest a single interbreeding population with seasonal, maternally directed site fidelity to different feeding areas.

Lang *et al*. (2014) conducted a more extensive analysis of both mitochondrial DNA (mtDNA) and 12 microsatellite markers from 113 samples of whales considered to represent the PCFG DU (collected between northern California and British Columbia and screened to confirm that their photo-ID histories made them assignable to the PCFG) and 75 samples of whales considered to represent the Northern Pacific Migratory DU (all collected from the subsistence hunt in Chukotka, Russia). (Note that the study by D'Intino *et al*. (2013) differed in that it used samples from the Mexican calving/nursery grounds rather than from the Chukotka feeding ground to represent the Northern Pacific Migratory DU; clearly some of the samples from Mexico may have been from PCFG individuals.) Lang *et al*. (2014) found statistically significant differences in all mtDNA comparisons of the PCFG whales with the Chukotka whales but none of their comparisons using microsatellite data was significant. Thus, their findings broadly corroborated those of Frasier *et al*. (2011) and D'Intino *et al*. (2013). The genetic data, particularly when combined with photo-identification data, are consistent with the hypothesis that the use of feeding grounds is influenced by internal recruitment but mating is random with respect to feeding ground affiliation. Determination of the balance between internal recruitment (whales with PCFG parents coming into the population) and external immigration (whales with non-PCFG parents coming into the population) is critical to determining whether or not the population is demographically discrete.

In conclusion, it is reasonable to argue that the PCFG is genetically distinct insofar as there is a consistent pattern of mtDNA differentiation even though the differences in haplotype frequencies between PCFG and other "eastern" Grey Whales are not large. There are no morphological or life history features that distinguish the two groups but a clear behavioural difference exists between them. The history and "origins" of the PCFG are obscure but summer and autumn observations of Grey Whales have been made within the range of the PCFG since as early as the 1920s (Lang *et al*. 2014).

Significance:

The genetic differences between PCFG and other "eastern" Grey Whales cannot be considered to reflect relatively deep intraspecific phylogenetic divergence nor is the PCFG the only surviving natural occurrence of its species. Therefore, any argument for the PCFG's evolutionary significance must hinge on at least one of two other criteria – either (1) it persists in an ecological setting unusual or unique to the species, such that it is likely or known to have given rise to local adaptations, or (2) its loss would result in an extensive disjunction in the range of the species in Canada that would not be recolonized by natural dispersal.

Regarding criterion (1), PCFG Whales occupy a unique environmental setting in which there are differences in behaviour, specifically related to their selection of feeding habitat and mode of foraging (e.g., Duffus 1996; Darling *et al*. 1998; Dunham and Duffus 2001, 2002; Nelson *et al*. 2008), that may distinguish PCFG whales from longer-distance migrating Grey Whales. If, as is likely, this behaviour is culturally inherited from mother to calf, these differences might be used to infer that some degree of "local adaptation" is present, or incipient. The California Current System (Figure 4) is an example of an Eastern Boundary Current System in which "wind-driven upwelling drives nutrient-rich water to the ocean surface, making these regions among the most productive on earth" (Jacox *et al*. 2016). In fact, a study of changes in the environmental carrying capacity for Grey Whales in the North Pacific over the past 120,000 years led Pyenson and Lindberg (2011) to conclude that the "ecological plasticity in feeding" exhibited by PCFG whales was a critical factor in allowing their species to adapt to dramatic fluctuations in the environment during the Late Pleistocene and the Holocene. In those authors' view, the "behavioral plasticity" shown by PCFG whales "will be an important trait with the increasingly rapid heating of the Northern cryosphere projected to occur in the coming decades" and therefore "protecting those individuals that display alternative migratory behavior and feeding modes should be an important priority regardless of their molecular or morphological similarity [to the rest of the Grey Whale population]."

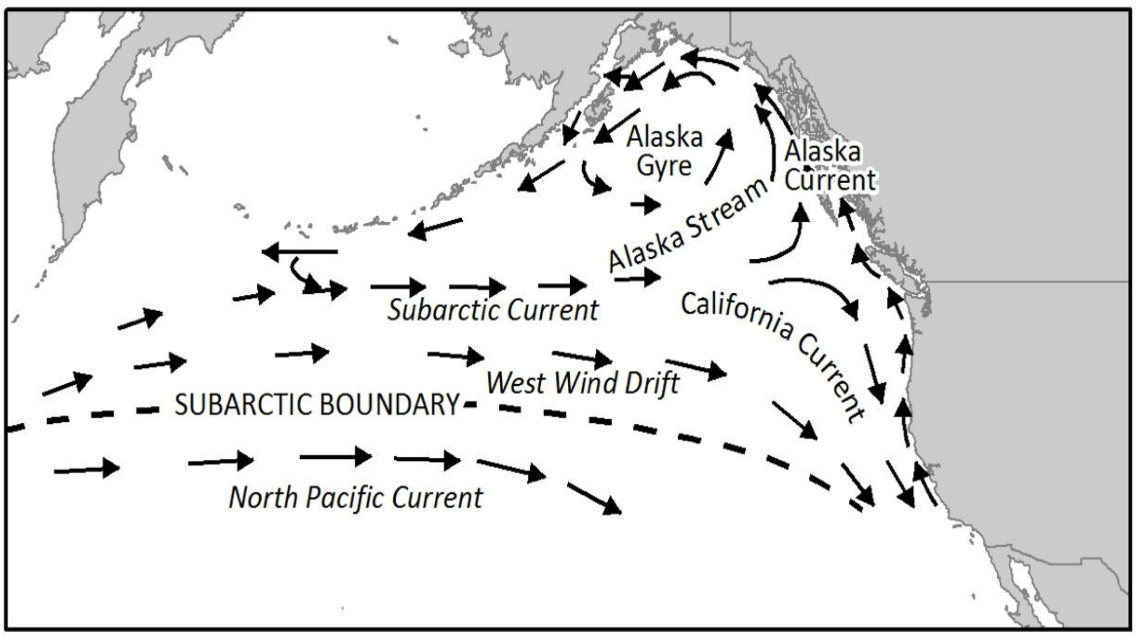

Figure 4. Northeast Pacific Currents including the California Current System. Reproduced from Ford (2014), courtesy Fisheries and Oceans Canada.

It is possible, however, that the purported difference in foraging behaviour between PCFG and northern migrant Grey Whales is not as consistent as Pyenson and Lindberg (2011) assumed. Dense aggregations of feeding Grey Whales were observed in the southern Chukchi Sea in association with a frontal system characterized by large concentrations of clams, epibenthic megafauna, pelagic crustaceans (especially euphausids) and Arctic cod (presumably *Boreogadus saida* although not specified in the source publication) (Bluhm *et al*. 2007). Those observations, combined with what appeared to be feeding by Grey Whales around Kodiak Island (Alaska) on swarming cumaceans (Crustacea: Diastylidae) (Moore *et al*. 2007), led Bluhm *et al*. (2007) to conclude that "flexibility in prey choice may have been underappreciated at the northern feeding sites."

Regarding criterion (2), Frasier *et al*. (2011) stated that the observed population structuring from maternally directed site fidelity to different feeding grounds (a pattern reflected in mtDNA as well as in photo-ID research on the PCFG – Calambokidis *et al*. 2012) is “common in whales and important for management,” leading them to make the following argument: “… because of this site fidelity, knowledge of specific feeding areas is only present within certain matrilines. Therefore, if whales are extirpated from a specific feeding ground, they will not be ‘replaced’ (or the area will not be repopulated) by others from the larger population because knowledge of that feeding area has been lost.” This argument could be extended to suggest that if the PCFG were to be extirpated, this would result in a persistent (albeit not very extensive) disjunction in the range of the species in Canada (temporal and possibly also spatial as PCFG whales are more likely than other whales to occur in waters between Vancouver Island and the mainland).

In fact, one of the best examples of whales being extirpated (or nearly extirpated) and not repopulating an extensive part of their range involves Grey Whales. The population that migrated annually from the Okhotsk Sea and south along the Japanese islands and the Asian mainland was nearly extirpated by the early 1970s (Bowen 1974; Brownell and Chun 1977) and its persistence remains in doubt today even though individuals are occasionally observed in Japan (Kato and Kasuya 2002; Weller *et al*. 2012) and China (Wang *et al*. 2015). There is no clear evidence of repopulation or re-establishment of the Grey Whale’s historical migration along the Asian mainland and Japan despite decades of complete protection from whaling.

It is worth emphasizing with regard to the PCFG that a large migratory population of the species moves near or through its habitat seasonally, and therefore even if all PCFG whales were to disappear suddenly, recolonization by individuals from the migratory population might occur fairly rapidly. A simulation-based analysis of plausible levels of external recruitment into the PCFG suggested that annual immigration of less than two and more than eight animals per year was inconsistent with empirical data and the authors concluded that immigration of around four whales per year led to the most consistent results (Lang and Martien 2012; IWC 2013, p.140). However, further analyses are being conducted to explore a number of different hypotheses because of a number of assumptions in the simulation approach. Another line of evidence that has been the subject of considerable discussion is an increase in estimated abundance of the PCFG in the late 1990s and early 2000s due to “an apparent influx of whales into the area” (Calambokidis *et al*. 2012). However, earlier estimates for 1996–1997 were recently reported to be biased low and the rapid increase in the abundance estimates at the start of the time series is in part due to the smaller area of coverage during 1996 and 1997 (Calambokidis *et al*. 2017). Updated analyses of photo-identification data through 2015 indicates a higher degree of internal recruitment than had been suggested by previous “less complete” data (Calambokidis and Pérez 2017).

Best (1993) drew attention to the difficulty of determining that there has been no recovery in whale populations, noting the "practical difficulties" of monitoring, as well as the possibility that long generation times mean there will be an "initial lag in [a population's] response to protection." Recent observations of relatively rapid repopulation of range (both breeding and feeding) and increase in abundance by baleen whales (Groch *et al*. 2005; Carroll *et al*. 2014; Boertmann *et al*. 2015) reinforce the need for caution in concluding that such manifestations of recovery cannot or will not occur in a given instance.

Western Pacific (Sakhalin) population (DU3)

As noted above, the western (Asian) migration of Grey Whales between the Sea of Okhotsk and southern China has been effectively lost and it is uncertain whether this natural phenomenon will ever be re-established. For the purposes of this COSEWIC report, however, it is necessary to consider the small population of Grey Whales that feeds in summer and autumn primarily in two small areas off the northeastern coast of Sakhalin Island, Russia (Weller *et al*. 2002a,b) as well as southern Kamchatka (Tyurneva *et al*. 2010). In the previous report (COSEWIC 2004) it was assumed that none of these whales occurred in Canada and therefore there was no need to include them in the assessment. However, the results of satellite-linked tagging at Sakhalin in 2010 and 2011, followed by an intensive effort to compare photographs and genetic biopsy samples between the Sakhalin whales and whales observed off western North America, have revealed what are apparently regular annual seasonal movements by at least some Sakhalin Grey Whales across the Pacific and into Canadian waters as they move toward the wintering grounds in Mexico (Weller *et al*. 2012; Mate *et al*. 2015; International Whaling Commission 2015b, 2016). Therefore, the question is not whether Grey Whales that forage off Sakhalin (and southern Kamchatka) in the summer and autumn are part of the fauna of Canada; they are. Rather, the question is whether that small group of animals – very roughly the same size as the PCFG DU (see **Population Size**) – qualifies as a DU.

As in the case of PCFG whales, the initiative of the Makah Tribe in Washington State to resume whaling for Grey Whales has prompted the U.S. government, and in turn the International Whaling Commission, to invest substantial resources in assessing the regularity and extent of movements by "western" Grey Whales into Canadian and U.S. waters (Moore and Weller 2013; International Whaling Commission 2015b, 2016).

Discreteness:

Genetic analyses indicate that Sakhalin Grey Whales can be distinguished from "eastern" Grey Whales on the basis of significant differences in mtDNA haplotype frequencies (LeDuc *et al*. 2002; Lang *et al*. 2010, 2011) and nuclear markers (Lang *et al*. 2011). However, there are no fixed differences that allow assignment of a given whale to either the "western" or the "eastern" archetype. Paternity analyses of adult males in the Sakhalin population showed that they had sired about half of the calves, leaving the other half with "unassigned paternities" and suggesting a substantial number of "missing fathers" (Lang *et al*. 2010). Those analyses were conducted at a time when it was still assumed that movement by Grey Whales across the North Pacific was infrequent (i.e., before the first satellite tagging in 2010).

Movements of the one Grey Whale tagged at Sakhalin whose tag continued transmitting long enough to be tracked through the full migration cycle (female, 9 years old when tagged in late August 2011) were indistinguishable from those of “eastern” Grey Whales once she reached British Columbia in mid-winter (Mate *et al*. 2015). Her sojourn in the calving/nursery grounds was similar to those of females from both of the other putative DUs. It is clear from the tagging results as well as numerous photographic and genetic (biopsy) matches of whales sampled in British Columbia (Weller *et al*. 2012), that B.C. waters are part of the normal migration route for at least some of the Grey Whales moving between feeding grounds in the Russian Far East and the wintering grounds in Mexico. Importantly, six whales that were photographed in both Sakhalin and B.C. (three of which had been initially identified at Sakhalin as first-year calves with their mothers) were sighted off Vancouver Island “in an area where some whales tend to linger and feed during the northbound migration (Darling *et al*. 1998)” (Weller *et al*. 2012). Thus, for Grey Whales that use the Sakhalin (and Kamchatka) feeding grounds, facing as they do “the long distance and potential open water crossing required to transit” between their summer and winter habitat, it may be “advantageous” to “spend time feeding in the Pacific Northwest (e.g., Vancouver Island) prior to undertaking a westerly passage to Sakhalin” (Weller *et al*. 2012). In other words, B.C. waters may serve as more than a migration corridor for these whales.

Significance:

Whether the genetic differences between Sakhalin Grey Whales and those in the other DUs “reflect relatively deep intra-specific phylogenetic divergence” is uncertain. The genetic analyses summarized above have been interpreted as indicating that the Sakhalin whales do not mate randomly with the whales feeding in the Bering and Chukchi Seas (Northern Pacific Migratory DU), suggesting that even though some (and possibly most or all) of them use migratory routes and wintering grounds in the eastern North Pacific, Sakhalin females preferentially (but not necessarily exclusively) mate with Sakhalin males.

From an ecological perspective, it is unclear whether the long-distance migration over deep oceanic waters between Sakhalin and British Columbia carried out by at least some of the Sakhalin whales would represent occurrence in “an ecological setting unusual or unique to the species.” If it is exceptional, such behaviour might be regarded as a kind of “local adaptation” on the part of Sakhalin whales. However, if, as some researchers suspect, most of the Grey Whales that migrate from the Bering Sea through Unimak Pass cut across deep water in the same way as the Sakhalin whales, this behaviour exhibited by the Sakhalin whales would not be exceptional.

As discussed above in the *Pacific Coast Feeding Group DU* section, the extirpation (or near-extirpation) of Grey Whales from mainland Asia and Japan by whaling has created a significant gap in the effective global distribution of the species. Even though that gap is not in Canada, it deserves consideration when assessing the “significance” of the Western Pacific DU, which probably constitutes the best, and perhaps only, prospect for enabling recolonization and recovery of Grey Whales in their historical western North Pacific range.

Special Significance

As major benthic predators in shallow cold temperate to Arctic marine waters, Grey Whales exert considerable influence on the structure and diversity of invertebrate assemblages on the sea floor (Nerini 1984; Oliver and Slattery 1985). Nerini (1984) estimated that in the early 1980s, Grey Whales turned over an area of 3 565 km^2 of sea bottom in the Arctic (primarily in the Bering and Chukchi seas) or 9% of the available amphipod community each year. Kvitek and Oliver (1986) used sidescan sonar to estimate that Grey Whales had disturbed up to 36% of the sea floor in three feeding sites off Vancouver Island. Grey Whale foraging in various "pockets" of habitat along the outer coast of Vancouver Island has been studied since the 1970s (e.g., Hatler and Darling 1974; Darling 1984; Kvitek and Oliver 1986; Murison *et al*. 1984; Dunham and Duffus 2001, 2002; Feyrer and Duffus 2011). The whales exert strong top-down pressure on prey populations, primarily mysid shrimp (family Mysidacea) and porcelain crab larvae (family Porcellanidae) at this site (Nelson *et al*. 2008). Their predation may also promote planktonic diversity (Feyrer and Duffus 2011).

Bottom-feeding Grey Whales rearrange soft sediments and thus mobilize chemical nutrients bound in benthic substrates (Feder *et al.* 1994; Oliver and Slattery 1985). Also, by feeding on the benthos but defecating and urinating in the water column, Grey Whales contribute to nutrient mobilization and cycling (c.f. Roman and McCarthy 2010; Lavery *et al*. 2014). Due to their coarse baleen, Grey Whales filter only relatively large (> 6 mm) invertebrates from the sediments and smaller invertebrates are expelled near the surface where they serve as food for marine birds and fishes (Obst and Hunt 1990; Grebmeier and Harrison 1992).

Grey Whales have been proposed as "sentinels" of large-scale ecosystem change. The delay in the timing of their southbound migration, expansion of their feeding range along the migration route and northward into Arctic waters, and the apparently growing tendency of some individuals to remain in polar waters throughout the winter months are probably all indications that North Pacific and Arctic ecosystems are in transition (Moore 2008).

As Grey Whales often travel close to shore, Aboriginal people along the migratory corridor and near the feeding grounds relied on these animals as subsistence resources for millennia (O'Leary 1984). Along the west coast of North America, whaling was probably most developed among the Nuu-chah-nulth of southwestern Vancouver Island and the Makah of nearby Washington State (O'Leary 1984). These two closely related groups hunted both Humpback Whales and Grey Whales, with an apparent preference for Humpbacks (McMillan *et al*. 2008). Whaling was of great spiritual and economic importance to the Makah and Nuu-chah-nulth and possibly other groups in the region (O'Leary 1984; Huelsbeck 1988; Happynook 2002; McMillan *et al*. 2008).

The killing of Grey Whales for subsistence continues in the Russian Arctic (Reeves 2002; International Whaling Commission 2015a). In addition, there has been interest in resumed subsistence whaling by the Makah and the Nuu-chah-nulth (e.g., Reeves 2002).

Grey Whales are a major attraction in recreational whale-watching along the west coast of North America including Canada, the United States, and Mexico. In British Columbia, commercial tour operators offer Grey Whale viewing along the west coast of Vancouver Island, with the greatest number of vessels operating out of Tofino and Ucluelet (Duffus 1996), and to a lesser degree Bamfield and Port Renfrew (COSEWIC 2004). While some trips operate during the northbound migration, most whale-watching activity takes place during the summer months. For this reason summer-resident (PCFG) whales are the primary focus of whale-watching excursions in this area (Duffus 1996).

DISTRIBUTION

Global Range

In response to changing climatic conditions and sea level, Grey Whales have moved between the Atlantic and Pacific oceans multiple times over the last 100,000 years (Alter *et al*. 2015). In the North Pacific, Grey Whale fossils date to at least 50,000 years before present (Barnes and McLeod 1984). Subfossil skeletal remains as well as historical accounts document their existence in the North Atlantic within the past 500 years, including the Baltic and North seas, the English Channel, and waters around Iceland (Mead and Mitchell 1984; Lindquist 2000). They apparently were extirpated from the Atlantic by the early 18th century (Mead and Mitchell 1984; Bryant 1995; Lindquist 2000). Since then, they have been endemic to the North Pacific, with occasional reports of vagrants in the North Atlantic (e.g., Scheinin *et al*. 2011) and even one in the South Atlantic off Namibia (Alter *et al*. 2015).

The range in the North Pacific is centred along the coasts and this includes the coast of Asia to as far south as southern China, where some Grey Whales apparently overwintered historically. As strongly migratory animals, most Grey Whales winter and breed in warm temperate or subtropical waters, then migrate to cold temperate, sub-Arctic, and Arctic waters where they feed intensively through the summer and autumn (Rice and Wolman 1971; Figure 5). Those in the east congregate in lagoons and embayments along the outer (ocean-side) coast of Mexico's Baja California peninsula for much of the winter and into the spring (Rice *et al.* 1981; Swartz 1986; Figure 6). Small numbers also visit portions of the Gulf of California (Sánchez-Pacheco *et al.* 2001) and the Mexican mainland to Banderas Bay at ca. 20°45'N (Gilmore *et al*. 1967; Henderson 1972). The northbound migration from January to May (females with calves generally leaving the calving/nursery grounds later than the rest of the population) follows the coast to southeastern Alaska and around the Gulf of Alaska (Braham 1984; Herzing and Mate 1984; Poole 1984a), with small numbers of individuals stopping along the way to forage in coastal waters through the summer and autumn and not moving north of the Aleutian Islands (e.g., International Whaling Commission 2015b; Figure 7). Those that regularly feed south of Alaska during the summer and autumn are considered part of the Pacific Coast Feeding Group (see later). While the vast majority of the whales pass through the Aleutians and continue north to high-latitude feeding grounds in the Bering, Chukchi, and Beaufort seas (International Whaling Commission 2015b, p. 494), some head west and arrive off northeastern Sakhalin Island in May or June (Mate *et al*. 2015).

The southbound migration generally begins in October and continues into January and February (northbound and southbound whales may pass one another in the late winter and early spring) (Braham 1984; Swartz 1986; Figure 8).

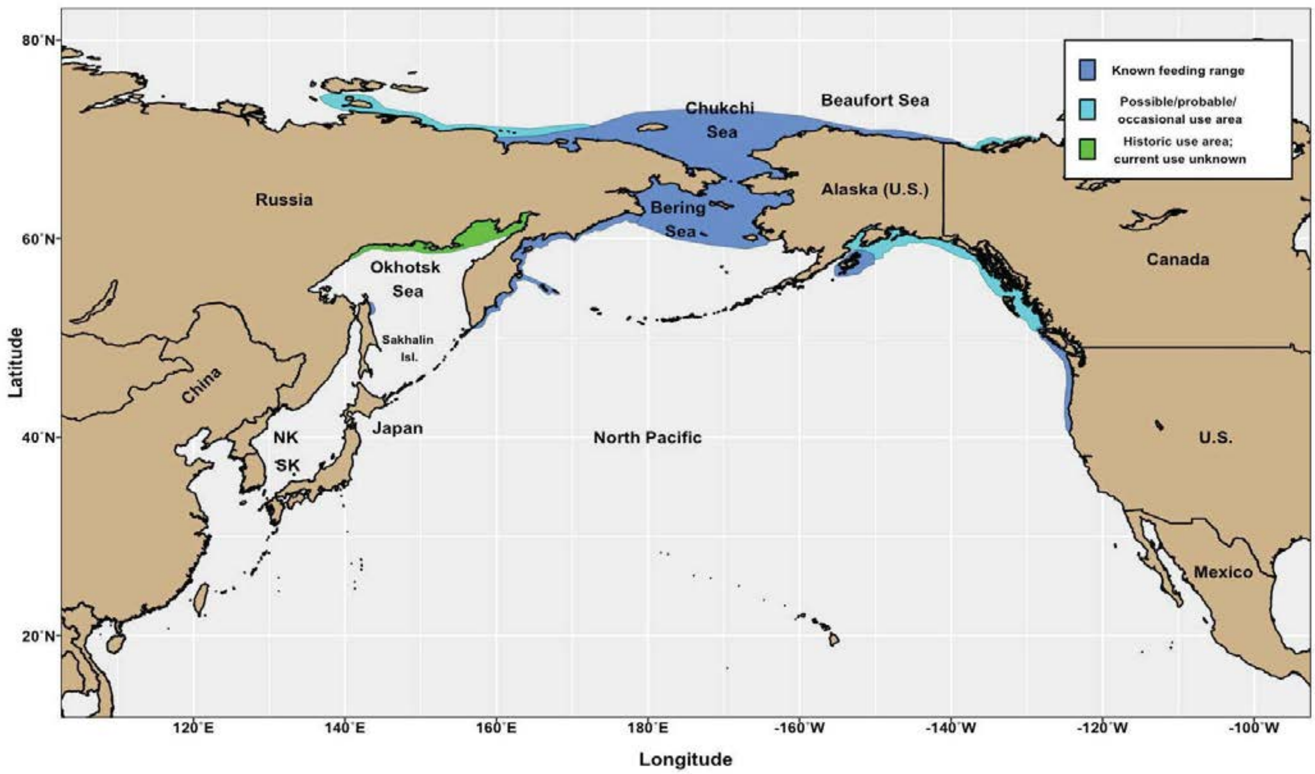

Figure 5. Approximate feeding distribution of Grey Whales in the North Pacific Ocean. Courtesy of International Union for Conservation of Nature and International Whaling Commission (IUCN 2016).

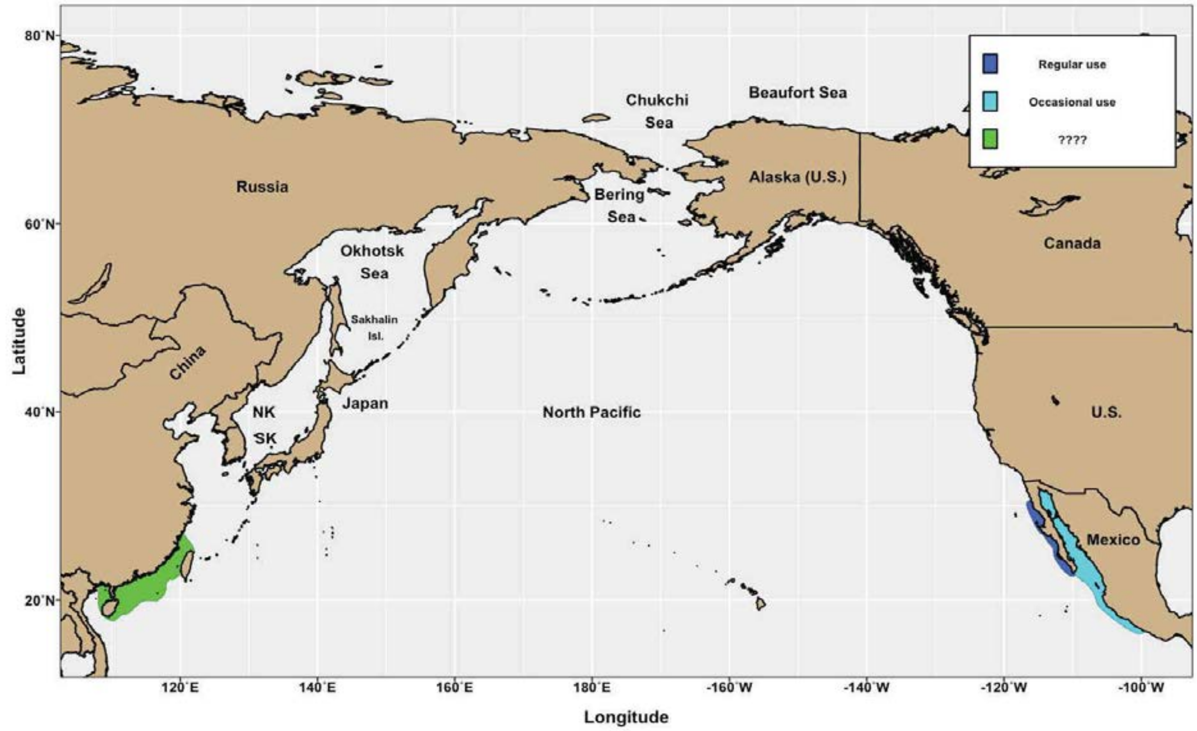

Figure 6. Approximate wintering distribution of Grey Whales in the North Pacific Ocean. Courtesy of International Union for Conservation of Nature and International Whaling Commission (IUCN 2016).

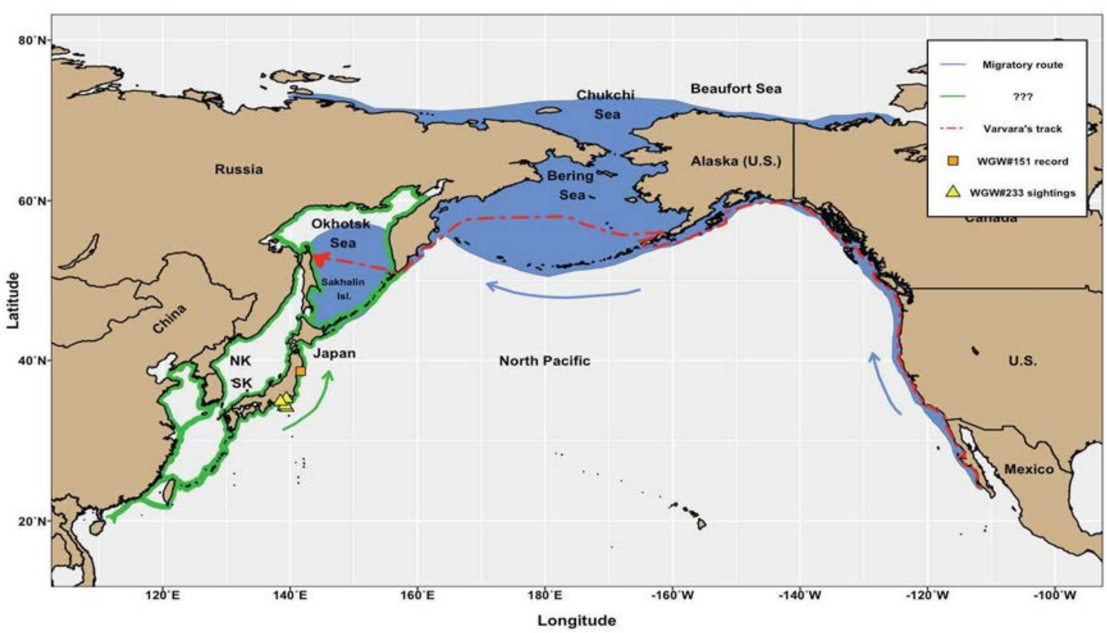

Figure 7. Approximate northbound migration routes of Grey Whales in the North Pacific Ocean. Broken line represents the northbound migration track from Baja California, Mexico, of a Grey Whale ("Varvara") that had been satellite-tagged at NE Sakhalin Island, Russia, in November 2011 and began moving northward from Mexico in late February 2012 (see Mate *et al*. 2015). Courtesy of International Union for Conservation of Nature and International Whaling Commission (IUCN 2016).

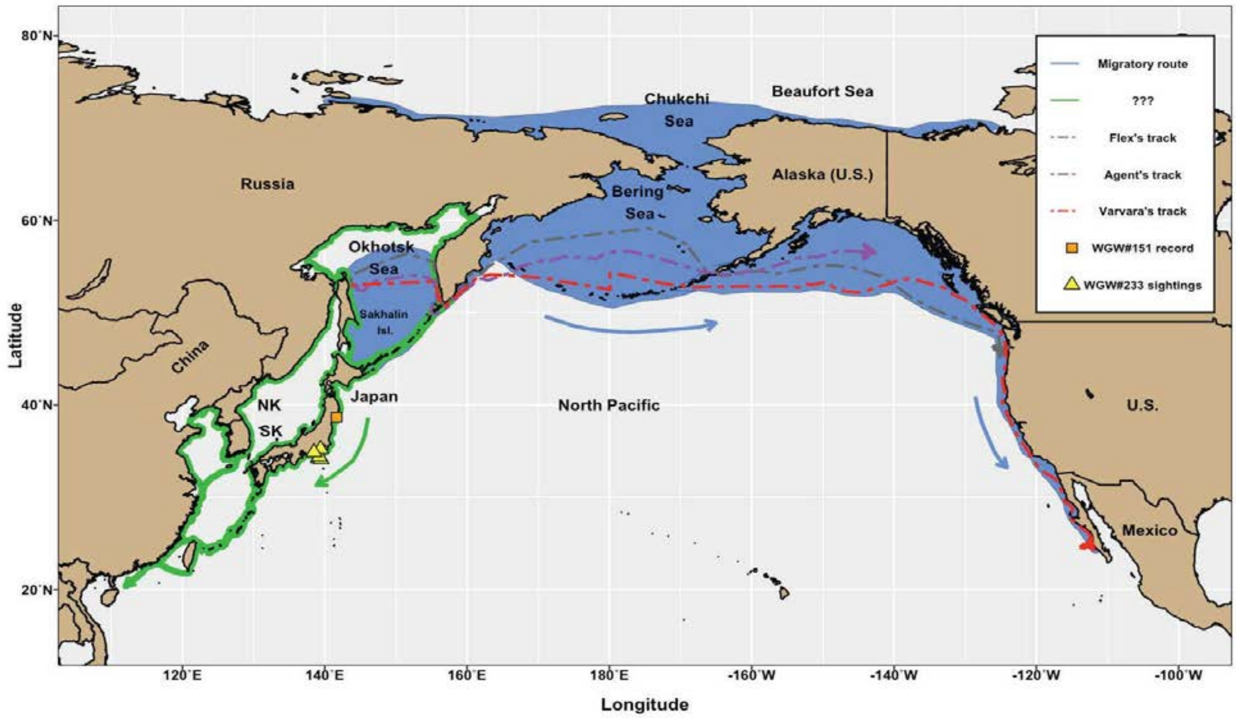

Figure 8. Approximate southbound migration routes of Grey Whales in the North Pacific Ocean. Broken lines represent the eastbound and southbound migration tracks of three Grey Whales ("Flex", "Agent" and "Varvara") satellite-tagged at NE Sakhalin Island, Russia, in December 2010 and November 2011 (see Mate *et al*. 2015). Courtesy of International Union for Conservation of Nature and International Whaling Commission (IUCN 2016).

Canadian Range

British Columbia Migrants:

A large proportion of the world's Grey Whales migrate through the coastal waters of British Columbia in the spring and autumn on their way between summer and autumn feeding grounds to the north and wintering grounds to the south. Some whales also forage in patches of habitat along the western shores of Vancouver Island and northward to southeastern Alaska and Kodiak Island between the late spring and autumn (Darling *et al*. 1998). Those that do not migrate into the Bering Sea and northward are considered part of the Pacific Coast Feeding Group (PCFG; see Calambokidis *et al*. 2002; also **Designatable Units** above and the subsection *Pacific Coast Feeding Group*, below).

Northbound migrants generally begin arriving in British Columbia waters in late February, reach a peak in the last two weeks of March, and become scarcer through April and May (Darling 1984; Ford 2014). They remain close to shore as they move along the outer coast of Vancouver Island. Until recently the migration route north from Vancouver

Island was poorly understood, but it was generally assumed that most whales crossed Queen Charlotte Sound to the rugged west coast of Haida Gwaii (formerly the Queen Charlotte Islands) and then crossed Dixon Entrance, making “landfall” at Cape Muzon on Dall Island, southeastern Alaska (ca. 54°40'N), before proceeding northward. However, in 2009-2011 a sighting program at two lightstations in northern British Columbia (one on Langara Island off the west coast of Haida Gwaii and one on Bonilla Island on the east side of Hecate Strait) and the tracking of five Grey Whales with satellite-linked radio tags determined that most of the population follows a coastwise route through Hecate Strait rather than veering offshore toward Haida Gwaii (Ford *et al*. 2013). During the southbound migration, the whales are believed to travel generally offshore and feed little, if at all. A recent undergraduate thesis study, however, provides acoustic evidence that southward-migrating Grey Whales are present closer to shore in the continental shelf waters of Vancouver Island between December and January (Meyer 2017). This study detected no Grey Whale vocalizations on deep-water offshore hydrophone recordings (Bowie Seamount, Dellwood Knolls, Cascadia Basin) during the southward migration period. This was interpreted as suggesting that the southward migration, like the northward migration, occurs primarily in shallower shelf waters rather than offshore.

Pacific Coast Feeding Group:

Pike (1962) first noted that some Grey Whales did not complete the full migration to Arctic feeding grounds, but spent the summer feeding off British Columbia. Such “summer-resident” Grey Whales (which are now more properly referred to as PCFG whales) have since been reported from many other areas off the west coast of North America. These whales often return to the same feeding sites year after year (Darling 1984; Calambokidis *et al.* 2002). The PCFG is defined as the whales that spend the spring, summer, and autumn feeding in coastal waters of the Pacific coast of North America from California to southeast Alaska (International Whaling Commission 2011, p.18). It should be noted, as acknowledged by the IWC Scientific Committee, that the precise boundaries of the PCFG area are “somewhat arbitrary,” but for modelling to test various stock identity hypotheses, the IWC Scientific Committee has defined it as being between 41°N and 52°N (excluding Puget Sound) (International Whaling Commission 2015b, p.489).

The presence of PCFG whales along the entire west coast of Vancouver Island is well documented (Darling 1984) and they are also often seen along the north coast of Vancouver Island from Cape Scott to Cape Sutil, as well as along the British Columbia mainland from Shelter Bay to Cape Caution (Deecke 1996; COSEWIC 2004; Ford 2014). In Haida Gwaii, Grey Whales are frequently seen feeding on Pacific Herring (*Clupea pallasii*) spawn in Skidegate Inlet and off the east coast of South Moresby Island between May and July (Nichol and Heise 1992; Ford *et al.* 1994). Reports of feeding Grey Whales in the summer months come from the west coasts of Calvert Island as well as Dundas and Aristazabal islands, and known PCFG whales have been photographed in the McMullin Group, as well as Sitka Sound, southeastern Alaska (Deecke 1996, 2003; Calambokidis *et al.* 2002; COSEWIC 2004). PCFG whales have also been sighted in the inside waterways of British Columbia, primarily in Boundary Bay (Deecke 1996; Ford 2014), as well as occasionally in Haro and Georgia Straits (COSEWIC 2004).

Ford (2014) noted that there is considerable movement by PCFG whales among feeding areas both within and outside British Columbia (also see Mate *et al*. 2010; International Whaling Commission 2015b p. 494) and he (Ford, p.121) estimated that "fewer than 100 summer resident Grey Whales are likely to occupy BC waters in any given year."

Yukon and Northwest Territories Migrants:

The role of the Canadian Beaufort Sea as a summer and autumn feeding ground for Grey Whales remains poorly understood. However, it seems clear that with the dramatic changes in ice conditions in this region, changes are also occurring in the geographical extent and duration of Grey Whales' presence in Arctic Canada. While the primary Arctic feeding grounds lie mainly within the waters of Russia and the USA, some whales move eastward into the eastern Beaufort Sea off the Northwest Territories (Rugh and Fraker 1981; International Whaling Commission 2015b, p. 494). Some of these whales definitely migrate westward and southward in the autumn but others may overwinter. A Grey Whale tagged off Atkinson Point, NWT, on 3 September 2009 was satellite-tracked as it moved west along the North Slope of Alaska to Chukotka, Russia and south to the eastern Aleutian Islands (Quakenbush *et al*. 2013). Acoustic recordings of Grey Whales in the western Beaufort Sea throughout the winter (Stafford *et al*. 2007) provide evidence to suggest that at least some individuals remain in the far north longer than was thought as recently as a few decades in the past. It has been suggested that remaining in the Beaufort Sea for the winter offers Grey Whales (at least a few of them, presumably individuals that do not breed in that year) a "net metabolic advantage whereby the energetic costs of thermoregulation in cold water are offset by not undertaking the 10 000-km round-trip migration and remaining in northern seas to take advantage of spring forage" (Moore and Huntington 2008).

Extent of Occurrence:

The estimated extent of occurrence in the previous COSEWIC report (2004) remains valid for the species in Canada: 250,000 km^2, encompassing all coastal waters of British Columbia as well as shallow portions of the southern Beaufort Sea from the U.S.-Canada border to Cape Bathurst. For the PCFG DU, the EOO would include only the B.C. portion of the species' EOO but that would certainly exceed 20,000 km^2. For the Western Pacific (Sakhalin Island) DU, too little is known about the extent of movements into Canadian waters to make an informed estimate of EOO.

Area of Occupancy:

Given the apparently extreme dependence of the Grey Whales in the eastern Pacific on specific lagoons and embayments along the outer (Pacific Ocean) coast of Baja California, Mexico, for a portion of the reproductive cycle (calving and early calf rearing), it might be appropriate to use the combined area of their calving/nursery habitat (all outside Canada) as an index of area of occupancy. The combined area of the four sites in Mexico where calving and early stages of nursing take place can be considered "the smallest area essential at any stage to the survival" of the Grey Whale as a species as well as to all of the Canadian DUs. The total area of these sites is 2241 km^2 (Laguna Ojo de Liebre and Guerrero Negro 366 km^2; Bahia Magdalena 1700 km^2; and Laguna San Ignacio 175 km^2) (COSEWIC 2004).

For the Western Pacific (Sakhalin Island) DU, it could also be argued that two very small and specific feeding areas off Sakhalin Island are "essential" for this population's survival. As indicated by Bradford *et al*. (2008), the Sakhalin Grey Whales are "strongly linked to the Piltun [near-shore] feeding ground, even though individuals may use other areas for all or part of a feeding season" (which they definitely do; see Tyurneva *et al*. 2010). The Piltun area is the main area where females with nursing calves are observed (Bradford *et al*. 2008). The Piltun feeding area is not much, if at all, larger than the "Offshore" area, estimated to be only 372 km^2 (optimal habitat for the amphipod prey of Grey Whales) (Demchenko *et al*. 2016). It is likely that the combined size of the two main feeding areas of the Western Pacific (Sakhalin Island) DU is < 1000 km^2.

The areas used for feeding by the other DUs are much less well defined but presumably exceed the threshold values for meeting any of the spatial criteria and subcriteria.

Search Effort

Effort to search for and study Grey Whales throughout their potential range in Canada has been varied but extensive, spanning many decades. It has included vessel-based surveys (e.g., Williams and Thomas 2007; Ford *et al*. 2010) as well as extensive shore-based observations from headlands and at lightstations (e.g., Pike 1962; Pike and MacAskie 1969; Hatler and Darling 1974; Darling 1984; Ford *et al*. 2013), supplemented in recent years by tracking with satellite-linked tags (Mate *et al*. 2010; Ford *et al*. 2013; Ford 2014). The photo-identification effort, supplemented more recently by remote biopsy collection, has been led by researchers from the Cascadia Research Collective in Olympia, Washington (e.g., Calambokidis *et al*. 2002, 2004, 2012, 2014) and by Jim Darling, an independent researcher.

The Scientific Committee of the International Whaling Commission (2015b, 2016) has attempted to collate and summarize the extensive sightings, photo-identification, genetic, and satellite telemetry data that have accumulated in recent years from all parts of the Grey Whale's range.

HABITAT

Habitat Requirements

Grey Whales require different types of habitat for foraging and for reproduction. The principal subtropical lagoons and embayments inhabited during the winter in Mexico are characterized by shallow (generally less than 4 m) water depths and have sandy or muddy bottoms covered in places by eelgrass beds and mangrove swamps (Rice *et al.* 1981). The main calving/nursery lagoons have winter water temperatures between 15 and 20°C and are hypersaline due to evaporation (Gardner and Chávez-Rosales 2000). Within the lagoons, mothers with calves tend to remain in the inner portions farthest from the open sea while whales engaged in sexual behaviour prefer the relatively deep and wide channels in the outer portions (Swartz 1986).

On feeding grounds in the Bering Sea and northward, Grey Whales are primarily benthic feeders and seem to prefer shallow (generally < 60 m) soft-bottom habitat (Moore and Ljungblad 1984; Moore and DeMaster 1997; Moore *et al.* 2000; Heide-Jørgensen *et al*. 2012). In the Bering Sea, they are seen mainly from 0.5 to 166 km from shore and tend to avoid areas of heavy ice (Clarke *et al.* 1989). They also enter shallow coastal lagoons to feed (Gill and Hall 1983).

In areas in British Columbia where they feed on amphipods (mainly *Ampelisca* spp., *Atylus* sp.) and Ghost Shrimp (*Calianassa californiensis*), PCFG whales similarly prefer shallow nearshore habitats with a mud or sand bottom. Feeding on Ghost Shrimp usually occurs in sheltered bays and inlets with muddy bottom and water depths of less than 3 m, whereas amphipods are found in sandy bays on the exposed outer coast in water depths of less than 35 m (Oliver *et al.* 1984; Weitkamp *et al.* 1992; Darling *et al.* 1998; Dunham and Duffus 2001, 2002). Feeding Grey Whales are also frequently seen over rock and boulder substrates in water less than 30 m deep, and in kelp beds where they feed primarily on mysids or crab larvae (Wellington and Anderson 1978; Nerini 1984; Deecke 1996; Darling *et al.* 1998; Dunham and Duffus 2001, 2002; Nelson *et al*. 2008). Eelgrass beds are the primary habitat where Grey Whales feed on the eggs and larvae of Pacific Herring (Ford *et al.* 1994; Darling *et al.* 1998; Ford 2014). Grey Whales are clearly adapted to living in a dynamic environment that includes multiple and connected summer foraging habitats (Nelson *et al*. 2008).

Habitat Trends

The calving/nursery and migration habitat of Grey Whales is not known to have changed appreciably in recent times other than the generalized increase in human activity and infrastructure (Moore and Clark 2002; and see **THREATS AND LIMITING FACTORS**). However, at least for the whales that migrate into the Bering Sea and northward to feed, major ecological changes have taken place and are ongoing.

A major shift in the northern Bering Sea ecosystem has been occurring since the early 2000s (Grebmeier *et al*. 2006). This involves change from an ice-dominated (in winter and spring), shallow system with tight pelagic-benthic coupling and favouring bottom-feeding organisms including Grey Whales, to a warmer, sub-Arctic system with lighter ice conditions that is increasingly dominated by pelagic fish. Satellite tracking of mothers with calves from Mexico to their northern feeding grounds in 2005 (Mate and Urbán-Ramírez 2007) supports the hypothesis that there has been a major shift northward in the Grey Whales' summer foraging range since the early 1980s (Moore *et al*. 2000). Of 17 adult whales tagged, only two spent significant time, presumably foraging, in the Bering Sea – one in Chirikov Basin and the other along the Russian coast south of the Bering Strait. All of the others headed directly into the Chukchi Sea and some of them only left there and moved back south through the Bering Strait in mid-November. None of the whales in the southern Chukchi Sea stayed in only one area, and they had large, mostly non-overlapping ranges. At least some of the whales moved north in June through approximately 30-40% ice cover (International Whaling Commission 2007, p. 151; Mate and Urbán-Ramírez 2007).

Concerning ice conditions, there is evidence suggesting a link between Grey Whale calf production and ice conditions in the Bering Sea during the preceding feeding season. As proposed by Perryman *et al*. (2002): "… years with low calf production were associated with feeding seasons effectively shortened by extensive seasonal ice and … suboptimal nutritive condition in pregnant females was the link in this apparent biophysical connection." The recent trend toward lighter ice conditions in the Bering Sea and increasing availability of Grey Whale foraging habitat in the Arctic may have a compensatory or offsetting effect. Increased human activity is probably the main factor affecting Grey Whale habitat along the migratory corridor. This includes increased industrial noise and increased vessel traffic for shipping, resource extraction and recreation. Grey whales have been shown to avoid loud sources of industrial noise (Richardson *et al.* 1995; Moore and Clarke 2002). Behavioural responses to boats range from actively seeking contact with boats to active avoidance (Jones and Swartz 1984; Heckel *et al.* 2001). Although the importance of acoustic signals for communication and orientation in Grey Whales is poorly understood, it is known that they produce a variety of communicative sounds (Dahlheim *et al.* 1984; Moore and Ljungblad 1984; Crane and Lashkari 1996). An increase in anthropogenic noise in Grey Whale habitat could negatively affect this acoustic communication (e.g., Clark *et al*. 2009). For more on the threats from human activities see below under **THREATS AND LIMITING FACTORS**.

BIOLOGY

Life Cycle and Reproduction

Calving is largely confined to specific subtropical lagoons and embayments (Rice *et al.* 1981), although occasionally females give birth off the California coast (Sund 1975). Sexual activity has been observed year-round (Wilson and Behrens 1982; Clarke *et al.* 1989), but most calves are conceived in late November and early December during the southbound migration (Rice and Wolman 1971). The animals arrive at the calving/nursery lagoons between December and January, and the median date of birth is estimated as 27 January with a range of at least 5 January to 15 February (Rice 1983). The gestation period is 13-14 months and females give birth to a single calf (Rice and Wolman 1971; Rice 1983).

Photographically identified females are usually seen with a calf every other year (Jones 1990; International Whaling Commission 2015b, Table 6 p. 506), although the interbirth interval is probably longer in years of poor prey abundance or availability (e.g., Perryman *et al*. 2002). During the 6-month lactation period, calves grow from 4.6 m at birth to 7.0 m. At one year of age, they typically measure 8.0 m (Sumich 1986). Grey Whales continue to grow until they are approximately 40 years old (Rice and Wolman 1971). Male and female Grey Whales attain sexual maturity at an average age of eight years, at which point they have reached about 85% of their physically mature body length (Rice and Wolman 1971).

For generation time, the previous COSEWIC report (2004) used the estimate by Heppell *et al.* (2000) of 22 years. Alter *et al*. (2007) cited a range of 15.5 to 22.3 years, citing Rice and Wolman (1971) and Heppell *et al*. (2000) as their sources. [Note that Rice and Wolman sampled the Grey Whale population at a time when it was growing rapidly and therefore not in a "pre-disturbance" state as required under the COSEWIC definition of generation time.] Taylor *et al*. (2007) estimated 22.9 years using the IUCN Red List definition (which is closely aligned with the COSEWIC definition). Taylor *et al*. (2007) used a 5-parameter demographic model based on an age of first reproduction value of 10 years, inter-birth interval value of 2.0 years, maximum age of reproductive females value of 55 years, calf survival rate value of 0.700, and non-calf survival value of 0.950. Data from subsistence whaling off Chukotka (Blokhin 1984), where only whales belonging to the Northern Pacific Migratory DU would be expected to be sampled, suggest that sexually mature individuals made up approximately 60% of the population (> 30 years ago). Taylor *et al*. (2007) used this same value, and it can be assumed to apply to all of the DUs except the Western Pacific DU. For that group, a sex- and age-structured model suggests there are 44 adult females and, assuming an equal number of mature males, a total of around 88 mature individuals (WGWAP 2016). If this population includes 186 (CI 171-203) non-calf individuals, as estimated (WGWAP 2016), this would suggest that approximately 47% of the population is mature.

Annual shore-based counts during the northbound migration along the American coastline indicated that calves represented between 4.6 and 5.2% of the population in the late 1970s and early 1980s (Herzing and Mate 1984; Poole 1984a,b) whereas estimates during the mid-1990s to 2000 ranged between 1.1% and 5.8% (Perryman *et al.* 2002). As mentioned earlier, Perryman *et al*. (2002) hypothesized that the significant apparent fluctuations in calf production (> 5-fold between some years) were linked to variable feeding conditions in the Bering Sea.

Physiology and Adaptability

The conventional view is that Grey Whales feed primarily in the summer and autumn and therefore a pregnant female has to depend entirely on stored fat to nourish her fetus on the southward migration, give birth, and nurse the calf during the northward migration (Perryman *et al.* 2002). That view is probably apt even though it must be qualified by noting that some successful foraging does occur in or near the wintering grounds (Sánchez-Pacheco *et al*. 2001; Caraveo-Patiño and Soto 2005) and even along the coast of California during migration (Clapham *et al*. 1997). From birth to weaning the calf nearly doubles in length (Sumich 1986). Because females with calves are generally the last to depart from the wintering grounds, their subsequent feeding season is curtailed by several months (3.5 months as opposed to 6.9 months for newly pregnant females and males according to Swartz 1986). Satellite tracking data indicate that "mothers of the previous year may linger longer on the feeding grounds to restore lost energy reserves from calf creation and suckling" (International Whaling Commission 2007, p. 151). The energy stores of a female Grey Whale are often severely depleted by the time her calf is weaned. This can mean that interbirth intervals lengthen under suboptimal feeding conditions, either through suppressed ovulation (Rice and Wolman 1971) or premature termination of pregnancy (Perryman *et al.* 2002).

Grey Whales were long believed to be specialized for feeding on benthic invertebrates. However, recent research has shown that they feed on a much broader range of organisms, suggesting that they are better characterized as opportunists (e.g., Darling *et al.* 1998; Benson *et al*. 2002; Moore *et al*. 2007). In fact, Moore and Huntington (2008) judged the Grey Whale to be "perhaps the most adaptable and versatile of the mysticete [baleen whale] species." It remains true nonetheless that there is a close link between the productivity of benthic habitats in cold temperate to Arctic waters and the overall size and health of Grey Whale populations (e.g., Coyle *et al*. 2007; Demchenko *et al*. 2016).

On the feeding grounds in the Bering, Chukchi and Beaufort seas, Grey Whales predominantly feed on epibenthic and infaunal amphipods of the genera *Ampelisca*, *Atylus*, and *Anonyx* (Bogoslovskaya *et al.* 1981; Nerini 1984). Quantitative studies have shown that amphipods represent 95% of the diet on Arctic (including the Bering Sea) feeding grounds (Nerini 1984). Grey Whales obtain these amphipods by diving to the bottom, rolling over on their side and sucking sediment into their mouth and straining the associated invertebrates through their baleen plates (Ray and Schevill 1974; Bogoslovskaya *et al.* 1981; Johnson and Nelson 1984; Nerini 1984; Oliver and Kvitek 1984). This benthic feeding can be easily identified by the plumes of mud trailing behind the animals as they surface, and the feeding activity leaves characteristic feeding pits in the sea floor (Johnson and Nelson 1984; Oliver and Kvitek 1984; Nerini 1984; Kvitek and Oliver 1986; Nelson *et al.* 1987; Weitkamp *et al.* 1992). Grey Whales also occasionally forage on Sand Shrimp (*Crangon septemspinosa*) in the southeastern Bering Sea (*Crangon* sp.; Gill and Hall 1983).

It appears that the diet of Grey Whales that remain in lower latitudes during the summer and autumn is more varied than that of those that migrate to the Bering Sea and north, although as indicated earlier (see **Designatable Units**), recent observations in northern areas cast some doubt on that assumption (e.g., Bluhm *et al*. 2007; Moore *et al*. 2007). Amphipods (*Ampelisca* spp., *Atylus borealis, Corophium spinicorne*) are important prey in the temperate feeding grounds off the west coast of North America (Oliver *et al.* 1984; Avery and Hawkinson 1992; Darling *et al.* 1998; Dunham and Duffus 2001, 2002), and Grey Whales feed preferentially in areas where large individuals (> 6 mm) are common (Dunham and Duffus 2001, 2002). PCFG Grey Whales have also been observed to feed extensively on Ghost Shrimp and small clams (*Cryptomya californica*) in shallow muddy bays (Weitkamp *et al.* 1992; Darling *et al.* 1998; Dunham and Duffus 2001). Grey Whales are known to be present year-round near Kodiak Island in the Gulf of Alaska where they feed intensively, at least during the summer and in some years, on cumaceans (Moore *et al*. 2007).

In addition to this benthic prey, PCFG whales feed extensively on planktonic invertebrates. In the exposed waters off the west coast of Vancouver Island and elsewhere, mysid shrimps (primarily *Holmesimysis sculpta*, *Neomysis rayii*, *Acanthomysis* spp.) are important prey (Wellington and Anderson 1978; Murison *et al.* 1984; Deecke 1996; Darling *et al.* 1998; Dunham and Duffus 2002; Feyrer and Duffus 2011). Grey Whales in British Columbia commonly feed on planktonic crab larvae (*Pachycheles rudis*, *Petrolisthes* spp., *Cancer magister*; Darling *et al.* 1998; Dunham and Duffus 2001, 2002) and off California they feed at least opportunistically on swarming euphausiids (*Thysanoessa spinifera*) at the sea surface (Benson *et al*. 2002).

In many areas along the British Columbia coast, the arrival of northbound Grey Whales coincides with the spawning of Pacific Herring in coastal eelgrass beds. The whales have been observed foraging on herring spawn and larvae in Barkley Sound (COSEWIC 2004) and Clayoquot Sound (Darling *et al.* 1998) as well as off Haida Gwaii (Nichol and Heise 1992; Ford *et al.* 1994). Feeding on herring spawn may represent an important “refuelling stop” for Grey Whales migrating to Arctic feeding grounds.

Some feeding occurs in and near the wintering grounds. When feeding has been observed there, amphipods (*Ampelisca* spp., *Aoroides columbiae*) and crab larvae were the dominant food source (Oliver *et al.* 1983; Nerini 1984; Tershy and Breese 1991; Sánchez-Pacheco *et al.* 2001). In addition, unidentified bait fish have been documented as Grey Whale prey in Mexico (Nerini 1984).

Dispersal and Migration

The transoceanic movement of tagged Grey Whales from Sakhalin Island to the North American coast and back involves swimming across large expanses of deep water, which means that Grey Whales are not the obligate coast-hugging animals they were previously characterized as being (e.g., Pike 1962). While the Grey Whale’s annual migration distance of more than 18,000 km was formerly regarded as “a distance exceeding that traveled by any other baleen whale” (Rice and Wolman 1971, p. 21), it is now known that some individual Grey Whales make round-trip migrations covering 22,500 km (Mate *et al*. 2015). Calves stay with their mothers during their first northward migration and likely in this way become acquainted with (i.e., learn) the area(s) of feeding grounds (Weller *et al*. 1999; Calambokidis *et al*. 2002).

Barrett-Lennard *et al*. (2011), citing Ford and Reeves (2008), suggested that Killer Whales (*Orcinus orca*) “strongly affect learned behaviors” of Grey Whales and that predation pressure helps shape migration patterns. For example, Grey Whales “behave most cryptically and follow shorelines most closely in areas where they have encountered Killer Whales in the past” (Barrett-Lennard *et al*. 2011).

Interspecific Interactions

As highly disruptive bottom feeders that remove and displace both prey and sediment (Oliver and Slattery 1985), Grey Whales exert substantial pressure on certain benthic and planktonic invertebrate communities in temperate and Arctic waters (see **Special Significance**). In addition to their influence on prey, Grey Whales interact with a number of species throughout their range. They are hosts to many endoparasites and ectoparasites (e.g., Blokhin 1984; Dailey *et al.* 2000) and are the exclusive hosts for one barnacle, *Cryptolepas rachianecti,* and the cyamid crustacean *Cyamus scammoni*.

Grey Whales are involved in a variety of symbiotic and commensal interactions. For example, Swartz (1981) described a cleaning symbiosis between Topsmelt (*Atherinops affinis*) and Grey Whales on the Mexican wintering grounds. On the sub-Arctic and Arctic feeding grounds, many species of seabirds (e.g., Northern Fulmar, *Fulmarus glacialis*; Red Phalarope, *Phalaropus fulicaria*; Black-legged Kittiwake, *Rissa tridactyla*; and Thick-billed Murre, *Uria lomvia*) feed on invertebrates from Grey Whale mud plumes. Grey Whales probably represent the only means of accessing benthic prey for these seabirds (Obst and Hunt 1990; Grebmeier and Harrison 1992).

Killer Whales frequently attack Grey Whales during the northbound migration and on the feeding grounds (Ljungblad and Moore 1983; Lowry *et al.* 1987; Goley and Straley 1994; Melnikov and Zagrebin 2005; Barrett-Lennard *et al*. 2011), but rarely in and near the Mexican wintering areas (e.g., Reeves *et al*. 2006). They appear to target primarily calves and yearlings and this predation likely represents an important source of mortality for immature Grey Whales. Eighteen percent of the Grey Whales landed at California whaling stations bore scars attributed to Killer Whale attacks (Rice and Wolman 1971). Grey Whales have multiple anti-predator strategies. They avoid, flee from, and retaliate against Killer Whales, making them difficult to classify as either flight or fight strategists; in some ways they fit the profile for both types (Ford and Reeves 2008).

Interactions of Grey Whales with cetaceans other than Killer Whales are generally not noteworthy. Clarke *et al*. (2013) indicated that they were “often observed in close association” with Humpback Whales in the southern Chukchi Sea in the summer and autumn.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Sampling methods differ significantly for the three putative DUs and each is treated separately here. However, it should be noted that the effort and methods attributed to the Northern Pacific Migratory DU necessarily apply, to an uncertain but possibly large extent, to the other two DUs given the spatial and temporal overlap in their distribution (common migratory corridor) where shore counts are conducted.

Northern Pacific Migratory population (DU1)

It has long been recognized that the most reliable way of assessing the absolute size of this population is by conducting counts of migrating individuals from strategic points on shore. Such counts have been made systematically during the southbound migration in northern California since 1967-68 (Reilly *et al*. 1983; Reilly 1984; Rugh *et al*. 2008; Laake *et al*. 2012). Shore-based counting, supported by aerial surveys, was conducted at Unimak Pass in the eastern Aleutians in 1977-1979 in the expectation of obtaining an estimate of the number of migrating Grey Whales that move into the Bering Sea (Rugh 1984). Various attempts have also been made to obtain counts of Grey Whales in their winter range in Mexico (Rice *et al*. 1981; Reilly 1984).

Pacific Coast Feeding Group (DU2)

The sole practical way to estimate the size of this population is with photo-identification mark-recapture methods. Photo-identification effort, increasingly supplemented by biopsy sampling, has been intensive within the range of the PCFG since the early 2000s although substantial numbers of individuals had been catalogued by then, primarily in British Columbia (Hatler and Darling 1974; Darling 1984). The first population analysis using all available photographs was that by Calambokidis *et al*. (2002) who compiled photographs from a large variety of sources including individual researchers, teams of scientists from government agencies and non-governmental organizations, whale-watch operators, and protected-area managers between northern California and southeastern Alaska. Their mark-recapture estimates of abundance were in the order of 180 individuals. More recent estimates are as indicated below.

Western Pacific (Sakhalin Island) population (DU3)

Here also, photo-identification and biopsy data have been the foundation for population analyses. Dedicated field effort by a group of scientists (formerly referred to as the Russia-US team, recently changed to Russian Gray Whale Program) began in 1994 and has continued annually since then (Weller *et al*. 1999, 2002a,b, 2012). A separate team (generally referred to as the Institute of Marine Biology, or IMB, team), under contract to two large oil and gas companies operating near the whales' principal feeding areas, has carried out a parallel annual photo-identification (and recently biopsy) program since 2002

(Tyurneva *et al*. 2010). A series of population assessments have been conducted by Justin Cooke (Reeves *et al*. 2005; Cooke *et al*. 2013; International Whaling Commission 2015b; Western Gray Whale Advisory Panel 2016) using an individual-based model designed specifically for application to the data available on the Grey Whales at Sakhalin (and southern Kamchatka where some of the Sakhalin whales spend part of the feeding season). An earlier photographic mark-recapture estimate was also published by Bradford *et al*. (2008) but is generally regarded as negatively biased.

Range-wide Historical Abundance

Models of historical catches and available habitat suggested that there were between 23,000 and 35,000 Grey Whales (all ages > 1 year) in the eastern North Pacific before the onset of commercial whaling in 1846 (Reilly 1992; Punt and Butterworth 2002; Wade 2002). That range of "historical carrying capacity" estimates was challenged by estimates using genetic approaches. Alter *et al*. (2007) found DNA variability at 10 loci that they considered typical of a population of ~76,000–118,000, with coalescent simulations suggesting an "average measurement" of around 96,000 Grey Whales (all ages) throughout the North Pacific at some unspecified time in the past. More recently, an age- and sex-structured model fitted using Bayesian methods and incorporating catch data, life history data, and census data (from shore counts in California) led Punt and Wade (2012) to conclude that the size of the population migrating along the west coast of North America in 2009 (posterior mean of 20,366) was at about 85% of its carrying capacity level (posterior mean of 25,808).

Aboriginal (subsistence) whaling for Grey Whales throughout much of their range occurred in antiquity (Krupnik 1984, 1987; O'Leary 1984) and continues today only in Chukotka, Russia. Migrating Grey Whales were also hunted commercially from shore stations between Baja, California and British Columbia from the 1850s to early 1900s (Sayers 1984; Reeves and Smith 2010). In addition, they were hunted from ships in the wintering lagoons and to some extent in feeding areas (including in the Sea of Okhotsk; Reeves *et al*. 2008) from 1846 to the early 1900s (Henderson 1984; Reeves *et al*. 2010). Between 1914 and 1946, modern factory ships reported taking 940 Grey Whales (Reeves 1984), but there is ample evidence that Soviet catches were underreported and continued past 1946 when Grey Whales were legally protected from commercial whaling (Rocha *et al*. 2014). Whaling for Grey Whales began in Japan in the early 1600s (Omura 1984), and Japanese modern whalers hunted Grey Whales in Japanese and Korean waters until at least 1966 (Kato and Kasuya 2002).

A relatively simple population dynamics model suggested that the number of Grey Whales migrating along the American west coast reached its low point in the late 19th century at approximately 4,000 individuals (Reilly 1981; Rice *et al.* 1984). The analysis by Alter *et al*. (2012) suggests a total population (presumably basin-wide) of close to 9,000 in around 1890, by which time the industrial whaling pressure on Grey Whales had eased, at least in the eastern part of the species' North Pacific range.

Recent Abundance in Eastern Pacific (Mainly North Pacific Migratory DU1)

Modern abundance estimates of Grey Whales in the eastern North Pacific are relatively precise, judging by the standards of cetacean population data. As migrating Grey Whales travel close to shore along the west coast of North America, the entire migrating population can be counted at strategic points along this corridor (e.g., Reilly *et al.* 1983; Rugh 1984; Buckland and Breiwick 2002) and standard errors for estimates of population size are generally small (4-8%; Buckland *et al.* 1993). Shore-based counts along the California coast during the southbound migration have been conducted approximately every other year since 1967 and these counts indicated an increase from around 13,000 in 1967 to nearly 21,000 in 1988 and more than 26,000 in 1998 (Buckland *et al.* 1993; Gerber *et al.* 1999; Buckland and Breiwick 2002), implying an average rate of population growth of approximately 2.5% (Buckland and Breiwick 2002). It is important to emphasize, however, that those estimates have become obsolete in the light of more rigorous recent analyses by Laake *et al*. (2012). The updated, integrated re-analysis of counts during the southbound migration from 1967 to 2006 indicated that earlier abundance estimates from the counts between 1967 and 1987 were biased low and those from the counts between 1992 and 2006 were biased high (Laake *et al*. 2012). The discrepancy was largely explained by differences in the correction for pod size bias.

In the winter of 1998-1999, a drastic change occurred in the eastern North Pacific as mortality increased substantially on the wintering grounds and during the 1999 northbound migration, including an unusually high proportion of adult and non-calf juveniles (Le Boeuf *et al.* 2000). At the same time, annual calf production, which had averaged 4.6% from 1994 to 1998, dropped to 1.7% in 1999 and 1.1% in 2000 (Perryman *et al.* 2002). Mortality was also high in 2000, but returned to normal levels in 2001 (Le Boeuf *et al.* 2000; Moore *et al.* 2001; Gulland *et al*. 2002; International Whaling Commission 2003). The estimated abundance of Grey Whales in the eastern North Pacific had declined to between 17,000 and 19,000 in 2002 (International Whaling Commission 2003). The currently accepted best estimate is 20,990 (CV=0.05) based on data from the shore count of whales during the southbound migration off California in the winter of 2010/2011 (Durban *et al*. 2013; Carretta *et al*. 2015).

Recent Abundance of Pacific Coast Feeding Group (DU2)

In the years from 1996 to 1998, Calambokidis *et al.* (2002) identified a total of 155 “summer-resident” Grey Whales along the west coast of North America of which at least 80 individuals had been seen in British Columbia waters (Deecke 2003). Photographic mark-recapture estimates for the period from 1996 to 2015 were reported in Calambokidis *et al*. (2017). The 2012 abundance estimate for the IWC-defined range of the PCFG between 41°N and 52°N was 209 (SE=15.4; CV= 0.07) (Carretta *et al*. 2015) and the 2014 estimate was 237 (SE=20.0) (Calambokidis *et al*. 2017). The numbers for the PCFG since the early 2000s have been relatively stable but the population appears to have increased in 2013–2015 (Calambokidis *et al*. 2017).

Recent Abundance of Western Pacific (Sakhalin Island) population (DU3)

The aged 1+ population (i.e., all animals except calves) in 2014 was estimated as 174 (CI 158-191) or 186 (CI 171-203), depending on assumptions (Western Gray Whale Advisory Panel 2016).

Fluctuations and Trends

Despite the die-off in 1999 and 2000, Grey Whale numbers in the eastern North Pacific have remained well above what they were in the middle of the twentieth century and overall abundance “has been relatively stable since the mid-1990s” (Carretta *et al*. 2015). The IWC Scientific Committee acknowledged that modelling efforts had, thus far, “failed to mimic well the change in abundance estimates from 1987/88 to 1992/93” (International Whaling Commission 2017; Figure 9). It noted that one hypothesis to explain this would be that migratory behaviour changed during the period such that differing proportions of the population migrated past the central California shore-based count site “depending upon body condition.” However, in the absence of any data to validate the plausibility of this hypothesis, it was decided not to change the operating model or to pursue this issue further.

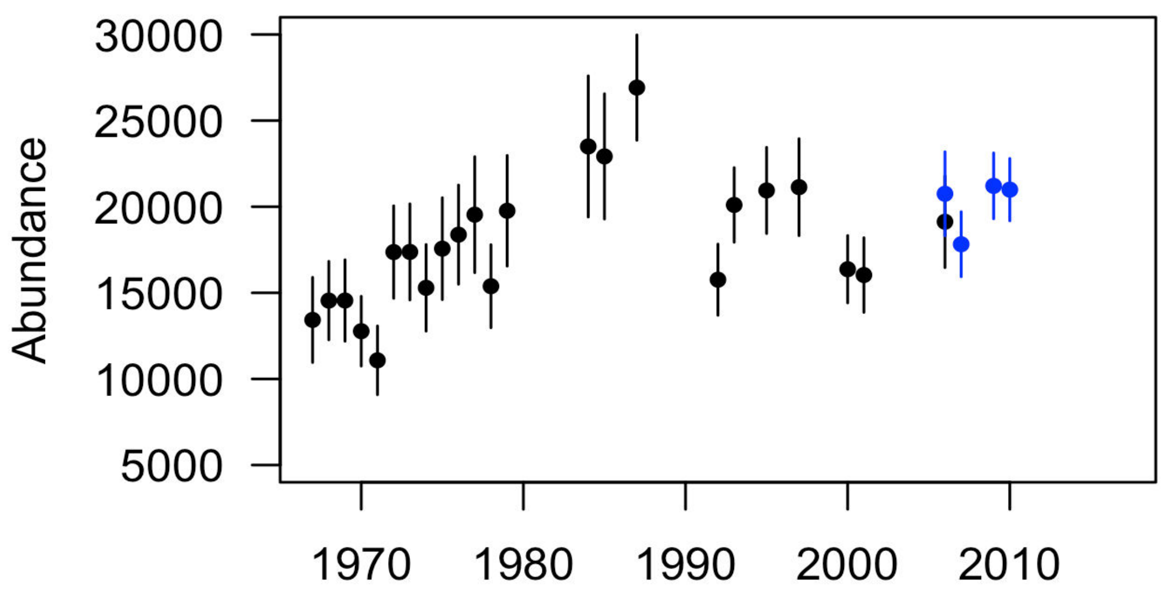

Figure 9. Estimates of absolute abundance of Grey Whales in the eastern North Pacific based on shore counts from Laake *et al*. 2012 (1967-2006; black) and Durban *et al*. 2013 (2006-2010; blue). These counts are assumed to have included the entire Northern Pacific Migratory DU (DU1) and uncertain proportions of whales considered to belong to the PCFG and Western Pacific DUs. Source: International Whaling Commission (2017; Document SC/66B/REP07, Table 2b). Plot prepared by Eva Stredulinsky, courtesy of John Ford.

Abundance estimates for the PCFG (DU2) reported by Calambokidis *et al*. (2014) indicated a high rate of increase in the late 1990s and early 2000s but numbers have been relatively stable since 2003 (Carretta *et al*. 2015; Figure 10).

The Western Pacific population (DU3) was increasing at an average rate of 3.8% per year (CI 2.8-4.8%) from 1994 through 2014 (Figure 11) and, on the assumption that average conditions would remain unchanged, the increase was projected to continue (Western Gray Whale Advisory Panel 2016).

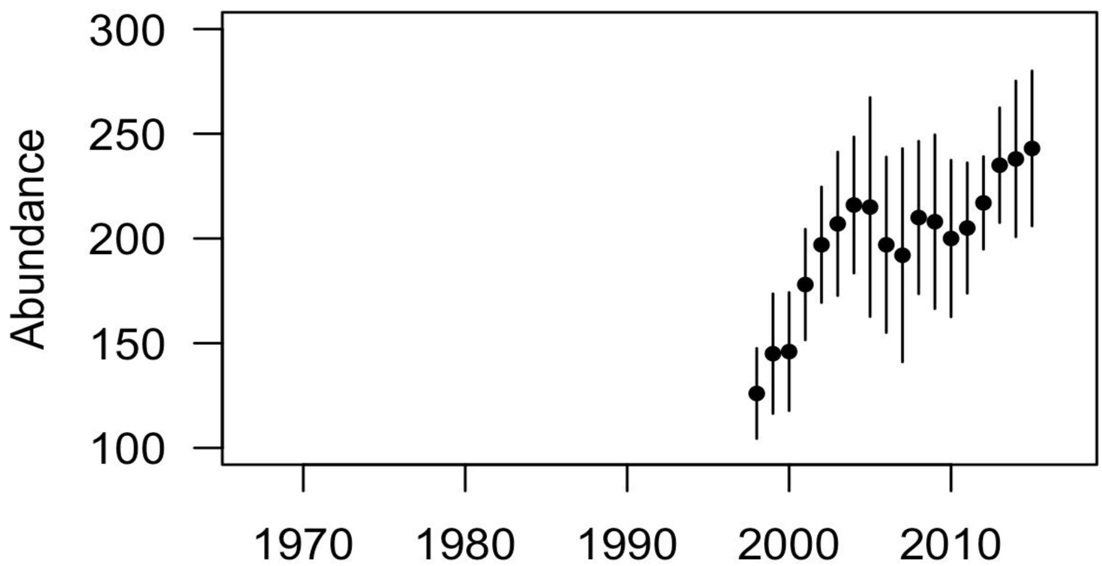

Figure 10. Estimates of absolute abundance (with 95% confidence limits) of Grey Whales considered to belong to the Pacific Coast Feeding Group DU (DU2) based on mark-recapture analysis by J. Laake. Source: International Whaling Commission (2017; Document SC/66B/REP07, Table 2c). Plot prepared by Eva Stredulinsky, courtesy of John Ford.

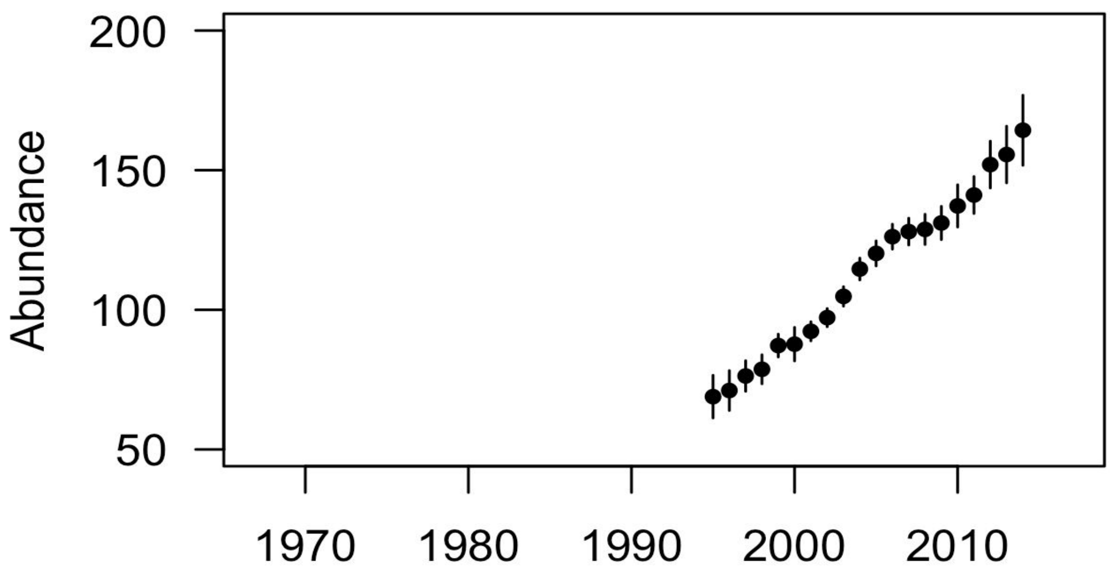

Figure 11. Indices of 1+ (i.e. non-calf-of-the-year) abundance of Grey Whales summering off Sakhalin Island Russia (and therefore considered to belong to the Western Pacific DU (DU3) based on Bayesian population dynamics modelling by J.G. Cooke. Source: International Whaling Commission (2017; Document SC/66B/REP07, Table 2a). Plot prepared by Eva Stredulinsky, courtesy of John Ford.

Rescue Effect

Because of their small numbers, neither of the smaller DUs considered here is likely to be a major source of rescue for the Northern Pacific Migratory DU, but individuals from either or both of those groups may be recruited into it occasionally. As discussed earlier under **Designatable Units**, there is substantial uncertainty about "internal recruitment" versus "external immigration" for the PCFG DU. The same can be said of the Western Pacific DU.

THREATS AND LIMITING FACTORS

Threats

Direct threats faced by Grey Whales assessed in this report were organized and evaluated based on the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system (Master *et al*. 2012). Threats were defined as the proximate activities or processes that directly and negatively impact Grey Whales. These were assessed for each of the proposed DUs, with results on the impact, scope, severity, and timing presented in tabular form in the appendices.

The overall calculated and assigned threat impact is Low to Medium for the North Pacific Migratory population (DU1), Medium to High for the Pacific Coast Feeding Group population (DU2) and High to Very High for the Western Pacific population (DU3). The greatest potential anthropogenic threat to Grey Whales may be “increasing activity and development in and around the breeding [i.e. wintering] lagoons in Mexico” (Ford 2014). However, at least for the present, this does not seem to constitute an actual or immediate threat.

Industrial activities (IUCN Threats #3.1[Oil and gas drilling], 3.3[Renewable energy])

Citing Hall *et al*. (2004) and MacConnachie *et al*. (2007), Ford *et al*. (2013) noted that the Queen Charlotte Basin, which underlies Hecate Strait, Dixon Entrance, and Queen Charlotte Sound, may contain significant petroleum reserves and therefore could become a site of oil and gas development. Concerns about the impacts of offshore oil and gas development as well as the transport of oil in the marine environment are widely recognized (Moore and Clarke 2002), and especially with regard to the Sakhalin feeding areas (Weller *et al*. 2002; Reeves *et al*. 2005).

Ford *et al*. (2013) drew attention to the NaiKun Wind Energy Group’s major offshore project proposed for Dogfish Bank off Haida Gwaii, in northwestern Hecate Strait, citing Esteban and Leary (2011) and the company’s website (NaiKun 2017). According to Ford *et al*. (2013), this project is “adjacent to or partly overlapping the [Grey Whale] migration corridor.” In January 2016 the project was “at an advanced stage of development with environmental approvals from the provincial and federal governments and agreements in place with key suppliers and First Nations,” and it was anticipated that construction could begin within two years. Underwater noise emitted during construction and operation of offshore wind farms has become a major concern although very little is known at this time about the possible impacts on baleen whales (Madsen *et al*. 2006; Bailey *et al*. 2014). Seismic surveys are often required during site selection and surveillance for turbine placement.

Transportation & service corridors (IUCN Threats #4.3[Shipping lanes])

Ford *et al*. (2013) suggested that the relatively low incidence of ship strikes is due, at least in part, to the fact that much of the migration route is near shore, meaning “there is minimal overlap with large ships, which are the type of vessels most likely to cause severe and lethal injuries to whales.” Those authors also noted, however, that for more than 500 km of the whales’ transit from northern Vancouver Island through Hecate Strait to western Dixon Entrance, their route “coincides with that of significant marine traffic, including large deep-sea ships.” Both Hecate Strait and Dixon Entrance contain active shipping lanes that overlap substantially with the Grey Whale migration corridor (Williams and O’Hara 2010; Pacific North Coast Integrated Management Area Initiative 2011).

Biological resource use (IUCN Threats #5.4[Fishing & harvesting aquatic resources])

Whaling was the most obvious threat to Grey Whales historically but it is generally accepted that recent and current removals, which are limited to Aboriginal subsistence whaling in Chukotka which targets only the Northern Pacific Migratory population (DU1), are adequately monitored, reported, and at sustainable levels (Carretta et al. 2015; Thomas *et al*. 2015). There is concern that resumption of subsistence whaling by the Makah Tribe in northeastern Washington State could have significant impacts on either the PCFG DU or the Western Pacific DU, or both, but it is unclear whether or when such resumption might occur. If and when it does, it is reasonable to expect that such whaling will be closely monitored and managed by U.S. authorities as well as the International Whaling Commission. The IWC's simulation analyses of the impact of the proposed Makah Tribe hunt led to the conclusion that the Tribe's proposed management plan would protect PCFG whales sufficiently to meet the conservation objectives of the IWC.

The other potential threat that involves outright deaths or serious injuries of Grey Whales is entanglement in fishing gear or debris (Moore and Clarke 2002; Thomas *et al*. 2015). Several recent efforts have been made to collate data on this threat for Grey Whales along the U.S. and Canadian coasts (Scordino and Mate 2012), in the western North Pacific (Bradford *et al*. 2009; Carretta *et al*. 2015), and range-wide (Scordino *et al*. 2016). Fishing gear found on entangled Grey Whales has included drift nets deployed offshore for swordfish, gill nets set inshore for a large variety of species, longlines, and crab or lobster trap/pot lines. Grey Whales also die in set nets in Japan (Weller *et al*. 2008) and in trawl gear in the Bering Sea (Carretta *et al*. 2015). In British Columbia, Grey Whale deaths have been recorded in salmon drift gillnets and seines, longlines for bottom fish, and lines attached to fish traps or pots (Baird *et al*. 2002); lines from Dungeness Crab (*Metacarcinus magister*) traps may be especially problematic (Ford 2014). One whale even died after becoming entangled and drowning in a herring net pen (Baird *et al*. 2002).

Natural system modifications (IUCN Threats #7.3[Other ecosystem modifications])

Offshore mining, dredging, construction, and pipe-laying activities add to underwater noise levels and could also affect Grey Whales by removing or degrading the quality of their feeding habitat (Jewett *et al.* 1999; Reeves *et al*. 2005). Grey Whales abandoned one of their calving and calf-rearing lagoons in Mexico (Laguna Guerrero Negro) for about a decade (1957-1967), when salt barges were using the channel and it was being dredged repeatedly. At the end of the 1960s, with the barge and dredging activity having abated, the whales returned (Gard 1974; Bryant *et al*. 1984). This has often been cited as an example of a strong displacement effect of "disturbance." It is interesting, however, that the whales reoccupied the lagoon, perhaps implying a certain degree of resilience and adaptability.

Other problematic species & genes (IUCN Threats #8.2[Problematic native species/diseases])

Their largely near-shore distribution and benthic or epibenthic feeding mode exposes Grey Whales to environmental toxins (e.g., from harmful algal blooms). However, there is no evidence, to date, that they have been seriously affected by such exposure.

Pollution (IUCN Threats #9.2[Industrial & military effluents], 9.4[Garbage & solid waste], 9.6[Excess energy])

It is important to acknowledge that the threat of exposure to oil and other toxic substances due to spills or leaks can quickly become lethal depending on, among other things, the nature of the substance, the circumstances surrounding the release, and the scale and duration of exposure. Because they regularly disturb and forage in bottom sediments, Grey Whales are clearly exposed to various contaminants. However, aside from somewhat elevated levels of copper in one stranded individual (Méndez *et al*. 2002), no alarming levels of organochlorines or heavy metals have been detected (Varanasi *et al*. 1994; Jarman *et al*. 1996; Krahn *et al*. 2001; Tilbury *et al*. 2002).

The incidental ingestion of both macro- and micro-plastics is a source of concern for many organisms in the ocean, including Grey Whales. Also, bottom trawling presumably has the potential to disturb and degrade the benthic prey resources of Grey Whales. However, the risks from these potential threats have not been investigated and assessed.

Besides the risk of vessel strikes, boat and ship traffic contribute to underwater noise that can cause disturbance to the whales, particularly when the traffic is non-routine or, as in the case of whale-centred tourism ("whale watching"), involves deliberate close approaches (Higham *et al*. 2014), or when the noise is especially intense and prolonged, as it is during seismic surveys and can be during marine or near-shore construction. In 2013, Kinder Morgan submitted an application with the National Energy Board to expand their pipeline operations from Alberta to the British Columbia coast. The project was approved in 2016 and will likely increase shipping. A study of North Atlantic Right Whales (*Eubalaena glacialis*) provided evidence that chronic exposure to low-frequency ship noise can be associated with elevated stress hormone levels (Rolland *et al*. 2012). Whether Grey Whales are as susceptible as right whales is uncertain. The relatively new concept of "acoustic habitat," as introduced and developed by Clark (2009), Moore *et al*. (2012), Hatch *et al*. (2012), and others, emphasizes the potential consequences for baleen whales of the cumulative and chronic loss of acoustic communication space as a result of "masking" by anthropogenic noise. This is a concern for Grey Whales, particularly in areas where it may be essential for the whales to maintain communication with one another.

Although the direct evidence of long-term displacement or other behavioural disruption of feeding Grey Whales is inconclusive, there was evidence of short-term displacement from prime feeding habitat and short-term changes in behaviour during a large-scale seismic survey off Sakhalin (Weller *et al*. 2002c; Yazvenko *et al*. 2007; Gailey *et al*. 2007). Concern about such effects has led to considerable efforts to monitor and mitigate the effects of seismic surveys (and other industrial activities) at Sakhalin and elsewhere (Nowacek *et al*. 2013, 2015). As noted earlier (Population Sizes and Trends), the number of whales off Sakhalin has been steadily increasing (Western Gray Whale Advisory Panel 2016), perhaps indicating that the investments in Grey Whale mitigation and monitoring by companies operating in and near those areas (Johnson *et al*. 2007; Bröker *et al*. 2015) helped limit the impacts.

Climate change & severe weather (IUCN Threats #11.1[Habitat shifting & alteration])

The effects of climate change, which are especially obvious and pronounced in high-latitude environments including the Arctic, where the sea-ice regime has shifted dramatically in recent decades, are generally viewed as more positive than negative for Grey Whales, at least in the immediate future (Moore and Huntington 2008).

Ocean acidification, which affects the viability of calcifying organisms, is predicted to be felt first in cold polar seas (Orr *et al*. 2005; Fabry *et al*. 2009). A recent review (Thomas *et al*. 2015) suggested that as higher-order predators that feed on at least some kinds of calcifying organisms in the northern Bering and Chukchi Seas, Grey Whales may be among the first baleen whales to be at risk from ocean acidification.

Limiting Factors

Punt and Wade (2012) considered the “eastern North Pacific population” to be at 85% of carrying capacity (K) in 2009. The statement in the previous COSEWIC report (2004) may still apply – that as the number of Grey Whales in the eastern North Pacific continues to increase toward carrying capacity (K) levels, the whales will be increasingly limited by the amount of available habitat on the feeding grounds. The “anomalous” years with high mortality and low recruitment in 1999 and 2000, as noted in COSEWIC (2004) and discussed above, are still generally regarded as indicative of poor nutrition on the feeding grounds, and more such events can be expected. A caveat is that alternative “long-term” estimates of K would indicate that Grey Whales are still far below “long-term” carrying capacity in the North Pacific (Alter *et al*. 2007, 2012); those estimates, however, “should be treated cautiously” (Alter *et al*. 2007, p. 15165) and are generally not considered relevant in a management context (Punt and Wade 2012; Carretta *et al*. 2015).

Number of Locations

The very high mobility of all Grey Whales, even those that may spend long periods in relatively small areas during parts of the year or during particular life stages, makes it difficult to apply the COSEWIC concept of “location” to them.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Grey Whales were first protected from commercial whaling under the International Agreement for the Regulation of Whaling, to which the United States and Norway (whose factory ships had taken about 200 Grey Whales off Mexico and Kamchatka in the 1920s) subscribed in 1937 and Canada in 1938 (Reeves 1984). Other whaling nations in the North Pacific (e.g., Japan, Soviet Union) did not sign that convention. However, Japan, the Soviet Union, and Mexico did sign the 1946 International Convention for the Regulation of Whaling, along with other relevant countries (except China, Taiwan, and the two Koreas), and as a result all nations likely to conduct whaling operations in the North Pacific had agreed by 1951 not to hunt Grey Whales for commercial purposes. Recent rectification of falsified Soviet whaling data has revealed that at least 149 Grey Whales, most of them unreported, were taken by Soviet industrial commercial whalers between 1948-1979, including 124 in the Bering Sea in 1967 (Ivashchenko *et al*. 2013).

Both the 1937 and 1946 agreements contained special provisions (which are still in force) allowing Grey Whales to be hunted by, or for the benefit of, local Aboriginal people as long as the products of such hunting are “exclusively for local consumption” by such people (Reeves 1984). The International Whaling Commission currently allows a total catch of 744 Grey Whales by “native people” of Chukotka (Russia) and Washington State (USA) for the years 2013-2018, with a maximum of 140 in any one year (IWC 2017). Contracting governments are also allowed to issue permits to kill whales for scientific purposes. This provision led to legally authorized catches of Grey Whales by the United States (316 between 1959-1970) and Canada (10 in 1953) (Reeves 1984) but there has been no authorized “scientific whaling” for Grey Whales over the past 45 years.

The species is in Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which prohibits international trade in Grey Whale products.

The conservation of whales in Canadian waters is a responsibility of Fisheries and Oceans Canada under the *Fisheries Act* and the Marine Mammal Regulations (Canadian Department of Justice 1993). It is illegal to hunt or disturb cetaceans except for subsistence use, but whales have no explicit legal protection from non-deliberate harm such as from vessel strikes or entanglement in fishing gear. Fisheries and Oceans Canada has established whale-watching guidelines, which prescribe that vessels maintain a distance of at least 100 m from any cetacean (e.g., Ford *et al.* 2000).

The Canadian *Species at Risk Act* currently recognizes two DUs of Grey Whales: the Eastern North Pacific population listed on Schedule 1 as Special Concern and an Atlantic population listed on Schedule 1 as Extirpated. Following the COSEWIC status assessment November 2017, the previous Eastern North Pacific population was split into three populations; North Pacific Migratory population (Not at Risk), Pacific Coast Feeding Group population (Endangered), and the Western Pacific population (Endangered).

In the United States Grey Whales are protected under the *Marine Mammal Protection Act*, which makes it illegal to 'harass, hunt, capture, or kill, or to attempt to harass, hunt, capture, or kill' marine mammals under most circumstances. Implementation of the Act with respect to whales rests with the National Marine Fisheries Service. The Grey Whale was listed as Endangered under the *U.S. Endangered Species Act* until 1994 when it was delisted, but the Grey Whales in the western North Pacific continue to be listed as Endangered.

In Mexico the Grey Whale is classified under *NORMA Oficial Mexicana NOM-059-SEMARNAT-2010* as: Sujeta a protección especial (Pr).

The Grey Whales that occupy feeding grounds in Kamchatka and Sakhalin in summer and autumn are considered an endangered "western" stock and are fully protected from hunting. Those that feed in summer and autumn off Chukotka are part of the Northern Pacific Migratory population (DU1) and are hunted for subsistence subject to annual catch limits set by the IWC.

Non-Legal Status and Ranks

The Grey Whale is of "Least Concern" according to the IUCN Red List (Reilly *et al*. 2008a) but the "western subpopulation" is listed as "Critically Endangered" (Reilly *et al*. 2008b). The species is on the B.C. Blue List (Special Concern) and ranked provincially as S3 (Vulnerable) and globally as G4 (Apparently Secure).

Habitat Protection and Ownership

As Grey Whales tend to occur primarily in relatively shallow near-shore waters, most of their habitat in the eastern North Pacific lies within the exclusive economic zones (EEZ) (200 nm limits) of Mexico, the USA, and Canada. However, they also occur widely across the Bering Sea, including in the Russian EEZ and large numbers of whales, including mothers with calves, that winter in Mexico and migrate through U.S. and Canadian waters spend much of the summer and autumn feeding in Russia (International Whaling Commission 2007; Mate and Urbán-Ramirez 2007).

According to Hoyt (2011, p. 91), the Channel Islands Marine Protected Area (MPA) network off California, which consists of ten marine reserves, two marine conservation areas, and the Channel Islands National Marine Sanctuary, was established to protect the habitat of Grey, Humpback (*Megaptera novaeangliae*), and Blue Whales (*Balaenoptera musculus*). Other MPAs that are designated at least in part for the purpose of protecting Grey Whale habitat in the eastern North Pacific include the Gwaii Haanas National Marine Conservation Area Reserve, Pacific Rim National Park Reserve, and Clayoquot Sound Biosphere Reserve in Canada; El Vizcaíno Biosphere Reserve (incorporating most of the species' known present-day wintering habitat); and Monterey Bay National Marine Sanctuary, Gulf of the Farallones National Marine Sanctuary, Cordell Bank National Marine Sanctuary, and Olympic Coast National Marine Sanctuary in the United States (Hoyt 2011). Some of these MPAs are managed to prevent oil and gas exploration and development, other forms of mining, waste dumping, and disturbance of the seabed. Commercial and recreational fishing is allowed in most of them, as is tourism that focuses on wildlife including whales, although these activities may be subject to special limitations that do not apply outside the MPAs. The MPAs are generally governed by management plans, encourage research, and carry out educational programs.

In Mexico, the three major calving/nursery lagoons for Grey Whales and the nearby coastal areas are included within the *Reserva de la Biosfera El Vizcaíno* (El Vizcaíno Biosphere Reserve). Whale-watching tourism is an important source of revenue for the reserve and the community, at least seasonally, and "there are some restrictions on tourism and fishing" (Hoyt 2011, p. 333). No special protective measures other than the standard regulations that apply to all whale-watching destinations in Mexico (Mexican STD SEMARNAT 131) are currently in place for Bahía Magdalena, the fourth main Grey Whale wintering area in Mexico.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Randall Reeves is a former co-chair of the COSEWIC Marine Mammals Specialist Sub-committee. He currently chairs the IUCN Species Survival Commission's Cetacean Specialist Group and the U.S. Marine Mammal Commission's Committee of Scientific Advisors. Of particular relevance to this report, he chaired IUCN's Independent Scientific Advisory Panel on Western Gray Whales in 2004-05 and since then has chaired or co-chaired the IUCN Western Gray Whale Advisory Panel. He has also been closely involved in the ongoing series of workshops on status and population structure of North Pacific Grey Whales convened by the International Whaling Commission's (IWC) Scientific Committee and in development of the IUCN/IWC Conservation Management Plan for Western Gray Whales.

COLLECTIONS EXAMINED

None.

Appendix 1. Threats Assessment for Grey Whale, Northern Pacific Migratory population.

Species or Ecosystem Scientific Name	Northern Pacific Migratory population of Grey Whale, *Eschrichtius robustus*			
Element ID			**Elcode**	
Date (Ctrl + ";" for today's date):	29/08/2017			
Assessor(s):	Randall Reeves, David Lee, Dave Fraser, Jennifer Shaw, Karen Timm, Tim Frasier, Dave Weller, Jaqueline Clare			
References:				
Overall Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	0	0
	C	Medium	1	0
	D	Low	2	3
	Calculated Overall Threat Impact:		Medium	Low
	Assigned Overall Threat Impact:		**Medium to Low**	
	Impact Adjustment Reasons:			
	Overall Threat Comments		GENERATION TIME 22.9 years (68.7 years = 3 GENERATIONS)	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development		Unknown	Restricted - Small (1-30%)	Unknown	High (Continuing)	
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas		Unknown	Restricted - Small (1-30%)	Unknown	High (Continuing)	Whale-watching tourism affects the whales mostly in terms of 'disturbance' and is probably not important to migrating whales but could be important to those on feeding patches. Vessel strikes are occasional as well.
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining	CD	Medium - Low	Restricted (11-30%)	Moderate - Slight (1-30%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3.1	Oil & gas drilling	CD	Medium - Low	Restricted (11-30%)	Moderate - Slight (1-30%)	High (Continuing)	This activity brings with it multiple types of threat but primarily oil contamination of the Grey Whales and their prey. There is also some risk of ship strikes by vessels involved in these operations. There is also oil and gas activity and development along the migratory route in California.
3.2	Mining & quarrying						
3.3	Renewable energy	D	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Offshore wind farms represent a potential threat to Grey Whales due to the associated noise from construction and operation. Not mentioned in the status report is the fact that seismic surveys are often required during site selection and surveillance for turbine placement (e.g., avoidance of gas pockets etc.). The NaiKun Wind Energy Group has a major offshore project proposed for Dogfish Bank off Haida Gwaii, in northwestern Hecate Strait. In 2016, the project was at an advanced stage of development with environmental approvals from the Provincial and Federal Governments.
4	Transportation & service corridors	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Definitely a threat primarily due to ship strike and noise.
4.4	Flight paths						
5	Biological resource use	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	This threat has two forms, the most serious of which is hunting in Russia. The large scope is due to the fact that more than a third of the population may be scarred or wounded at some point in their life by entanglement in fishing gear, be shot by a whaler or at least approached by a whaling vessel. However, it appears that the recent and current scale of effect is tolerable, thus severity is only slight.
6	Human intrusions & disturbance		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	Boating in coastal waters can be disturbing to the whales and create a small risk of injury from being struck accidentally.
6.2	War, civil unrest & military exercises						Whales can migrate close to areas of military activities, but impacts likely not felt at a population level.
6.3	Work & other activities						
7	Natural system modifications		Unknown	Large - Small (1-70%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression						
7.2	Dams & water management/use						
7.3	Other ecosystem modifications		Unknown	Large - Small (1-70%)	Unknown	High (Continuing)	Offshore mining, dredging, construction, and pipe-laying activities remove or degrade the quality of their feeding habitat (Jewett *et al*. 1999; Reeves *et al*. 2005). Effects of dredging, bottom trawling, and development near breeding lagoons in Mexico were discussed but of unknown impact.
8	Invasive & other problematic species & genes		Unknown	Unknown	Unknown	Unknown	
8.1	Invasive non-native/alien species/diseases						
8.2	Problematic native species/diseases		Unknown	Unknown	Unknown	Unknown	The threat of harmful algal blooms is placed here because it involves naturally occurring organisms that carry toxins. And human actions are almost certainly a contributing factor in driving both the intensity and areal extent of such blooms.
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	There is no evidence to date of anything major but the large-scale die-off in 1999-2000, during which time there was a strong spike in strandings with evidence of emaciation, is of concern (although the population has rebounded since then). Also, the fact that Grey Whales congregate in relatively high densities during the winter and tend to be 'clumped' even when migrating suggests that the risk of rapid spreading of disease (e.g. a virus) certainly exists.
9	Pollution		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.1	Domestic & urban waste water		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.2	Industrial & military effluents		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Includes tanker spills.
9.3	Agricultural & forestry effluents		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.4	Garbage & solid waste		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Whales can ingest plastics from benthos, and swim through large garbage polluted areas but not much known.
9.5	Air-borne pollutants		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.6	Excess energy		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	The sound energy from human activities is pervasive and significant for animals like Grey Whales that are critically dependent on sound for communication if not also for other purposes. There are examples of avoidance (short -term site abandonment) in calving lagoons in noise filled (salt mines) areas but population consequences unknown. The fact that the whale population is as large and robust as it appears to be suggests that the current level of exposure is tolerable, but this issue bears watching. There are efforts underway to reduce noise levels.
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Climate change is definitely affecting Grey Whales in a number of ways, some of which appear to be, for the moment at least, beneficial -- as explained in the Status Report. However, over the long term, effects and consequences are still unknown. This does not seem to have had an impact yet given the evident condition of the population but it could become a problem in the future, probably beyond 10 years.
11.2	Droughts						
11.3	Temperature extremes						
11.4	Storms & flooding						
11.5	Other impacts						

Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).

Appendix 2. Threats Assessment for Grey Whale, Pacific Coast Feeding Group population.

Species or Ecosystem Scientific Name	Pacific Coast Feeding Group DU, Grey Whale			
Element ID			**Elcode**	
Date (Ctrl + ";" for today's date):	29/08/2017			
Assessor(s):	Randall Reeves, David Lee, Dave Fraser, Jennifer Shaw, Karen Timm, Tim Frasier, Dave Weller, Jaqueline Clare			
References:				
Overall Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	1	0
	C	Medium	1	0
	D	Low	2	4
		Calculated Overall Threat Impact:	High	Medium
		Assigned Overall Threat Impact:	**High to Medium**	
		Impact Adjustment Reasons:		
		Overall Threat Comments	GENERATION TIME 22.9 years (68.7 years = 3 GENERATIONS)	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development		Unknown	Restricted - Small (1-30%)	Unknown	High (Continuing)	
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas		Unknown	Restricted - Small (1-30%)	Unknown	High (Continuing)	Whale-watching tourism affects the whales mostly in terms of 'disturbance' and is probably not important to migrating whales but could be important to those on feeding patches. Vessel strikes are occasional as well.
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3	Energy production & mining	BD	High - Low	Large - Restricted (11-70%)	Serious - Slight (1-70%)	High - Low	
3.1	Oil & gas drilling	BD	High - Low	Large - Restricted (11-70%)	Serious - Slight (1-70%)	High - Low	This activity brings with it multiple types of threat but primarily oil contamination of the Grey Whales and their prey. There is also some risk of ship strikes by vessels involved in these operations. There is oil and gas activity occuring along the migratory route in California (e.g., Ellwood, South Ellwood and Dos Cuadras Offshore Oil Fields). Noise associated with seismic surveys, construction of offshore structures (platforms, artificial islands etc.), drilling noise, and vessel traffic associated with operations.
3.2	Mining & quarrying						
3.3	Renewable energy	D	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Offshore wind farms represent a potential threat to Grey Whales due to the associated noise from construction and operation. Seismic surveys are often required during site selection and surveillance for turbine placement (e.g., avoidance of gas pockets etc.). The NaiKun Wind Energy Group has a major offshore project proposed for Dogfish Bank off Haida Gwaii, in northwestern Hecate Strait. In 2016, the project was at an advanced stage of development with environmental approvals from the Provincial and Federal Governments.
4	Transportation & service corridors	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Definitely a threat primarily due to ship strike and noise.
4.4	Flight paths						
5	Biological resource use	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	The large scope is due to the fact that more than a third of the population may be scarred or wounded at some point in their life by entanglement in fishing gear, be shot by a whaler or at least approached by a whaling vessel. However, it appears that the recent and current scale of effect is tolerable, thus Severity is only slight. The Makah tribe considers timing of seasonal movements in order to avoid take of PCFG whales.
6	Human intrusions & disturbance		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Boating in coastal waters can be disturbing to the whales and create a small risk of injury from being struck accidentally.
6.2	War, civil unrest & military exercises						Whales can migrate close to areas of military activities, but impacts not felt at a population level.
6.3	Work & other activities						
7	Natural system modifications		Unknown	Large - Small (1-70%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression						
7.2	Dams & water management/use						
7.3	Other ecosystem modifications		Unknown	Large - Small (1-70%)	Unknown	High (Continuing)	Offshore mining, dredging, construction, and pipe-laying activities remove or degrade the quality of their feeding habitat (Jewett *et al*. 1999; Reeves *et al*. 2005). Effects of dredging, bottom trawling and development near breeding lagoons (in Mexico) were discussed.
8	Invasive & other problematic species & genes		Unknown	Unknown	Unknown	Unknown	
8.1	Invasive non-native/alien species/diseases						
8.2	Problematic native species/diseases		Unknown	Unknown	Unknown	Unknown	The threat of harmful algal blooms is placed here because it involves naturally occurring organisms that carry toxins. And human actions are almost certainly a contributing factor in driving both the intensity and areal extent of such blooms.
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	There is no evidence to date of anything major but the large-scale die-off in 1999-2000, during which time there was a strong spike in strandings with evidence of emaciation, is of concern (although the population has rebounded since then). Also, the fact that Grey Whales congregate in relatively high densities during the winter and tend to be 'clumped' even when migrating suggests that the risk of rapid spreading of disease (e.g., a virus) certainly exists.
9	Pollution	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
9.1	Domestic & urban waste water		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.2	Industrial & military effluents	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Includes tanker spills.
9.3	Agricultural & forestry effluents		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.4	Garbage & solid waste		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Whales can ingest plastics from benthos, and swim through large garbage polluted areas but not much known.
9.5	Air-borne pollutants		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.6	Excess energy		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	The sound energy from human activities is pervasive and significant for animals like Grey Whales that are critically dependent on sound for communication if not also for other purposes. The fact that the whale population is as large and robust as it appears to be suggests that the current level of exposure is tolerable, but this issue bears watching. There are efforts underway to reduce noise levels.
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Over the long term, the effects and consequences are still unknown.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.2	Droughts						
11.3	Temperature extremes						
11.4	Storms & flooding						
11.5	Other impacts						

Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).

Appendix 3. Threats Assessment for Grey Whale, Western Pacific population.

Species or Ecosystem Scientific Name	Western Pacific DU of Grey Whale, *Eschrichtius robustus*		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	29/08/2017		
Assessor(s):	Randall Reeves, David Lee, Dave Fraser, Jennifer Shaw, Karen Timm, Tim Frasier, Dave Weller, Jaqueline Clare		
References:			

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	low range
A	Very High	1	0
B	High	0	0
C	Medium	1	1
D	Low	2	3
Calculated Overall Threat Impact:		Very High	High
Assigned Overall Threat Impact:		**Very High to High**	
Impact Adjustment Reasons:			
Overall Threat Comments		GENERATION TIME 22.9 years (68.7 years = 3 GENERATIONS)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						Whale-watching tourism affects the whales mostly in terms of 'disturbance' and is probably not important to migrating whales but could be important to those on feeding patches. Vessel strikes are occasional as well.
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3	Energy production & mining	AC	Very High - Medium	Pervasive (71-100%)	Extreme - Moderate (11-100%)	High (Continuing)	
3.1	Oil & gas drilling	AC	Very High - Medium	Pervasive (71-100%)	Extreme - Moderate (11-100%)	High (Continuing)	This activity brings with it multiple types of threat but primarily oil contamination of the Grey Whales and their prey. There is oil and gas activity and development near the feeding areas. Sakhalin-1 is a project that exploits the three oil and gas fields in the vicinity of Sakhalin Island. Sakhalin-2 represents one of the world's largest integrated oil and gas projects. It exports liquefied natural gas (LNG) and oil to Asia-Pacific and the west coast of North America. There is also some risk of ship strikes by vessels involved in these operations.
3.2	Mining & quarrying						
3.3	Renewable energy	D	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Offshore wind farms represent a potential threat to Grey Whales due to the associated noise from construction and operation. Not mentioned in the status report is the fact that seismic surveys are often required during site selection and surveillance for turbine placement (e.g., avoidance of gas pockets etc.). The NaiKun Wind Energy Group has a major offshore project proposed for Dogfish Bank off Haida Gwaii, in northwestern Hecate Strait. In 2016, the project was at an advanced stage of development with environmental approvals from the Provincial and Federal Governments.
4	Transportation & service corridors	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Definitely a threat primarily due to ship strikes.
4.4	Flight paths						
5	Biological resource use	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	The large scope is due to the fact that more than a third of the population may be scarred or wounded at some point in their life by entanglement in fishing gear. However, it appears that the recent and current scale of effect is tolerable, thus severity is only slight.

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6	Human intrusions & disturbance	Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities	Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Boating in coastal waters can be disturbing to the whales and create a small risk of injury from being struck accidentally.
6.2	War, civil unrest & military exercises					Whales can migrate close to areas of military activities, but impacts not felt at a population level.
6.3	Work & other activities					
7	Natural system modifications	Unknown	Large - Small (1-70%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression					
7.2	Dams & water management/use					
7.3	Other ecosystem modifications	Unknown	Large - Small (1-70%)	Unknown	High (Continuing)	Offshore mining, dredging, construction, and pipe-laying activities remove or degrade the quality of their feeding habitat (Jewett *et al*. 1999; Reeves *et al*. 2005). Effects of dredging, bottom trawling and development near breeding lagoons (in Mexico were discussed but unknown impacts.
8	Invasive & other problematic species & genes	Unknown	Unknown	Unknown	Unknown	
8.1	Invasive non-native/alien species/diseases					
8.2	Problematic native species/diseases	Unknown	Unknown	Unknown	Unknown	The threat of harmful algal blooms is placed here because it involves naturally occurring organisms that carry toxins. And human actions are almost certainly a contributing factor in driving both the intensity and areal extent of such blooms.
8.3	Introduced genetic material					
8.4	Problematic species/diseases of unknown origin					
8.5	Viral/prion-induced diseases					
8.6	Diseases of unknown cause	Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	There is no evidence to date of anything major but the large-scale die-off in 1999-2000, during which time there was a strong spike in strandings with evidence of emaciation, is of concern (although the population has rebounded since then). Also, the fact that Grey Whales congregate in relatively high densities during the winter and tend to be 'clumped' even when migrating suggests that the risk of rapid spreading of disease (e.g., a virus) certainly exists.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9	Pollution	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
9.1	Domestic & urban waste water		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.2	Industrial & military effluents	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Includes tanker spills. Potential pipeline leak in Sahkalin was discussed. The offshore pipelines are located approximately 20 km north of the feeding grounds.
9.3	Agricultural & forestry effluents		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.4	Garbage & solid waste		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Whales can ingest plastics from benthos, and swim through large garbage polluted areas but not much known.
9.5	Air-borne pollutants		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.6	Excess energy		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	The sound energy from human activities is pervasive and significant for animals like Grey Whales that are critically dependent on sound for communication if not also for other purposes. There are examples of avoidance (short -term site abandonment) in calving lagoons in noise filled (salt mines) areas but population consequences unknown. The fact that the whale population is as large and robust as it appears to be suggests that the current level of exposure is tolerable, but this issue bears watching. There are efforts underway to reduce noise levels.
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Climate change is definitely affecting Grey Whales in a number of ways, some of which appear to be, for the moment (short-term) at least, beneficial -- as explained in the Status Report. However, over the long term, effects and consequences are still unknown. This does not seem to have had an impact yet given the evident condition of the population but it could become a problem in the future, probably beyond 10 years.
11.2	Droughts						
11.3	Temperature extremes						
11.4	Storms & flooding						
11.5	Other impacts						

Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).