NOAA Technical Memorandum NMFS

MARCH 2015

STATUS REVIEW OF THE HUMPBACK WHALE *(MEGAPTERA NOVAEANGLIAE)* UNDER THE ENDANGERED SPECIES ACT

Shannon Bettridge, C. Scott Baker, Jay Barlow, Phillip J. Clapham, Michael Ford, David Gouveia, David K. Mattila, Richard M. Pace, III, Patricia E. Rosel, Gregory K. Silber, Paul R. Wade

NOAA-TM-NMFS-SWFSC-540

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ACKNOWLEDGEMENTS

The Humpback Biological Review Team would like to thank Alyson Fleming and Jennifer Jackson for their invaluable work on the NOAA Technical Memorandum that provided significant contributions to this status review. Alyson Fleming also served as rapporteur for the Biological Review Team's meetings. The Society for Marine Mammalogy's Taxonomic Committee provided their collective expertise and advice on genetics and classification of this cosmopolitan species. Sonja Kromann provided great assistance locating background literature for this review. Layne Bolen researched and provided background information on existing regulatory mechanisms, and Jeff Adams created several of the maps contained in this report. We also thank Alex Zerbini, peer reviewers, and other individuals who provided information and guidance in support of this document.

EXECUTIVE SUMMARY

Humpback whales (*Megaptera novaeangliae*) were listed as endangered in 1970 under the Endangered Species Conservation Act of 1969, the precursor to the Endangered Species Act (ESA). When the ESA was enacted in 1973, humpback whales were included in the List of Endangered and Threatened Wildlife and Plants (the List) as endangered and were considered as "depleted" under the Marine Mammal Protection Act (MMPA).

In May 2010, the National Marine Fisheries Service (NMFS) convened the Humpback Whale Biological Review Team (BRT) to conduct a comprehensive review of the status of humpback whales as the basis for considering revisions to this species' listing status. The ESA, as amended in 1978, defines a species to be "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature" (Section 3(16)). Guidance on what constitutes a "distinct population segment" (DPS) is provided by the joint NMFS-Fish and Wildlife Service (FWS) interagency policy on vertebrate populations (61 FR 4722, 7 February 1996). To be considered a DPS, a population, or group of populations, must be "discrete" from the remainder of the taxon to which it belongs; and "significant" to the taxon to which it belongs. Information on distribution, ecological situation, genetics, and other factors is used to evaluate a population's discreteness and significance.

Conducting an ESA status review therefore involves two key tasks: identifying the taxonomic units (species, subspecies or DPS) to be evaluated, and assessing the risk of extinction for each of these units.

Identification of Distinct Population Segments

Humpback whales are found in all oceans of the world with a broad geographical range from tropical to temperate waters in the Northern Hemisphere and from tropical to near-ice-edge waters in the Southern Hemisphere. Nearly all populations undertake seasonal migrations between their tropical and sub-tropical winter calving and breeding grounds[1] and high-latitude summer feeding grounds.

Humpback whales are currently considered to be a monotypic species, but whales from the Northern and Southern Hemispheres differ from each other substantially in a number of traits, including coloration, timing of reproduction and migratory behavior, diet, and molecular genetic characteristics. Within the Northern Hemisphere, populations from the Atlantic and Pacific also differ markedly in molecular genetic traits and coloration patterns, with no evidence of exchange of individuals between these ocean basins. In the Northern Indian Ocean, a population inhabiting the Arabian Sea is also markedly divergent in molecular and behavioral characteristics from all other populations globally. Whales from these four areas (North Pacific, North Atlantic, Southern Hemisphere, and Arabian Sea) were so divergent that the BRT considered the possibility that they might reasonably be considered different sub-species, and enlisted the aid of the Committee on Taxonomy of the Society for Marine Mammalogy to help address this question. The committee concluded that if a taxonomic revision of humpback whales were to be undertaken, it is likely that the North Atlantic, North Pacific and Southern Hemisphere groups

[1] In this document, the term "breeding ground" refers to areas in tropical or subtropical waters where humpback whales migrate in winter to mate and give birth to calves.

would be recognized as sub-species. The BRT therefore largely focused on the question of whether any DPS could be identified within each of these major ocean basins, although we also evaluated whether any DPS so identified would also be discrete and significant if evaluated with reference to the entire global species.

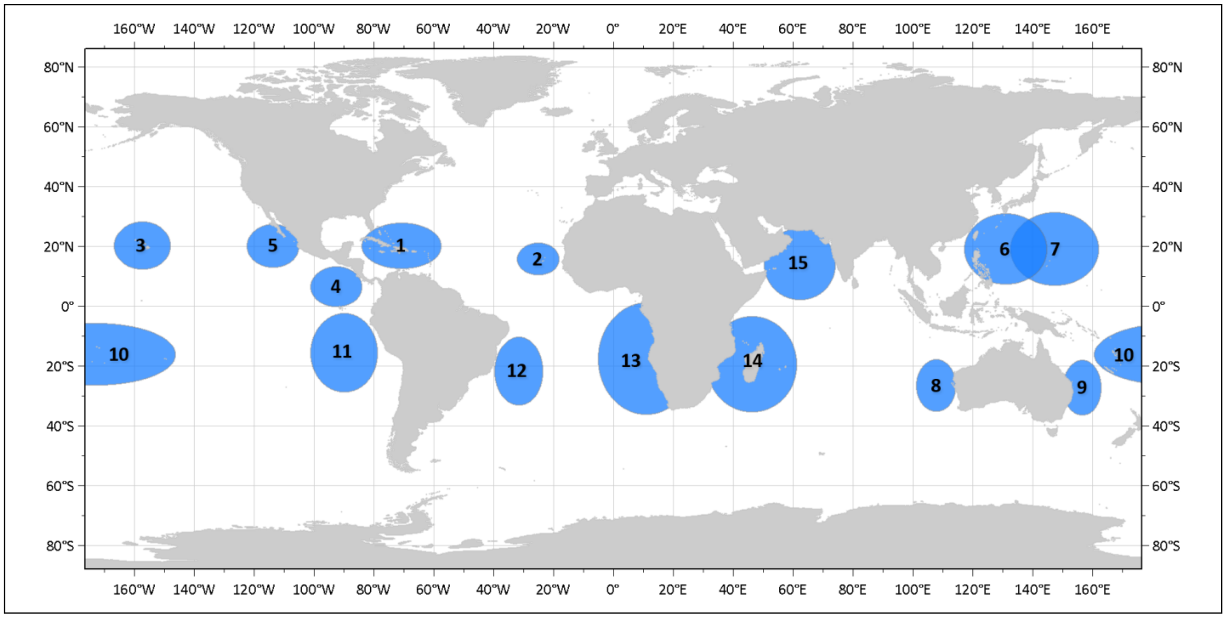
Population structure in humpback whales has been previously evaluated both for breeding areas and feeding areas. In applying the discreteness and significance criteria, the BRT focused on breeding populations as the units that could be identified as DPSs, consistent with the language in the ESA that species (including DPS) "interbreed when mature." Information on where a breeding population feeds, however, was considered in evaluating both the significance and discreteness of that population.

The BRT evaluated genetic data, tagging and photographic-ID data, demographic information, geographic barriers, and stranding data, and determined that there are at least 15 DPS of humpback whales. Significant differences in patterns of genetic variation and information on the rates of exchange of individuals among breeding areas were particularly important for evaluating population discreteness, and patterns of geographic occurrence, differences in ecology among feeding and in some cases breeding areas, and degree of genetic differentiation were most important for determining significance.

Based on this information, the BRT identified the following humpback whale distinct population segments, named after their primary breeding locations (Figure 1):

1. West Indies
2. Cape Verde Islands/Northwest Africa
3. Hawaii
4. Central America
5. Mexico
6. Okinawa/Philippines
7. Second West Pacific (exact location unknown)
8. West Australia
9. East Australia
10. Oceania
11. Southeastern Pacific
12. Brazil
13. Gabon/Southwest Africa
14. Southeast Africa/ Madagascar
15. Arabian Sea

Figure 1. Approximate locations of breeding/wintering areas for the 15 DPSs.



A brief description of each DPS is provided below.

North Atlantic Distinct Population Segments

1. West Indies – The West Indies DPS consists of the humpback whales whose breeding range includes the Atlantic margin of the Antilles from Cuba to northern Venezuela, and whose feeding range primarily includes the Gulf of Maine, eastern Canada, and western Greenland. While many West Indies whales also use feeding grounds in the central (Iceland) and eastern (Norway) North Atlantic, many whales from these feeding areas appear to winter in another location. The West Indies DPS was determined to be discrete based upon genetic evidence and on a lack of evidence for exchange with the eastern Atlantic breeding population (or any other population) based on re-sighting data. This DPS was determined to be significant with respect to other North Atlantic DPS due to the significant gap in the breeding range that would occur if it went extinct. Loss of the West Indies population would result in the loss of humpback whales from all the Northwest Atlantic breeding (Caribbean/West Indies) and feeding grounds (United States, Canada, Greenland) and would also result in the loss of a significant portion of whales occupying feeding grounds in the Northeast Atlantic.

2. Cape Verde Islands plus Northwest Africa – This DPS consists of the humpback whales whose breeding range includes waters surrounding the Cape Verde Islands as well as an undetermined breeding area in the eastern tropical Atlantic which may be more geographically diffuse than the West Indies breeding ground. The population of whales breeding in Cape Verde Islands plus this unknown area likely represent the remnants of a historically larger population breeding around Cape Verde Islands and northwestern Africa (Reeves *et al.* 2002). There is no known overlap in breeding range with North Atlantic humpback whales that breed in the West Indies, although overlap occurs among feeding aggregations from different breeding populations.

The DPS was determined to be discrete based upon genetic evidence that suggests a second breeding ground occupied by whales that feed primarily off Norway and Iceland, as well as the gap that would exist in the breeding range if it became extinct. Loss of this unit would result in a loss of this unique breeding ground as well as a significant number of whales that feed in Iceland and Norway.

North Pacific Distinct Population Segments

3. Hawaii – The Hawaii DPS consists of humpback whales that breed within the main Hawaiian Islands. Whales from this breeding population have been observed in most known feeding grounds in the North Pacific, but about half of the whales from population migrate to Southeast Alaska and Northern British Columbia. They also commonly utilize northern British Columbia, northern Gulf of Alaska and Bering Sea feeding grounds. This DPS was determined to be discrete based on significant genetic differentiation from other North Pacific breeding areas and evidence for low rates of movement among breeding areas in the North Pacific based on sighting data. The Hawaii DPS was determined to be significant due to the gap that would result in breeding and feeding ranges if it were to go extinct, ecological differences in feeding areas compared to other populations, and marked levels of genetic divergence to other populations.

4. Central America – The Central American DPS is composed of whales that breed along the Pacific coast of Costa Rica, Panama, Guatemala, El Salvador, Honduras and Nicaragua. Whales from this breeding ground feed almost exclusively offshore of California and Oregon in the eastern Pacific, with only a few individuals identified at the northern Washington –southern British Columbia feeding grounds. This DPS was determined to be discrete based on re-sight data as well as findings of significant genetic differentiation between it and other populations in the North Pacific. The genetic composition of the DPS is also unique in that it shares mitochondrial DNA (mtDNA) haplotypes with some Southern Hemisphere DPSs, suggesting it may serve as a conduit for gene flow between the North Pacific and Southern Hemisphere. The breeding ground of this DPS occupies a unique ecological setting, and its primary feeding ground is in a different marine ecosystem from most other populations. Loss of this population would also result in a significant gap in the range the species.

5. Mexico – The Mexican DPS consists of whales that breed along the Pacific coast of mainland Mexico, the Baja California Peninsula and the Revillagigedos Islands. The Mexican DPS feeds across a broad geographic range from California to the Aleutian Islands, with concentrations in California-Oregon, northern Washington – southern British Columbia, northern and western Gulf of Alaska and Bering Sea feeding grounds. This DPS was determined to be discrete based on significant genetic differentiation as well as evidence for low rates of movements among breeding areas in the North Pacific based on sighting data. It was determined to be significant due to the gap in breeding grounds that would occur if this DPS were to go extinct and the marked degree of genetic divergence to other populations. It also differs from some other North Pacific populations in the ecological characteristics of its feeding areas.

6. Okinawa/Philippines – The Okinawa/Philippines DPS consists of the whales' breeding/wintering in the area of Okinawa and the Philippines. Animals transiting the Ogasawara area are believed to be a mixture of whales from this DPS and the second West Pacific DPS (# 7, below). The Okinawa/Philippines DPS migrates to feeding grounds in the northern Pacific, primarily off the Russian coast. The population was determined to be discrete

based upon both significant genetic differentiation from other North Pacific populations and apparently limited exchange with other breeding populations in the North Pacific based on re-sighting data. The population was determined to be significant due to the gap in both the breeding and feeding ranges that would arise if the population were to go extinct, marked levels of genetic differentiation from other populations, and a primary feeding area that differs in its ecological characteristics from other populations. The relationship between this DPS and the Second West Pacific DPS is somewhat uncertain, however, due to the latter's unknown breeding location.

7. Second West Pacific DPS – The existence of this breeding population is inferred from sightings of whales in Aleutian Islands area feeding grounds that cannot be linked to any known breeding population and by the significant genetic differences that were found between Ogasawara and the Okinawa/Philippines DPS. Some of these whales may transit the Ogasawara area in route to unknown breeding grounds further south. This inferred breeding population was considered to be discrete based primarily upon the apparent low exchange with other breeding populations in the North Pacific. Its significance was hard to assess, but it appears to feed primarily in a marine ecosystem (the Aleutian Islands) that is rarely used by whales from other populations. Loss of this population was also considered likely to result in a gap in the range, based on a discrete feeding area and an unknown breeding area.

Southern Hemisphere Distinct Population Segments

8. West Australia – The West Australia DPS consists of the whales whose breeding/wintering range includes the West Australia coast, primarily in the Kimberly Region. Individuals in this population migrate to feeding areas in the Antarctic, primarily between 80°E and 110°E based on tagging data. The population was considered discrete based upon lack of evidence for exchange with other breeding populations as well as significant genetic differentiation from other populations in the Southern Hemisphere. It was considered significant due to the gap in both the breeding and feeding range that would be created should the population go extinct.

9. East Australia – The East Australia DPS consists of the whales' breeding/wintering along the eastern and northeastern Australian coast. Based upon tagging, telemetry, and re-sighting data, individuals in this population migrate to Antarctic feeding areas ranging from 100°E to 180°E, but concentrated mostly between 120°E and 180°E. The population was considered discrete based upon its distribution and level of genetic differentiation from other populations. It was considered significant due to the gap in the range that would occur should the population go extinct.

10. Oceania – The Oceania DPS consists of whales that breed/winter in the South Pacific Islands between ~160°E (west of New Caledonia) to ~120°W (east of French Polynesia), including American Samoa, the Cook Islands, Fiji, French Polynesia, Republic of Kiribati, Nauru, New Caledonia, Norfolk Island, New Zealand, Niue, the Independent State of Samoa, Solomon Islands, Tokelau, Kingdom of Tonga, Tuvalu, Vanuatu, Wallis and Futuna. Individuals in this population are believed to migrate to a largely undescribed Antarctic feeding area. The population was considered discrete based on its breeding distribution and level of genetic differentiation from other populations. It was considered significant based upon the gap in the range that would occur should the population go extinct.

11. Southeastern Pacific – The Southeastern Pacific DPS consists of whales that breed/winter along the Pacific coasts of Panama to northern Peru (9°N-6°S), with the main wintering areas concentrated in Colombia. Feeding grounds for this DPS are thought to be concentrated in the Chilean Magellan Straits and the western Antarctic Peninsula. These cross-equatorial breeders feed in the Southern Ocean during much of the austral summer. The population was considered discrete based on its breeding distribution and level of genetic differentiation from other populations. It was considered significant based on the gap in the range that would occur should it go extinct, the marked level of genetic divergence from other populations, and the unique ecological setting of its breeding area.

12. Brazil – This DPS consists of whales that breed between 3°S and 23°S in the southwestern Atlantic along the coast of Brazil with a prominent concentration around the Abrolhos Bank (15°-18°S) and feed off South Georgia and the South Sandwich Islands. The population was considered discrete based on its breeding distribution and level of genetic differentiation from other populations. It was considered significant based upon the gap in range that would occur should the population go extinct and its feeding location in a distinct marine ecosystem.

13. Southwest Africa – The Southwest Africa DPS consists of whales that breed and calve off central western Africa between ~6°S and ~6°N in the eastern Atlantic, including the coastal regions of northern Angola, Congo, Togo, Gabon, Benin, other coastal countries within the Gulf of Guinea and possibly further north. This DPS is thought to feed offshore of west South Africa and Namibia south of 18°S and in the Southern Ocean beneath west South Africa (20°W – 10°E). The population was considered discrete based on its breeding distribution, which is geographically separated from other breeding distributions, and level of genetic differentiation from other populations. It was considered significant based upon the gap in the range that would occur should the population go extinct.

14. Southeast Africa/ Madagascar– The Southeast Africa/ Madagascar DPS includes whales breeding in at least three different areas in the western Indian Ocean: one associated with mainland coastal waters of southeastern Africa, extending from Mozambique to as far north as Tanzania and southern Kenya, a second found in the coastal waters of the northern Mozambique Channel Islands and the southern Seychelles and the third found in the coastal waters of eastern Madagascar. The feeding grounds of this DPS in the Southern Ocean are not well defined but are believed to include multiple localities to the west and east of the region bounded by 5°W – 60°E. The population was considered discrete based on its breeding distribution, which is geographically separated other breeding grounds and level of genetic differentiation from other populations. It was considered significant based upon the gap in the range that would occur should the population go extinct.

Northern Indian Ocean Distinct Population Segments

15. Arabian Sea – The Arabian Sea DPS includes those whales that are currently known to breed and feed along the coast of Oman. However, historical records from the eastern Arabian Sea along the coasts of Pakistan and India indicate its range may also include these areas. The population was considered discrete based upon its unique breeding and feeding distribution which is geographically separated other breeding distributions, and level of genetic differentiation from other populations. It was considered significant based upon the gap in both

the range that would occur should the population become extinct, its unique ecological setting, and marked degree of genetic differentiation from other populations.

Threats Assessment and Evaluation of Extinction Risk

The BRT then assessed the extinction risk of each DPS. Assessment of extinction risk includes the evaluation of demographic information and threats experienced by each DPS. The BRT qualitatively assessed the severity, geographic scope, and level of certainty of potential individual threats to humpback whales, and assessed abundance and trend data (where available) for each DPS. Because the severity and scope of these threats may change through time, each threat was evaluated based on its current impact.

Overall, no humpback whale DPSs are known to be declining, although seven DPSs do not have trend information available. Eight of the DPSs are thought to be increasing or stable. Twelve of the DPSs are estimated to number more than 2,000 total individuals (some much more). Three DPSs have an estimated abundance between 100 and 2,000 total individuals. There is much uncertainty about the population size of two DPSs, the Cape Verde Islands/Northwest Africa and the Second Western Pacific. The Arabian Sea DPS is the only DPS likely to number fewer than 100 individuals.

In the North Atlantic Ocean, the threats of harmful algal blooms (HABs), vessel collisions, and fishing gear entanglements are likely to moderately reduce the population size or the growth rate of the West Indies DPS. All other threats, with the exception of climate change (uncertain severity), are considered likely to have no or minor impact on population size or the growth rate of this DPS. For the Cape Verde Islands plus Northwest Africa DPS, the threats of HABs, disease, parasites, vessel collisions, fishing gear entanglements and climate change were identified but the effects remain uncertain. All other threats to this DPS are considered likely to have no or minor impact on the current population size or growth rate. The population of whales in this DPS likely represent the remnants of a historically larger population.

In the North Pacific Ocean, energy development, directed or incidental takes (bycatch), whaling, and competition with fisheries are each considered likely to moderately reduce the population size or the growth rate of the Okinawa/Philippines DPS. Vessel collisions are considered likely to moderately reduce the population size or the growth rate of the Central America and Okinawa/Philippines DPSs. Fishing gear entanglements are considered likely to moderately reduce the population size or the growth rate of the Hawaii, Central America, and Mexico DPSs and likely to seriously reduce the population size or growth rate of the Okinawa/Philippines DPS. In general, there is great uncertainty about the threats facing the Second West Pacific DPS. All other threats are considered likely to have no or minor impact on population size or the growth rate or are unknown.

In the Southern Hemisphere, all threats are considered likely to have no or minor impact on population size or the growth rate or are unknown, with the exception of energy exploration posing a moderate threat in western Australia and in various locations on the western coast of Africa (because of the substantial number of oil rigs and proposals for many more in these regions) and fishing gear entanglements posing a moderate threat to the Colombia, Southeast Africa/ Madagascar, and Oceania DPSs.

The Arabian Sea DPS faces unique threats in part because these whales do not extensively migrate and therefore feed and breed in the same, relatively constrained, geographic location. Energy exploration and fishing gear entanglements are considered likely to seriously reduce the population's size or growth rate, and disease, vessel collisions and climate change are likely to moderately reduce the population's size or growth rate.

Considering the demographics of existing (or imminent) threats facing each DPS, the BRT evaluated the risk of extinction for each DPS. The BRT used a structured decision-making process to account for uncertainty in risk assessment. In this approach, each BRT member distributed 100 likelihood points among the defined scenarios or options, reflecting their opinion of the relative likelihood that the status of a specific DPS falls into each of three risk categories: high, moderate, and not at risk. For example, if a BRT member concluded that the available information indicated a very high certainty that a DPS was at high risk of extinction, that member would put all or most points into the "high risk" category. On the other hand, if a BRT member concluded that information was inconclusive, she or he might split his or her points into two or even all three categories. High risk of extinction was defined by the BRT as: a species or DPS that has productivity, spatial structure, genetic diversity, and/or a level of abundance that place its near term persistence in question. Moderate risk of extinction was defined by the BRT as: a species or DPS is at moderate risk of extinction if it exhibits characteristics indicating that it is likely to be at a "high risk of extinction" in the future. The third risk category was "not at risk of extinction". The BRT decided to evaluate extinction risk over a time frame of the next 3 generations (~60 years).

Conclusions of the Status Review

The BRT conducted its analysis using the best available science and concluded:

- Nine DPSs are *not at risk of extinction* with high certainty (>80% of votes): the West Indies, Hawaii, Mexico, west Australia, east Australia, Colombia, Brazil, Gabon/Southwest Africa, and Southeast Africa/Madagascar;
- The Oceania DPS is *not at risk of extinction* with moderate certainty (68% of votes), with some support for *moderate risk of extinction* (29% of votes);
- Both the Okinawa/Philippines and Central America DPSs were most likely at *moderate* risk of extinction (44% and 56% of votes, respectively), with some support for *high risk* (36% and 28% of votes, respectively) and minor support for *not at risk* (21% and 16% of votes, respectively);
- The Arabian Sea DPS is *at high risk of extinction* (87% of votes); and
- There was considerable uncertainty regarding the risks of extinction of two of the DPSs due to a general lack of data: the Cape Verde Islands plus Northwest Africa and the Second West Pacific.

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LIST OF ACRONYMS AND TERMS

The following are standard abbreviations for acronyms and terms found throughout this document:

ATBA	Area to be Avoided
BRT	Biological Review Team
CH	Chlordane (insecticide)
CITES	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals or Bonn Convention
DDT	Dichloro-diphenyl-trichloroethane
DOY	Day of year
DPS	Distinct population segment
ESA	Endangered Species Act of 1973, as Amended
EU	European Union
FEMAT	Forest Ecosystem Management Assessment Team
FWS	U.S. Fish and Wildlife Service
HAB	Harmful algal bloom
HCH	Hexachlorocyclohexane
IMO	International Maritime Organization
IUCN	International Union for the Conservation of Nature and Natural Resources or “the World Conservation Union”
IUU	Illegal, unreported or unregulated
IWC	International Whaling Commission
JARPA	Japanese Whale Research Program under Special Permit in the Antarctic
JARPN	Japanese Whale Research Program under Special Permit in the North Pacific
LFA	Low-frequency active (sonar)
LNG	Liquefied Natural Gas
The List	List of Endangered and Threatened Wildlife and Plants
MARPOL	International Convention for the Protection of Pollution from Ships
MMPA	Marine Mammal Protection Act of 1972, as Amended
MONAH	More of North Atlantic Humpbacks
MOU	Memorandum of Understanding
MPA	Marine protected area
mtDNA	Mitochondrial deoxyribonucleic acid
nDNA	Nuclear deoxyribonucleic acid
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWHI	Northwest Hawaiian Islands
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
PAH	Polycyclic aromatic hydrocarbons
PARS	Port Access Route Study
PBDE	Polybrominated diphenyl ether

PCB	Polychlorinated biphenyl
PSSA	Particularly Sensitive Sea Areas
PVA	Population viability analysis
SMM	Society for Marine Mammalogy
SPLASH	Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific
TSS	Traffic Separation Scheme
UME	Unusual mortality event
USCG	United States Coast Guard
WNP	Western North Pacific
YONAH	Years of North Atlantic Humpbacks

I. INTRODUCTION

This review assesses the status of humpback whales (*Megaptera novaeangliae*), listed globally as an endangered species under the U.S. Endangered Species Act (ESA). The National Marine Fisheries Service (NMFS) recognized that significant new information was available since the original listing of humpback whales under the ESA, warranting an in-depth analysis of the species' classification and status under the ESA. The agency convened a Biological Review Team (BRT) to conduct a comprehensive evaluation of humpback whales worldwide to determine 1) whether Distinct Population Segments (DPS) could be identified within this species' global distribution, and 2) to evaluate the extinction risk of each identified DPS. This report describes the BRT's deliberations and conclusions. A companion report (Fleming and Jackson 2011) summarizing the available information on the biology and threats facing humpback whales globally was prepared for the BRT's review, and provides more detailed information on these topics.

A. ESA Overview

A.1 Purpose

The purpose of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.), is to provide a means to conserve the ecosystems upon which endangered species and threatened species depend, to provide a program for the conservation of endangered and threatened species, and to provide a means toward taking appropriate steps to recover endangered and threatened species. NMFS and U.S. Fish and Wildlife Service (FWS) jointly administer the ESA, and are responsible for determining whether species, subspecies, or distinct population segments of vertebrate species (DPS) are endangered or threatened. NMFS has jurisdiction over most species of marine mammals, including humpback whales.

A.2 Listing

Humpback whales were listed as endangered in 1970 under the Endangered Species Conservation Act of 1969, the precursor to the ESA. When the ESA was enacted in 1973, humpback whales were included in the List of Endangered and Threatened Wildlife and Plants (the List) as endangered and were also considered as "depleted" under the Marine Mammal Protection Act (MMPA).

Under section 4(a) of the ESA and 50 CFR part 424 of NMFS' listing regulations, NMFS makes determinations as to whether a marine mammal species should be listed as endangered or threatened, or whether it should be reclassified or removed from the List. Section 4(c)(2)(A) requires that NMFS conduct a review of listed species at least once every five years. On the basis of such reviews, under section 4(c)(2)(B) NMFS determines whether a particular species should be removed from the List (delisted), or reclassified from endangered to threatened, or from threatened to endangered. Accordingly, in 2010 NMFS began a comprehensive evaluation of the status of humpback whales, currently classified globally as an endangered species, as the basis for considering revisions to this species' listing status. This report is intended to form the basis for that review.

B. Scope and Intent of the Status Review

The purpose of this status review is to evaluate the extinction risk of the humpback whale. The ESA, as amended in 1978, defines a species to be "any subspecies of fish or wildlife or plants, and any distinct population segment of any species or vertebrate fish or wildlife which interbreeds when mature" (Section 3(16)). Therefore, this status review evaluates whether any subspecies or DPSs can be identified, and then evaluates the risk of extinction of each identified DPS. The report provides reviews and summaries of published and unpublished literature, reports, plans, and data, coupled with numerous communications and consultation with appropriate experts for obtaining updated information. NMFS formally announced initiation of a humpback whale Status Review on 12 August 2009 (74 FR 40568), and solicited new information concerning the status of humpback whales worldwide from the public, relevant governmental agencies, tribes, the scientific community, industry, environmental entities, and any other interested parties. NMFS requested information pertaining to species' biology including population trends, distribution, abundance, demographics, and genetics; habitat conditions; conservation measures that have been implemented that benefit the species; status and trends of threats; and other new information, data, or corrections.

In addition to soliciting new information from the public, NMFS contracted with two researchers to prepare a Background Report on humpback whale biology, population status, and threats. The researchers conducted numerous interviews and an extensive literature review, and the information they compiled is synthesized in a report (Fleming and Jackson (2011). The document underwent scientific peer review and was then made available for use in the Status Review. This Status Review report contains a summary of general information on humpback whale biology, population status, and threats, but we refer readers to the Background Report for a more thorough discussion of many of these topics.

In May 2010, NMFS convened the Humpback Whale Biological Review Team (BRT), comprised of experts in the fields of humpback whale biology and ecology, conservation biology, taxonomy, population dynamics and modeling, and marine policy and management to conduct a comprehensive review of the status of humpback whales and develop a Humpback Whale Status Review Report (Status Review). The BRT's charge was to:

(a) Synthesize and analyze available information on the species;

(b) Evaluate best available scientific information on population structure and analyze these data for potential identification of DPSs;

(c) If DPSs are identified, analyze the status of each; and

(d) Review the five factors listed under Section 4(a)(1) of the ESA that describe the reasons for a species' or DPS' status and potential threats.

In April 2013, NMFS received a petition from the Hawai'i Fishermen's Alliance for Conservation and Tradition to delineate a Distinct Population Segment of humpback whales in the North Pacific and to de-list this DPS under the ESA. In August 2013, NMFS issued its 90-day finding in response to this petition and determined that the petitioned action may be warranted (78 FR 53391, August 29, 2013). A status review was initiated in response to the petition and that review was included under the BRT's on-going global review of humpback whale status. On February 26, 2014, the State of Alaska submitted a petition to delineate the Central North Pacific stock of the humpback whale as a DPS and remove the DPS from the List of Endangered and Threatened Species under the ESA. NMFS issued its 90-day finding in response to this petition and determined that the petitioned action may be warranted (79 FR 36281, June 26, 2014). Both petitioned actions were incorporated into this global status review.

This Status Review and the accompanying Background Report are a compilation of the best available scientific and commercial information on humpback whales and a description of threats to the species, as well as an evaluation of whether any populations meet the DPS Policy criteria and an analysis of extinction risk to any identified DPSs. It does not represent a decision by NMFS on whether this species, or any subdivision thereof, should be proposed for listing as threatened or endangered under the ESA or a change in status with regard to the List. That decision will be made by NMFS after reviewing this document, efforts being made to conserve the species, and relevant laws, regulations, and policies. The determinations in this regard will be posted on the NMFS Office of Protected Resources web site (http://www.nmfs.noaa.gov/pr) and published in the *Federal Register*.

C. Key Questions in ESA Evaluations

Conducting an ESA status review involves two key tasks: delineating the taxonomic group(s) under consideration and assessing the risk of extinction for the identified taxonomic group(s) (or DPSs). Such a review may also consider the extent to which existing and emerging threats, while not necessarily posing an immediate extinction risk, may hamper the recovery of a species.

C.1 The "species" question

For the purpose of the ESA, a species is defined as "any subspecies of fish or wildlife or plants, and any distinct population segment of vertebrate fish or wildlife which interbreeds when mature" (16 U.S.C. 1532). As amended in 1978, the ESA allows listing of DPSs of vertebrates, as well as named species and subspecies. The BRT applied the joint U.S. NMFS-FWS "Policy Regarding the Recognition of Distinct Population Segments Under the Endangered Species Act" (61 FR 4722, 7 February 1996) to determine whether the globally-listed humpback whale could be delineated into DPSs. This analysis is described in detail in Chapter II of this Review.

C.2 The "extinction risk" question

The term "endangered species" is defined in section 3 of the ESA as "any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."

The ESA directs that when evaluating a species' extinction risk, a variety of information shall be considered, including the following factors (section 4(a)(1)(A)-(E)):

A. The present or threatened destruction, modification, or curtailment of its habitat or range;

B. Overuse for commercial, recreational, scientific or educational purposes;

C. Disease or predation;

D. The inadequacy of existing regulatory mechanisms; or

E. Other natural or man-made factors affecting its continued existence.

The BRT assessed the extinction risk for each identified DPS based on a variety of factors, including abundance, trends in abundance, risks to diversity and spatial structure, and the risk factors A-E above. Based on this information, each DPS was placed in one of three extinction risk categories: high, moderate, or not at risk. This process and the conclusions of the BRT are described in Chapter III of this review.

C.3 Decision making process

In reaching its conclusions, the BRT considered all available information, both qualitative and quantitative. To allow for expressions of the level of uncertainty in identifying DPSs or in assessing extinction risk, the BRT adopted a likelihood point method, often referred to as the FEMAT method, because it is a variation of a method used by scientific teams evaluating options under the Forest Plan (Forest Ecosystem Management: An Ecological, Economic, and Social Assessment Report of the Forest Ecosystem Management Assessment Team, or FEMAT) (FEMAT 1993). This method has been previously used in numerous ESA status reviews (e.g., Krahn *et al.* 2004b; Gustafson *et al.* 2006; Gustafson *et al.* 2010). In this approach, each BRT member distributes 10 “likelihood” points among a number of proposed options (e.g., DPS configurations or extinction risk categories), reflecting their opinion of how likely each option correctly reflects the true situation.

II. The Species Question

The ESA, as amended in 1978, defines a species to be "any subspecies of fish or wildlife or plants, and any DPS of any species or vertebrate fish or wildlife which interbreeds when mature" (Section 3(16)). Guidance on what constitutes a DPS is provided by the joint NMFS-FWS interagency policy on vertebrate populations (61 FR 4722, 7 February 1996). To be considered "distinct", a population, or group of populations, must be "discrete" from the remainder of the taxon to which it belongs; and "significant" to the taxon to which it belongs as a whole. Discreteness and significance are further defined by the Services in the following Policy language:

> <u>Discreteness</u>: A population segment of a vertebrate species may be considered discrete if it satisfies either one of the following conditions:
>
> 1. It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation.
>
> 2. It is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the [Endangered Species] Act.
>
> <u>Significance</u>: If a population segment is considered discrete under one or more of the above conditions, its biological and ecological significance will then be considered in light of congressional guidance (see Senate Report 151, 96th Congress, 1st Session) that the authority to list DPSs be used "sparingly" while encouraging the conservation of genetic diversity. In carrying out this examination, the Services will consider available scientific evidence of the discrete population segment's importance to the taxon to which it belongs. This consideration may include, but is not limited to, the following:
>
> 1. Persistence of the discrete population segment in an ecological setting unusual or unique for the taxon,
>
> 2. Evidence that loss of the discrete population segment would result in a significant gap in the range of a taxon,
>
> 3. Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range, or
>
> 4. Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

The joint policy states that international boundaries within the geographical range of the species may be used to delimit a discrete population segment in the United States. This criterion is applicable if differences in the control of exploitation of the species, the management of the species' habitat, the conservation status of the species, or regulatory mechanisms differ between countries that would influence the conservation status of the population segment in the United States. However, as this report focuses on the biological status of the species, the BRT focused only on biological information in identifying humpback whale DPSs, understanding that factors associated with international boundaries could be considered elsewhere.

Most populations of humpback whales migrate seasonally between low latitude breeding areas and high latitude feeding areas. In applying the significance and discreteness criteria, the BRT focused on breeding populations as the units that could potentially be identified as DPSs, consistent with the language in the ESA that species "interbreed when mature." The BRT was also interested in identifying demographically cohesive populations, and some feeding areas contain whales from multiple breeding populations. Information related to a population's feeding area(s) was clearly important for evaluating the population's ecological setting, however, which is an important factor for evaluating both discreteness and significance. Information on genetic differences among breeding populations, rates of observed intra- or inter-seasonal movement of individuals among breeding areas, and the physical locations of breeding areas were particularly useful for evaluating discreteness. Information on a population's distribution and ecological setting, including both the breeding and feeding areas, along with the degree of genetic, behavioral or morphological differentiation from other populations, was important for evaluating significance.

A. Humpback whale life history and ecology

Humpback whales (*Megaptera novaeangliae*; Borowski, 1781) are baleen whales of the family Balaenopteridae. They are found in all oceans. This chapter presents a general overview of the biology of the humpback whale species, excerpted largely from Fleming and Jackson (2011).

A.1 Taxonomy

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Cetacea
Family: Balaenopteridae
Genus: *Megaptera*
Species:*Megaptera novaeangliae*
Common name: Humpback whale

Historically, numerous subspecies of humpback whales have been named, although they are not widely recognized today and *Megaptera novaeangliae* remains the accepted taxonomic classification for the species. A thorough review of known taxonomic listings for humpback whales is presented in Clapham and Mead (1999) and Rice (1998). Recently, Jackson *et al.* (2014) proposed that humpback whales in three major ocean basins (North Pacific, North Atlantic, and Southern hemisphere) be considered separate subspecies, a possibility discussed in more detail in section II B below.

A.2 Physical Description

Humpback whales are large baleen whales with long pectoral flippers, distinct ventral fluke patterning, dark dorsal coloration, a highly varied acoustic call (termed 'song') and a diverse repertoire of surface behaviors. Their body coloration is primarily dark grey, but individuals have a variable amount of white on their pectoral fins, flukes, and belly. This variation is so distinctive that the pigmentation pattern on the undersides of their flukes is used to identify individual whales. Coloring of the ventral surface varies from white to marbled to fully black. Dorsal surfaces of humpback whale pectoral flippers are typically white in the North Atlantic and black in the North Pacific (Perrin *et al.* 2002), and are one-third of the total body length. Similar to all baleen whales, body lengths differ between the sexes, with adult females being approximately 1-1.5m longer than males. Humpback whales reach a maximum of 16-17 m, although lengths of 14-15 m are more typical. Adult body weights in excess of 40 tons make them one of the largest mammals on earth (Ohsumi 1966).

A.3 Behavior

Humpback whales are globally distributed and generally are highly migratory, spending spring, summer, and fall feeding in temperate or high-latitude areas of the North Atlantic, North Pacific and Southern Ocean and migrating to the tropics in winter to breed and calve. The Arabian Sea humpback whale population does not migrate extensively, remaining in tropical waters year-round (Baldwin 2000; Minton *et al.* 2010b).

Humpback whales travel great distances during migration, the farthest migration of any mammal. The longest recorded migration between a breeding and feeding area was 5,160 miles (8,300 km). This trek, from Costa Rica to Antarctica, was completed by seven individuals, including a calf (Rasmussen *et al.* 2007). One of the more closely studied routes has shown whales making the 3,000-mile (4,830 km) trip between Alaska and Hawaii in as little as 36 days (Gabriele *et al.* 1996).

During summer and fall, humpback whales spend much of their time feeding and building fat stores for winter. In their low-latitude wintering grounds, humpback whales congregate and are believed to engage in mating and other social activities. Humpback whales are generally polygynous, with males exhibiting competitive behavior on wintering grounds (Tyack 1981; Baker and Herman 1984; Clapham 1996). A complex behavioral repertoire exhibited in these areas can include aggressive and antagonistic behavior, such as chasing, vocal and bubble displays, horizontal tail thrashing, and rear body thrashing. Males within these groups also make physical contact, striking or surfacing on top of one another. Also on wintering grounds, males sing complex songs that can last up to 20 minutes and may be heard up to 20 miles (30 km) away (Clapham and Mattila 1990; Cato 1991). A male may sing for hours, repeating the song numerous times. All males in a population sing the same song, but that song continually evolves over time (Darling and Sousa-Lima 2005). Humpback whale singing has been studied for decades, but its function remains uncertain.

Humpback whales are a favorite of whale watchers, as the species frequently performs aerial displays, including breaching, lobtailing, and flipper slapping, the purposes of which are not well understood. Diving behavior varies by season, with average lengths of dives ranging from <5 minutes in summer to 10-15 minutes (and sometimes more than 30 minutes) in winter months (Clapham and Mead 1999). Typically, humpback whale groups are small (*e.g.,* <10 individuals but can vary depending on social context and season), and associations between individuals do not last long, with the exception of the mother/calf pairs (Clapham and Mead 1999).

A.4 Feeding

Humpback whales have a diverse diet that slightly varies across feeding aggregation areas. The species is known to feed on both small schooling fish and on euphausiids (krill). Known prey organisms include species representing *Clupea* (herring), *Scomber* (mackerel), *Ammodytes* (sand lance), *Sardinops* (sardine), *Engraulis* (anchovy), *Mallotus* (capelin), and krills such as *Euphausia, Thysanoessa,* and *Meganyctiphanes* (Baker 1985; Geraci *et al.* 1989; Clapham *et al.* 1997). Humpback whales also exhibit flexible feeding strategies, sometimes foraging alone and sometimes cooperatively (Clapham 1993). During the winter, humpback whales subsist on stored fat and likely feed little or not at all.

In the Northern Hemisphere, feeding behavior is varied and frequently features novel capture methods involving the creation of bubble structures to trap and corral fish; bubble nets, clouds, and curtains can be observed when humpback whales are feeding on schooling fish (Hain *et al.* 1982). Lobtailing and repeated underwater 'looping' movements (referred to as kick feeding) have also been observed during surface feeding events and it may be that certain feeding behaviors are spread through the population by cultural transmission (Weinrich *et al.* 1992; Friedlaender *et al.* 2006). On Stellwagen Bank, in the Gulf of Maine, repeated side rolls have been recorded when whales were near the bottom, which likely serves to startle prey out of the substrate for better foraging access (Friedlaender *et al.* 2009). In many locations, feeding in the water column can vary with time of day, with whales bottom feeding at night and surface feeding near dawn (Friedlaender *et al.* 2009).

Humpback whales are 'gulp' or 'lunge' feeders, capturing large mouthfuls of prey during feeding rather than continuously filtering food, as may be observed in some other large baleen whales (Ingebrigtsen 1929). In the Southern Hemisphere, only one style of foraging ('lunge' feeding) has been reported. When lunge feeding, whales advance on prey with their mouths wide open, then close their mouths around the prey and trap them by forcing engulfed water out past the baleen plates. Southern Hemisphere humpback whales forage in the Antarctic circumpolar current, feeding almost exclusively on Antarctic krill (*Euphausia superba*) (Matthews 1937; Mackintosh 1965; Kawamura 1994). Stomach content analysis from hunted whales taken in sub-tropical waters and on migratory routes indicated that stomachs were nearly always empty (Chittleborough 1965). Infrequent sightings of feeding activity and stomach content data suggest that some individuals may feed opportunistically during the southward migration toward Antarctic waters (Matthews 1932; Dawbin 1956; Kawamura 1980).

In the Southern Ocean, Antarctic krill tend to be most highly concentrated around marginal sea ice zones, where they feed on sea ice algae. As a result, Southern Hemisphere humpback whale distribution is linked to regions of marginal sea ice (Friedlaender *et al.* 2006) and zones of high euphausiid density (Murase *et al.* 2002), with foraging mainly concentrated in the upper 100m of the water column (Dolphin 1987; Friedlaender *et al.* 2006). There is evidence of a positive relationship between prey density and humpback whale abundance (Friedlaender *et al.* 2006).

A.5 Reproduction

The mating system of humpback whales is generally thought to be male-dominance polygyny, also described as a 'floating lek'(Clapham 1996). In this system, multiple males compete for individual females and exhibit competitive behavior. Humpback song is a long, complex vocalization (Payne and McVay 1971) produced by males on the winter breeding grounds, and also less commonly during migration (Clapham and Mattila 1990; Cato 1991) and on feeding grounds (Clark and Clapham 2004). The exact function has not been determined, but behavioral studies suggest that song is used to advertise for females, and/or to establish dominance among males (Tyack 1981; Darling and Bérubé 2001; Darling *et al.* 2006). It is widely believed that, while occasional mating may occur on feeding grounds or on migration, the great majority of mating and conceptions take place in winter breeding areas (Clapham 1996; Clark and Clapham 2004). Breeding in the Northern and Southern Hemisphere populations is out of phase by approximately six months, corresponding to their respective winter periods.

Sexual maturity of humpback whales in the Northern Hemisphere occurs at approximately 5-11 years of age, and appears to vary both within and among populations (Clapham 1992; Gabriele *et al.* 2007; Robbins 2007). Average age of sexual maturity in the Southern Hemisphere is estimated to be 9-11 years. In the Northern Hemisphere, calving intervals are between one and five years, though 2-3 years appears to be most common (Wiley and Clapham 1993; Steiger and Calambokidis 2000). Estimated mean calving rates are between 0.38 and 0.50 calves per mature female per year (Clapham and Mayo 1990; Straley *et al.* 1994; Steiger and Calambokidis 2000) and reproduction is annually variable (Robbins 2007). In the Southern Hemisphere, most information on humpback population characteristics and life history was obtained during the whaling period. Post-partum ovulation is reasonably common (Chittleborough 1965) and inter-birth intervals of a single year have occasionally been recorded. This may be a consequence of early calf mortality; the associated survival rates for annually born calves are unknown in the Southern Hemisphere.

Humpback whale gestation is 11-12 months and calves are born in tropical waters (Matthews 1937). Lactation lasts from 10.5-11 months (Chittleborough 1965), and weaning begins to occur at about age six months and calves attain maternal independence around the end of their first year (Clapham and Mayo 1990). Humpback whales exhibit maternally directed fidelity to specific feeding regions (Martin *et al.* 1984; Baker *et al.* 1990).

The average generation time for humpback whales (the average age of all reproductively active females at carrying capacity) is estimated at 21.5 years (Taylor *et al.* 2007). Empirically estimated annual rates of population increase range from a low of 0 to 4% to a maximum of 12.5% for different times and areas throughout the range (Baker *et al.* 1992; Barlow and Clapham 1997; Steiger and Calambokidis 2000; Clapham *et al.* 2003a); however, Zerbini *et al.* (2010) recently concluded that any rate above 11.8% per year is biologically implausible for this species.

A.6 Natural Mortality

Annual adult mortality rates have been estimated to be 0.040 (SE = 0.008) (Barlow and Clapham 1997) in the Gulf of Maine, and 0.037 (95% CI 0.022-0.056) (Mizroch *et al.* 2004) in the North

Pacific Hawaiian Islands populations. In the Southern Hemisphere, estimates of annual adult survival rates have been made using photo-identification studies in Hervey Bay, east Australia (1987-2006) and range between 0.87 and 1.00 (Chaloupka *et al.* 1999).

Robbins (2007) estimated calf (0-1 year old) survival for humpback whales in the Gulf of Maine at 0.664 (95% CI: 0.517-0.784) which is low compared to other areas and annually variable. Barlow and Clapham (1997) estimated a theoretical calf mortality rate of 0.125 on the Gulf of Maine feeding ground. Using associations of calves with identified mothers on North Pacific breeding and feeding grounds, Gabriele (2001) estimated mortality of juveniles at 6 months of age to be 0.182 (95% CI: 0.023-0.518). Survival of calves (6-12 months) and juveniles (1-5 years) has not been described in detail for the Southern Hemisphere. Killer whales are likely the most common natural predators of humpback whales.

B. Differentiation among ocean basins and sub-specific taxonomy

Humpback whales routinely make extensive migrations between breeding and feeding areas within an ocean basin. Despite this potential for long distance dispersal, there is considerable evidence that dispersal or interbreeding of individuals from different major ocean basins is extremely rare and that whales from the major ocean basins are differentiated in a number of characteristics that are summarized below.

<u>Reproductive Seasonality</u>: Humpback whales breed and calf in July-November in the Southern Hemisphere and in Jan-May in the Northern Hemisphere (including the Arabian Sea). It is not known if reproductive seasonality in baleen whales is determined genetically or whether it results from a learned behavior (migration to a particular feeding destination) combined with a physiological response to day length.

<u>Behavior</u>: The most obvious behavioral difference is that migrations to and from high latitudes are in opposite times of the calendar year for Southern Hemisphere and most Northern Hemisphere populations, following the difference in reproductive seasonality. A Northern Hemisphere exception to this migration pattern is found in the Arabian Sea where a non-migratory population is found. Although these behavioral differences could be learned, they could also be innate, genetically determined traits. Seasonality in singing and other mating behaviors also follows the differences in reproductive seasonality.

<u>Color patterns</u>: Humpback whales in the Southern Hemisphere tend to have a much more white pigmentation on their bodies which is especially noticeable laterally (Matthews 1937; Chittleborough 1965). This has been noted in eastern and western Australia, the Coral Sea, and Oceania, but might not be characteristic of all Southern Hemisphere populations. Rosenbaum *et al.* (1995) ranked ventral fluke coloration patterns from one (nearly all white) to five (nearly all black) and compared whales from several breeding areas. He found that over 80% of humpback whales in eastern and western Australia were in Category 1, and that less than 10% of whales in three breeding areas in the North Pacific were ranked in that category. Only 36% of Southern Hemisphere whales in Colombia were classified in Category 1, but Colombian whales were still, on average, whiter than North Pacific whales. A higher frequency of pectoral fins with white dorsal pigmentations is found in the North Atlantic compared to the North Pacific (Clapham 2009).

Genetics: Baker and Medrano-Gonzalez (2002) reviewed the worldwide distribution of mtDNA haplotypes. They found three major clades with significant differences among major ocean basins (Figure 2), although there were no completely fixed differences among these areas. The North Pacific included only the AE and CD clades, the North Atlantic included only the CD and IJ clades, and the Southern Oceans included all three. In a more recent comparison, Jackson *et al.* (2014) found no shared haplotypes between the North Pacific and North Atlantic. Based on patterns of mtDNA variation, Rosenbaum *et al.* (2009) estimated an average migration rate of less than one per generation between the Arabian Sea and neighboring populations in the southern Indian Ocean, and Jackson *et al.* (2014) also estimated generally <1 migrant per generation among the North Pacific, North Atlantic and Southern Hemisphere populations. Ruegg *et al.* (2013) also found a high degree of genetic differentiation between samples from the North Atlantic and the Southern Hemisphere.

The BRT considered the possibility that humpback whales from different ocean basins might reasonably be considered to belong to different subspecies. Subspecific taxonomy has some potential relevance to the identification of DPSs, because under the 1996 DPS policy the discreteness and significance of a potential DPS is evaluated with reference to the taxon (species or subspecies) of which it is a part. In some cases previous BRTs concluded that subspecific taxonomy has a large influence on DPS structure (e.g. southern resident killer whales; Krahn *et al.* 2004b), while in others subspecific taxonomy has not been relevant (e.g. steelhead trout DPS – (Busby *et al.* 1996).

Rice (1998) reviewed previous subspecies designations for humpback whales. Tomilin (1946) named a Southern Hemisphere subspecies (*M. n. lalandii*) based on body length, but this length difference was not substantiated in subsequent studies. The populations around Australia and New Zealand were described as another subspecies (*M. n. novazelandiae*) based on color patterns and length (Ivashin 1958). Rice (1998) noted that the statistical ability to classify these proposed subspecies is "not quite as high as is customarily required for division into subspecies" and that genetic analyses using restriction-fragment length polymorphisms is not congruent with the proposed regional division. Rice (1998) therefore recommended that *Megaptera novaeangliae* be considered monotypic. As was summarized above, however, since 1998 additional information has accumulated on the genetic distinctiveness of different geographic populations of humpback whales, and some new subspecies have been proposed (Jackson *et al.* 2014).

One criterion for separation of subspecies is the ability to differentiate 75% of individuals found in different geographic regions (Reeves *et al.* 2004b). Based on this criterion, differences in the calendar timing of mating and reproduction could be used to distinguish close to 100% of Northern Hemisphere from Southern Hemisphere individuals, but it is not known if this genetically determined. Based on mtDNA haplotypes that have been identified to date, haplotype could be used to distinguish 100% of North Pacific from North Atlantic individuals, but some haplotypes from both ocean basins are shared with the Southern Ocean. Ventral fluke color patterns can be used to correctly differentiate >80% of whales in eastern and western Australia from the whales in the North Pacific (Rosenbaum *et al.* 1995).

Given this uncertainty, the BRT asked the Committee on Taxonomy of the Society for Marine Mammalogy (SMM) to examine the evidence for the recognition of subspecies of humpback whale and to determine whether subspecies are likely to be recognized. Specifically, the following question was asked of the Committee: "Are humpback whales (*Megaptera novaeangliae*) that feed in the North Atlantic, North Pacific, Southern Oceans and Arabian Sea likely to belong to different sub-species?" A questionnaire (Appendix A) with related background information was provided to the chairman of the SMM Committee on Taxonomy (Dr. William Perrin, SWFSC), and he distributed the questionnaire to the Committee (which also included two members of the humpback whale BRT)[2]. The Committee was asked only for their scientific opinion on the likelihood of the existence of humpback whale subspecies and was not asked to comment on the relevance of their opinion on the designation of DPSs for humpback whales. The responses from members of the Committee were summarized by their chairman:

> "The balance of opinion in the SMM Committee on Taxonomy is that given the evidence on genetics, morphology, distribution and behavior, if a taxonomic revision of the humpback whale were undertaken, it is likely that the North Atlantic, North Pacific and Southern Hemisphere populations would be accorded subspecific status. Whether the Arabian Sea population would merit recognition as a subspecies separate from the Southern Hemisphere whales, with which it is most closely related genetically, is less certain. However, it is clearly geographically isolated and genetically differentiated."

Using its structured decision making process, the BRT evaluated the following question: Based on the discussions and collective knowledge of the BRT, the Background Report (Fleming and Jackson 2011), and the response from the SMM Committee on Taxonomy, is there enough scientific information to suggest that humpback whales from different major ocean basins could reasonably be considered different subspecies? BRT members were given 100 probability units, which they distributed into following three scenarios based on their assessment of the available information.

Table 1. Humpback Whale Subspecies Scenarios Voting.

Scenario	Description	Proportion of Votes
1. Single Species	• Single global species	22%
2. Three subspecies	• North Atlantic • North Pacific • Southern Hemisphere (including Arabian Sea)	55%
3. Four subspecies	• North Atlantic • North Pacific • Southern Hemisphere • Arabian Sea	23%

[2] William F. Perrin, Chair (Southwest Fisheries Science Center, USA), C. Scott Baker (Oregon State University, USA), Annalisa Berta (San Diego State University, USA), J. Boness (University of Maine, USA), Robert L. Brownell, Jr. (NOAA Fisheries, USA), Merel L. Dalebout (University of New South Wales, Australia), Daryl P. Domning (Howard University, USA), Rebecca M. Hamner (student member, Oregon State University, USA), Thomas A. Jefferson (NOAA Fisheries, USA), James G. Mead (National Museum of Natural History, USA (emeritus)), Dale W. Rice (National Marine Mammal Laboratory, USA (retired)), Patricia E. Rosel (Southeast Fisheries Science Center, USA), John Y. Wang (FormosaCetus Research and Conservation Group, Canada/Taiwan), Tadasu Yamada (National Museum of Nature and Science, Japan)

Overall, the three subspecies scenario had 55% support while both the single global species scenario and the four subspecies scenario had ~22% support. The BRT therefore felt reasonably certain (78% support) that the available information suggested that multiple subspecies of humpback whale could be identified[3].

Figure 2. Frequency of major mtDNA clades among humpback whale populations. Reproduced from Baker and Medrano-Gonzalez (Baker and Medrano-Gonzalez 2002).

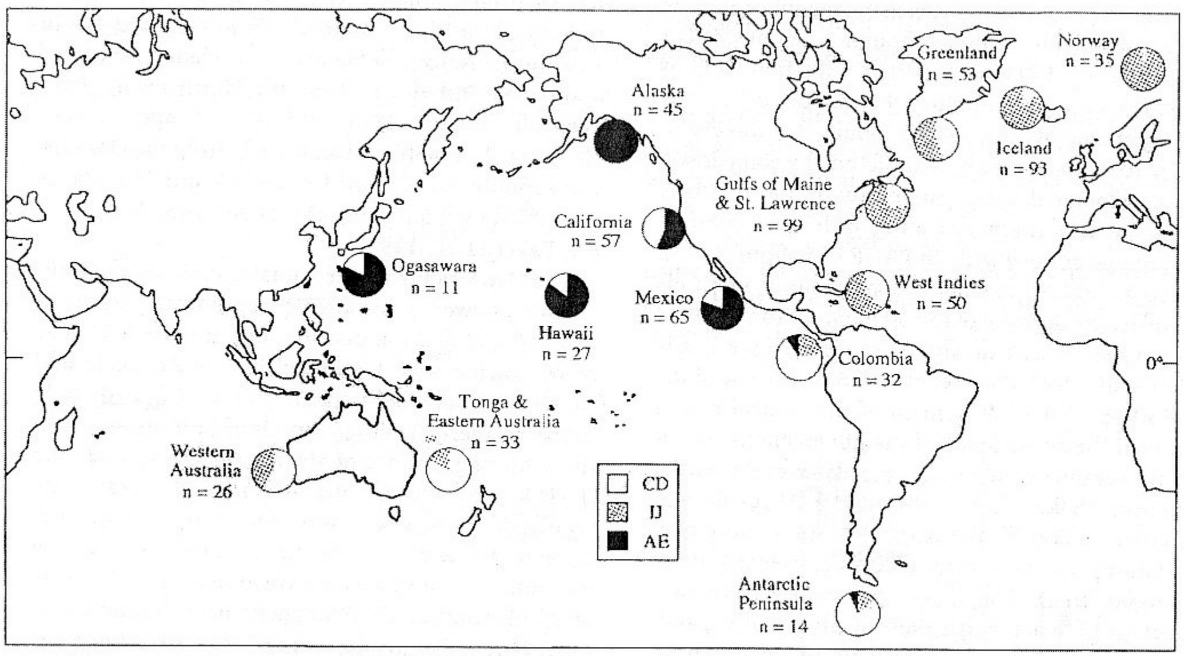


Figure 8.5. Regional frequencies of the three primary clades of humpback whale mtDNA lineages inferred from control region sequenes and RFLP analyses of the partial and complete mitochondrial genome (Baker et al., 1990, 1993, 1994, 1998a and b; Medrano-González et al., 1995; Palsbøll et al., 1995; Larsen et al., 1996).

C. North Atlantic Populations Overview

C.1 Distribution and Migratory Patterns

In the Northern Hemisphere, humpback whales summer in the biologically productive, northern latitudes and travel south to warmer waters in winter to mate and calve. Migratory routes and migratory behavior are likely to be maternally directed (Martin *et al.* 1984; Baker *et al.* 1990). Feeding areas are often near or over the continental shelf, and are associated with cooler temperatures and oceanographic or topographic features that serve to aggregate prey (Moore *et al.* 2002; Zerbini *et al.* 2006b).

Primary humpback whale feeding areas in the North Atlantic Ocean range from 42° to 78°N and include waters around Iceland, Norway and the Barents Sea in the central and eastern North

[3] In October 2014, subsequent to the Team's deliberations, the SMM Committee on Taxonomy revised their official list of recognized species and subspecies to include three named subspecies of humpback whale: *M. n. australis* (Lesson, 1828) − southern humpback whale, *M. n. kuzira* (Gray, 1850) − North Pacific Humpback whale, and *M. n. novaeangliae* (Borowski, 1781) − North Atlantic humpback whale.

Atlantic Ocean, and western Greenland, Newfoundland, Labrador, the Gulf of St Lawrence and the Gulf of Maine in the western North Atlantic Ocean. Known breeding areas occur in the West Indies and (to a much lesser extent) around the Cape Verde Islands (Katona and Beard 1990; Clapham 1993; Palsbøll *et al.* 1997). In contrast to humpbacks in the North Pacific, a relatively small proportion of whales in the North Atlantic Ocean feed in U.S. waters; in addition, the predominant breeding and calving area lies in the territorial sea of the Dominican Republic, although whales are also found scattered throughout the rest of the Antilles and coastal waters of Venezuela.

Recently, a few humpback whales have also been found in the Mediterranean Sea but little is known about humpback whale use of this region and there is no evidence for a large humpback whale presence there, either currently or in historical times (Frantzis *et al.* 2004). There are also sporadic sightings of humpback whales in a wide range of places including waters offshore from of the Southeast U.S. and mid-Atlantic States, in the Gulf of Mexico and in the waters around Ireland. Bermuda is a known mid-ocean stopover point for humpback whales on their northbound migration (Stone *et al.* 1987).

C.2 Patterns of genetic variation among the North Atlantic breeding areas

Genetic studies have identified 25 humpback whale haplotypes in the western North Atlantic, 12 haplotypes in eastern North Atlantic samples, and 19 haplotypes in the Gulf of Maine population (Palsbøll *et al.* 1995; Larsen 1996; Rosenbaum *et al.* 2002). Humpback whales in the North Atlantic Ocean appear to have higher haplotype diversity than humpback whales in the North Pacific Ocean (Baker and Medrano-González 2002). Haplotype diversity is lowest in populations around Norway and Iceland and higher around the northwestern feeding areas off Greenland, Gulf of St. Lawrence and Gulf of Maine (Baker and Medrano-González 2002). Observed nucleotide diversity is also higher in the North Atlantic than the North Pacific (Baker and Medrano-González 2002).

There are no published studies of genetic variation between breeding areas in the western and eastern North Atlantic. Palsboll *et al.* (Palsbøll *et al.* 1995) and Valsecchi *et al.* (1997) found significant (F_{ST}= ~0.04) levels of mtDNA and nuclear genetic variation among North Atlantic feeding areas, however, suggesting the possibility that there may also be genetically distinct breeding areas. Photo-ID and genetic matching data suggest no evidence for substructure within the West Indies breeding population (reviewed by Fleming and Jackson 2011), so this differentiation likely is due to genetic divergence between the West Indies and a second North Atlantic breeding population likely associated with the Cape Verde Islands or other areas in the North Eastern Atlantic.

D. North Pacific Populations Overview

D.1 Distribution and Migratory Patterns

Humpback whales in the North Pacific migrate seasonally from northern latitude feeding areas in summer to low-latitude breeding areas in winter. Feeding areas are dispersed across the Pacific Rim from California, USA to Hokkaido, Japan. Within these regions, humpback whales have been observed to spend the majority of their time feeding in coastal waters. Breeding areas in the North Pacific are more geographically separated than the feeding areas and include regions offshore of mainland Central America; mainland, Baja Peninsula and the Revillagigedos Islands, Mexico; Hawaii; and Asia including Ogasawara and Okinawa Islands and the Philippines. About half of the humpback whales in the North Pacific Ocean breed and calve in the U.S. waters off Hawaii; greater than half of North Pacific Ocean humpback whales feed in U.S. waters.

Humpback whales in the North Pacific rarely move between these breeding regions. Strong fidelity to both feeding and breeding sites has been observed but movements between feeding and breeding areas are complex and varied (Calambokidis *et al.* 2008; Barlow *et al.* 2011). An overall pattern of migration has recently emerged. Asia and Mexico/Central America are the dominant breeding areas for humpback whales that migrate to feeding areas in lower latitudes and more coastal areas on each side of the Pacific Ocean, such as California and Russia. The Revillagigedo Archipelago and Hawaiian Islands are the primary winter migratory destinations for humpback whales that feed in the more central and higher latitude areas (Calambokidis *et al.* 2008). However, there are exceptions to this pattern and it seems that complex population structure and strong site fidelity coexist with lesser known, but potentially high, levels of plasticity in the movements of humpback whales (Salden *et al.* 1999).

D.2 Patterns of genetic variation among the North Pacific breeding areas

Baker *et al.* (2013) recently analyzed genetic variation in a large (n = 2,193) sample of whales from 8 breeding and 10 feeding regions within the North Pacific. The 8 possible breeding regions included the Philippines, Okinawa, Ogasawara, Hawaii, Revillagigedo, Baja California, the Mexican mainland coast, and Central America. Overall, the level of genetic divergence among breeding areas at the mtDNA control region was substantial (F_{ST} = 0.093). Pairwise estimates of divergence among breeding areas ranged from none (F_{ST} = ~0.000; Philippines vs Okinawa) to very high (F_{ST}>0.2 for Hawaii vs Okinawa and Philippines, and Hawaii vs Central America). In addition to little divergence between Okinawa and the Philippines, the three Mexican areas (mainland coast, Baja California, and Revillagigedos Islands) were also not significantly differentiated. The breeding areas were less strongly (but still significantly) differentiated at 10 nuclear microsatellite loci (F_{ST} = 0.006), suggesting the possibility of male mediated gene flow among breeding areas.

E. Southern Hemisphere Populations Overview

Current Southern hemisphere humpback whale population abundance based on circumpolar surveys of the Antarctic is estimated to be over 50,000 (Branch 2007) with at least twelve breeding grounds identified at temperate latitudes: Brazil, Gabon and central West Africa, Mozambique, the Comoros Archipelago, Madagascar, the Arabian Sea, West Australia, East Australia, New Caledonia, Tonga, French Polynesia, and the southeastern Pacific (Stevick *et al.* 2006; Zerbini *et al.* 2006b; Engel and Martin 2009; IWC 2011).

E.1 Distribution and Migratory Patterns

Southwestern Atlantic Ocean (Brazil)
The primary mating/calving ground of humpback whales in the western South Atlantic Ocean is the coast of Brazil. Whales are regularly found over the continental shelf (up to about 500m in depth) from 5-24ºS between April and December with peaks in August and September (Martins *et al.* 2001; Zerbini *et al.* 2004; Rossi-Santos *et al.* 2008; Andriolo *et al.* 2010). Occasional sightings have been made in coastal waters north of 5ºS and south of 24ºS as well as in various oceanic islands (e.g. near the Fernando de Noronha, São Pedro and São Paulo and Trindade-Martinz Vaz Archipelagos, Pretto *et al.* 2009), but it is not yet clear whether these regions correspond to the typical range of the species. This population migrates to feeding grounds located east of the Scotia Sea near South Georgia and the South Sandwich Archipelagos (Stevick *et al.* 2006; Zerbini *et al.* 2006b; Engel *et al.* 2008; Engel and Martin 2009; Zerbini *et al.* 2011).

The winter breeding distribution of humpback whales in the southwestern Atlantic (June to December) is concentrated around the Abrolhos Bank region in Brazil (15-18°S) and 500 km north, along the north coast of Bahia State and Espirito Santo State (Rossi-Santos *et al.* 2008) and near Salvador and Recife. In a line transect survey of the coastal waters between 5° and 12°S, the majority of humpback whales (>90%) were found to be concentrated within 300m of the shoreline, with all whales distributed within 800m of the shore (Zerbini *et al.* 2004). Humpback whales migrate seasonally past coastal waters off the South American coast, the majority travelling offshore towards feeding grounds between 20° and 25°S (Andriolo *et al.* 2006; Zerbini *et al.* 2006c), via a narrow (~600km wide) migratory corridor (Zerbini *et al.* 2006c). Satellite telemetry, photo-identification and genetic studies indicate that most whales frequent offshore summer feeding grounds in the South Atlantic, near South Georgia and the South Sandwich Islands (Stevick *et al.* 2006; Zerbini *et al.* 2006b; Engel and Martin 2009).

Southeastern and Central eastern Atlantic (Gabon)
A humpback whale winter breeding and calving ground is located off central western Africa between ~6°S and ~6°N in the eastern Atlantic. This includes the coastal regions of northern Angola (Best *et al.* 1999; Weir 2007), Congo, Togo, Gabon (Walsh *et al.* 2000; Rosenbaum and Collins 2006), Benin (Van Waerebeek 2003), offshore islands (Príncipe and São Tomé, Carvalho *et al.* 2011), Pagalu (Aguilar 1985) and other coastal countries within the Gulf of Guinea (Rosenbaum and Mate 2006), with a northerly extent that includes occasional sightings and strandings off the coast of Ghana (Van Waerebeek *et al.* 2009). Periods of peak abundance are found between July and September, with some whales still present as late as December and January in Angola, Gabon and São Tomé (Weir 2007). Ongoing investigations are studying migratory patterns to summer feeding grounds (Rosenbaum and Mate 2006; Zerbini *et al.* 2011). The Gabon/Southwest Africa region appears to serve a variety of purposes with some individual whales remaining in the area through the year while some utilize the area for feeding and others for mating.

Southwestern Indian Ocean (Madagascar, Comoros Archipelago, Mozambique)
At least three winter breeding aggregations of humpback whales have been suggested in the southwestern Indian Ocean from historical whaling records and contemporary surveys (Wray and Martin 1983; Best *et al.* 1998). One is associated with the mainland coastal waters of southeastern Africa, extending from Mozambique (24°S, Findlay *et al.* 1994), to as far north as Tanzania and southern Kenya (Wamukoya *et al.* 1996; Berggren *et al.* 2001; O'Connor *et al.* 2009). The second is found in the coastal waters of the northern Mozambique Channel Islands

(Comoros Archipelago) (Ersts *et al.* 2006; Kiszka *et al.* 2007; Kiszka *et al.* 2010) and the southern Seychelles (Reeves *et al.* 1991; Hermans and Pistorius 2008). The third is associated with the coastal waters of Madagascar (15-25°S), best described in Antongil Bay on the east coast (Rosenbaum *et al.* 1997).

At least three migratory pathways to Antarctic summer feeding grounds in this region have been proposed using a compilation of data from surveys, whaling and acoustic records and sightings (Best *et al.* 1998). The first pathway (and the one for which the greatest evidence is available) occurs off the coast of east South Africa, where humpback whales arrive at the coast from Knysna (33°S 23°E, April onwards) during the northward migration and depart the coast at a similar longitude on the southward migration through December. Other potential migratory paths have been suggested in the central Mozambique Channel and offshore along the Madagascar Ridge (which runs between Madagascar and ~40°S). The Madagascar Ridge has been identified as a potential migratory route based on whaling and sightings data from Walter's Shoal, a location on the Madagascar Ridge, south of Madagascar (Best *et al.* 1998). The Mozambique Channel route was proposed based on acoustic surveys in 1994, which recorded a few singing whales in the center of the channel. That the same surveys did not detect singers away from the middle of the channel might suggest (on rather weak evidence) that the Channel is not commonly bisected but instead serves primarily as a thoroughfare for whales on the east African migratory route (Best *et al.* 1998). The migratory path for whales wintering in La Réunion and Mauritius has not yet been identified.

Southeastern Indian Ocean (West Australia)
Humpback whale wintering grounds and coastal migratory routes in the eastern Indian Ocean are located between 15-35°S along the west coast of Australia, with major calving grounds occurring in the Kimberley Region (15-18°S) and resting areas on the southern migration at Exmouth Gulf (21°S) and at Shark Bay (25°S) (Bannister and Hedley 2001; Jenner *et al.* 2001).

During the southward migration to their Antarctic feeding grounds, whales are found close to shore along much of the coast, mostly occurring within the 200m isobath. During the northward migration, whales tend to be distributed farther from shore, out to the continental shelf boundary (Jenner *et al.* 2001; Jenner *et al.* 2006), with whales observed as far out as the 1400m isobath in some places *e.g.* Northwest Cape (Jenner *et al.* 2006).

Southwestern Pacific (East Australia)
Humpback whales along the east coast of Australia are thought to breed primarily in waters inside the Great Barrier Reef (16-21°S) (Chittleborough 1965; Simmons and Marsh 1986) and are seen as far north as Murray Island at ~10°S (Simmons and Marsh 1986). Northward migration of humpbacks to the breeding ground occurs (*i*) along the Australian mainland coast (and sometimes eastwards through Bass Strait, Paterson 1991), (*ii*) through New Zealand's Cook Strait, and (*iii*) past Foveaux Strait off the New Zealand southwest coast (Dawbin 1964; Franklin *et al.* 2011), as suggested by photo-identification studies and Discovery- mark returns. Discovery marks and satellite telemetry suggest east Australian whales feed in a broad swath of the Antarctic between 100°E-175°W, or that they frequent at least two feeding regions, one due south of eastern Australia stretching to the east beneath New Zealand, and one south of west Australia at ~100°E and accessed via migration through Bass Strait.

Oceania
The longitudinal distribution boundaries of humpback whales wintering in Oceania lie between ~160°E (west of New Caledonia) and ~120°W (east of French Polynesia) and latitudinally between 0° and 30°S (Reeves *et al.* 1999), a range that includes American Samoa (United States of America), the Cook Islands, Fiji, French Polynesia (France), Republic of Kiribati, Nauru, New Caledonia (France), Norfolk Island, New Zealand, Niue, the Independent State of Samoa, Solomon Islands, Tokelau, Kingdom of Tonga, Tuvalu, Vanuatu, Wallis and Futuna (France).

Southeastern Pacific (Colombia, Panama, Ecuador)
The wintertime breeding distribution of humpback whales in the southeastern Pacific (May to November) includes the coastal waters between Panama and northern Peru, with the main wintering areas concentrated in Colombia (Gorgona Island, Málaga Bay and Tribugá Gulf), Panama and Ecuador. Low densities of whales are also found around the Galápagos Islands (Félix *et al.* 2006b) and coastal sightings have been made as far north as Costa Rica (Coco Island and Golfo Dulce, 8°N) (Acevedo and Smultea 1995; May-Collado *et al.* 2005). In the summer months, these whales migrate to feeding grounds located in waters off of southern Chile, the Magellan Strait, and the Antarctic Peninsula (May-Collado *et al.* 2005; Félix *et al.* 2006b; Acevedo *et al.* 2008).

E.2 Patterns of genetic variation among the Southern Hemisphere breeding areas

Olavarría *et al.* (2007) analyzed patterns of mtDNA control region variation obtained from 1,112 samples from 6 breeding grounds in the South Pacific: New Caledonia, Tonga, Cook Islands, eastern Polynesia, Colombia, and Western Australia. Of these areas, the samples from Colombia were most differentiated (F_{ST} = 0.06 – 0.08 in pairwise comparison to other areas). Pairwise divergence among the other areas was lower (F_{ST} = 0.01 – 0.05). All pairwise comparisons were statistically >0, however, and indicated a lack of free exchange among these breeding areas. Levels of haplotype diversity were generally very high (0.90 – 0.97). Rosenbaum *et al.* (2009) conducted a similar study of breeding areas in the Southern Atlantic and Western Indian Oceans, including the coastal areas of Brazil, Southwestern Africa, and Southeastern Africa. Levels of differentiation among these are statistically significant but relatively low, with F_{ST} ranging from 0.003 (among two Southwestern African locations) to 0.017 (between Brazil and Southeastern Africa). Although there was some detectable differentiation among samples from Southwestern and Southeastern African coastal locations (B1/B2 and C1/C2/C3 IWC stocks, respectively), the levels of divergence within these areas were very low (F_{ST} = 0.003-0.009 within the “B” stock and 0.002-0.005 within the “C” stock). The estimated number of migrants per generation was 26 between Brazil and Southwestern Africa, and 33 between Southwestern and Southeastern Africa.

F. Arabian Sea Population

F.1 Distribution and Migratory Patterns

Sightings and survey data suggest that humpback whales in the Arabian Sea are primarily concentrated in the shallow near-shore areas off the coast of Oman, particularly in the Gulf of Masirah and Kuria Muria Islands regions (Minton 2004); sightings and strandings suggest a population range that encompasses the northern Gulf of Aden, the Balochistan coast of Pakistan, and western India and Sri Lanka, with occasional sightings on the Sistan and Baluchistan coasts of Iran, and also Iraq (Al Robaae 1974; Braulik *et al.* 2010). Photo-identification re-sightings suggest humpback whales move seasonally between the Dhofar region (Kuria Muria Islands) in winter and the Gulf of Masirah to the north in summer, with similar re-sighting rates between and within regions (Minton *et al.* 2010b).

Despite extensive comparisons of photo-identification catalogues and genotyped individuals between Oman and the other Indian Ocean catalogues and genetic datasets, no matches have been detected between regions (Pomilla *et al.* 2006; Minton *et al.* 2010a). Humpback whales from this region carry fewer and smaller barnacles than Southern Hemisphere whales, and do not exhibit the white oval scars indicative of cookie cutter shark (*Isistius brasiliensis*) bites, a feature commonly seen on some Southern Hemisphere humpback whales (Mikhalev 1997).

Connections with the Northern Hemisphere populations are highly unlikely as there is no accessible northward passage from the Arabian Sea. Furthermore, there are no mitochondrial haplotypes or song patterns shared with North Pacific humpback whales (Whitehead 1985; Rosenbaum *et al.* 2009); thus, on current evidence, and in the absence of comparisons with far western North Pacific humpbacks, it appears that whales from these populations have no recent biological connectivity. Analysis of fetal lengths in pregnant females killed by Soviet whalers clearly indicate that this population exhibits a Northern Hemisphere reproductive cycle, with births occurring in the boreal winter (Mikhalev 1997).

F.2 Patterns of genetic variation between the Arabian Sea population and other populations

Nuclear and mitochondrial genetic diversity of humpback whales from Oman (up to 47 individuals sampled) is the lowest among all breeding grounds (Pomilla *et al.* 2006; Olavarría *et al.* 2007; Rosenbaum *et al.* 2009). Mitochondrial DNA analysis revealed only eight distinct haplotypes, half of which are exclusive to Oman (not detected on other breeding grounds, Pomilla *et al.* 2006). Haplotype diversity at the mtDNA control region is markedly lower than in other populations (0.69 vs 0.90-0.98 for Southern Hemisphere populations and 0.84 for North Pacific populations (Olavarría *et al.* 2007; Rosenbaum *et al.* 2009; Baker *et al.* 2013).

Genetic data (nuclear microsatellites and mitochondrial control region) and fluke pigmentation markings indicate that this breeding population is significantly differentiated from Southern Indian Ocean breeding grounds (Rosenbaum *et al.* 2009). Nuclear genetic analysis suggests that this population is the most strongly and significantly differentiated in all comparisons among other Indian Ocean and South Atlantic breeding populations (pair-wise F_{ST} range between Oman and Southern Indian Ocean breeding populations = 0.38-0.48; (Pomilla *et al.* 2006). Levels of mitochondrial differentiation between Oman and other Indian Ocean breeding grounds are around ten times higher than among the other breeding grounds (pair-wise F_{ST} range between Oman and other Indian Ocean breeding populations 0.11-0.15; (Rosenbaum *et al.* 2009).

G. Evaluation of Discreteness

The BRT initially evaluated the discreteness of known major humpback whale breeding populations (Table 2). Quantitative measures of genetic differentiation; direct estimates of dispersal among breeding populations from tagging, photo-identification, or genetic recapture;

and geographic discontinuities in distribution were used as the primary information sources for determining population discreteness. This information is summarized in the previous sections of this report and is reviewed in greater detail by Fleming and Jackson (2011). The BRT concluded that populations from different ocean basins were clearly distinct on the basis of geographic isolation, substantial levels of genetic divergence, coloration differences between northern and Southern Hemisphere populations, behavioral differences in migration and breeding timing, and lack of observed dispersal (see Chapter II B). The discussion below therefore focuses largely on the information related to the existence of discrete populations within major ocean basins.

Table 2. Major known humpback whale breeding areas by major ocean basin.

Ocean Basin	**Major known breeding area**
North Atlantic	West Indies, along the Atlantic margins of the Antilles from Cuba to Northern Venezuela
	Cape Verde Islands
North Pacific	Hawaii Islands
	West coast of Central America
	West coast of Mexico
	Revillagigedos Islands
	Baja California
	Okinawa
	Philippines
	Ogasawara
Southern Hemisphere	Western Australian coastal areas
	Eastern Australia coastal area
	Oceania, from New Caledonia to French Polynesia
	Coastal areas of Colombia, Panama and Ecuador
	Coastal areas of Brazil
	Southwest African coastal areas
	Southeast African coastal areas, including the Comoros and the Seychelles and Madagascar
Arabian Sea	Oman coastal areas

G.1 North Atlantic Ocean

There is one very well studied breeding ground in the North Atlantic Ocean: the West Indies. Most of the humpback whales on the western North Atlantic feeding grounds (Gulf of Maine, Gulf of St Lawrence, West Greenland, and eastern Canada) go to the West Indies to breed (approximately 90%; (Clapham *et al.* 1993; Mattila *et al.* 2001). Some of the Iceland and Norway feeding ground whales also go to the West Indies, but genetic evidence suggests that most whales that feed off Iceland and Norway migrate to some other breeding ground possibly in the eastern tropical Atlantic (Clapham *et al.* 1993). However, the location of the northeastern

Atlantic breeding ground is still not well understood. The only candidate from historical whaling records is the Cape Verde Islands, but current studies show only a small number of whales there (far fewer than are known to exist in the northeastern Atlantic) and sighting histories of these whales link them to waters off Iceland or Norway (Katona and Beard 1990; Jann *et al.* 2003). The Cape Verde Islands may be part of a larger breeding area or there may be a third separate breeding area that is as yet undiscovered (Charif *et al.* 2001; Reeves *et al.* 2002). There is a significant degree of heterogeneity in nuclear DNA between the western, central (Iceland) and eastern (Norway) North Atlantic feeding grounds further supporting the possibility of a third breeding area (Larsen 1996).

The BRT decided upon four plausible discreteness scenarios among which they would vote:

1. One unit
2. Two units: West Indies and Cape Verde Islands
3. Two units: West Indies and Cape Verde Islands plus an associated breeding area
4. Three units: West Indies and Cape Verde Islands and another unknown breeding area

The group evaluated the proposed scenarios, distributing 100 points across the range of four scenarios to reflect their levels of confidence in each option. After initial votes were cast and shared with the group, a discussion of the results followed and some members modified their votes. Final voting results showed approximately 70% support for two distinct populations based on a two breeding area scenario and 27% support for three distinct populations (Table 3). The BRT noted that the distinction between scenarios 2 and 3 was relatively unimportant (in that they both designate 2 discrete populations), and it is clear that gaining a better understanding of where the whales that do not go to the West Indies are migrating is a major priority. Scenario 3 was viewed as the most likely scenario, and the BRT concluded that two populations of humpback whales in the North Atlantic Ocean meet the established criteria for being discrete under the DPS policy guidelines: West Indies and Cape Verde Islands plus another associated breeding area off northwest Africa.

The BRT concluded that the humpback whales found breeding around the Cape Verdes Islands, which include at least some of the whales that feed in the eastern and perhaps central North Atlantic, constitute a discrete population from humpback whales that breed in the West Indies. In particular, the West Indies and Cape Verde Islands are separate breeding grounds based on: 1) no photographic matches between individuals using the West Indies and Cape Verde Islands areas (acknowledging that there is a large discrepancy in sample size between the two areas), 2) occupation of both breeding grounds at the same time, 3) evidence from 19th century whaling data of a historically larger population at the Cape Verde Islands than exists today, and 4) evidence from genetic heterogeneity that the West Indies is not the only breeding ground. In addition, the Cape Verde Islands cannot account for the abundance of whales estimated from the eastern North Atlantic feeding grounds that are apparently not using the West Indies, so there must be an additional breeding area somewhere, likely near Northwest Africa.

Table 3. North Atlantic Discreteness Scenarios Voting.

Scenario	Description	Proportion of Votes
1. One unit	All of North Atlantic Ocean	2%
2. Two discrete units	West Indies Cape Verde Islands	18%
3. Two discrete units	West Indies Cape Verde Islands plus other associated breeding area	53%
4. Three discrete units	West Indies Cape Verde Islands Unknown breeding area	27%

G.2 North Pacific Ocean

North Pacific humpback whales are known to aggregate in at least eight geographically separate areas during their breeding season: Central America; mainland Mexico; Baja California, Mexico; the Revillagigedos Archipelago, Mexico; the Hawaiian Islands, USA; Ogasawara Islands, Japan; Okinawa Islands, Japan; and the northern Philippine Islands. In addition, results from the Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific (SPLASH) study (Calambokidis *et al.* 2008) indicate the existence of at least one additional breeding area whose location has not been identified.

Two of these nine areas were identified as likely migratory routes to other locations and might therefore not be primary migratory destinations: the waters off Baja California and the Ogasawara Islands. Available genetic and demographic studies indicate that humpback whales migrating to mainland Mexico and to the Revillagigedos Islands pass by the tip of Baja California. The BRT therefore concluded that humpback whales off Baja California should not be considered a discrete population. Similarly, some humpback whales migrating to the Okinawa Islands pass by the Ogasawara Islands, and the Ogasawara Islands are thought likely to be along the migration route to the yet-unidentified breeding area that was described by the SPLASH program. The BRT was not certain, however, on how to classify the Ogasawara area and therefore used the structured decision making process to evaluate relative certainty of whether whales in this area formed a discrete population (see below).

In the eastern North Pacific, humpback whales in Central America have a unique mtDNA signature, as reflected in the frequencies of haplotypes (Baker *et al.* 2008a; Baker *et al.* 2008b). This frequency composition is significantly different from that found in all other breeding grounds in the North Pacific. The BRT concluded that humpback whales in Central America are a discrete population. In Mexico, the mainland population does not differ significantly from the Revillagigedos population in its mtDNA haplotype frequencies (Baker *et al.* 2013). Photo-identification studies also indicate considerable movement of individuals between mainland and offshore island breeding areas in Mexico (Calambokidis *et al.* 2008). The BRT also therefore concluded that mainland Mexico and the Revillagigedos populations are not discrete from each other but considered together as a single Mexico population are discrete from all other populations. The Hawaii population of humpback whales is separated by the greatest geographic distance from neighboring populations and was significantly different from other populations in both frequencies of mtDNA haplotypes and nDNA (microsatellite) alleles (Baker *et al.* 2013). The BRT therefore concluded that whales wintering in Hawaii constitute a discrete population.

Humpback whales in Okinawa were not significantly different in either mtDNA or nDNA from whales in the Philippines (Baker *et al.* 2013), so those two areas were pooled for all subsequent analyses of population structure. The genetic data from the pooled populations from Okinawa and the Philippines populations differ significantly in both mtDNA and nDNA markers from humpback whale in the Ogasawara Islands and all other populations (Baker *et al.* 2013); however, given the likelihood that Ogasawara whales are only passing through en route to two or more migratory destinations, the BRT could not reach consensus in delineating discrete populations in the western North Pacific.

The diversity of opinion in the BRT regarding population discreteness in the western North Pacific was expressed in the voting process. BRT members were given 100 probability units, which they voted according to the strength of their belief in the following three scenarios given the available information (**Error! Reference source not found.**).

Table 4. Western North Pacific Discreteness Scenarios Voting.

Scenario	Description	Proportion of Votes
1. One discrete unit	• Okinawa/Philippines/Ogasawara pooled	13%
2. Two discrete units	• Okinawa/Philippines pooled • Ogasawara	25%
3. Two discrete units	• Okinawa/Philippines pooled and 2nd unidentified breeding area; • Ogasawara as migratory route	62%

The percentage distribution of votes strongly favored the delineation of two distinct populations (with a combined 87% of votes). Scenario 3 (which included the Ogasawara area as a migratory route for both discrete populations) was viewed as the most likely scenario.

The BRT concluded that five breeding populations of humpback whales in the North Pacific meet the established criteria for being discrete under the DPS policy guidelines: (1) Central America, (2) Mexico (mainland Mexico and the Revillagigedos Islands), (3) the Main Hawaiian Islands, (4) the Okinawa and Philippine Islands pooled, and (5) an unidentified breeding area in the western North Pacific.

Recently, Lammers *et al.* (2011) used acoustic recorders to document the presence of humpback whales wintering in the Northwest Hawaiian Islands (NWHI) and suggested this area as a possibility for the unidentified breeding location. Johnston *et al.* (2007) also reported whales in the NWHI area, and using habitat modeling suggested that it was well suited to being a humpback whale wintering area. However, the theory that the NWHI is the unidentified western North Pacific breeding area, and its status relative to adjacent breeding areas, cannot be evaluated until individual identification data (photo-id and genetic) from the NWHI are compared to other areas of the North Pacific, including Hawai'i and to the feeding grounds to which animals from the unidentified western Pacific DPS are believed to migrate. Furthermore, the BRT noted that the presence of humpback whales in the NWHI is also consistent with an alternative explanation, namely expansion of the range of the population of the main Hawaiian Islands. Further research is required to determine which of these hypotheses is correct.

G.3 Southern Hemisphere and Arabian Sea

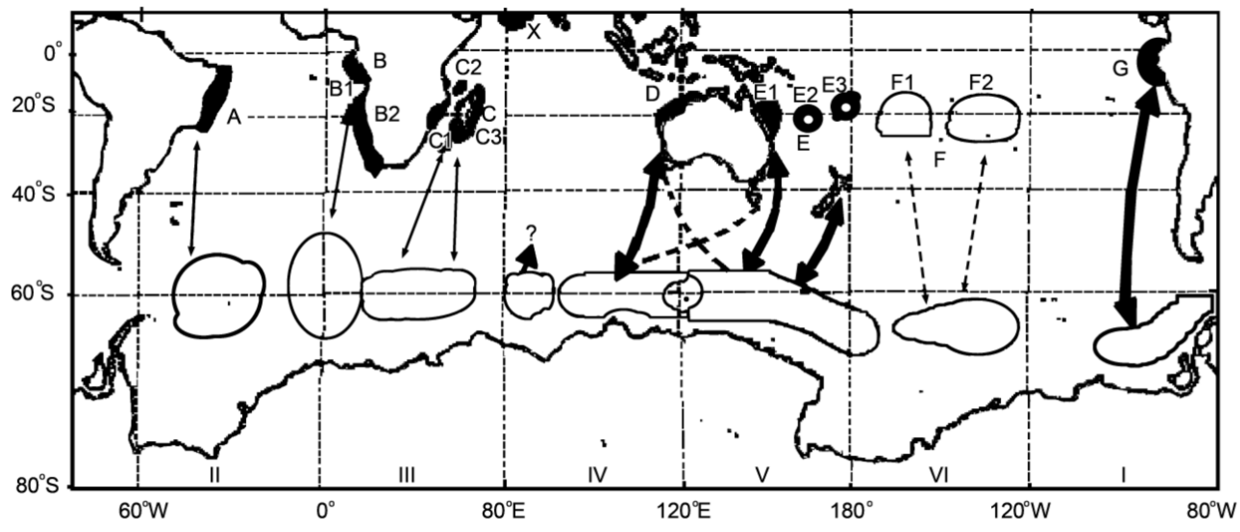
The International Whaling Commission (IWC) has been involved in the comprehensive assessment of humpback whales in the Southern Hemisphere since 1991, bringing together available information on distribution, migration, abundance, past exploitation and population (stock) structure. A report on an IWC workshop devoted to Southern Hemisphere stock structure issues has recently been published (IWC 2011). On the basis of these ongoing assessments, the IWC recognizes at least seven "breeding stocks" associated with low-latitude, winter breeding grounds and, in some cases, migratory corridors. These seven breeding stocks are referred to alphabetically, from A to G, to distinguish them from the six management areas on feeding grounds of the Antarctic, referred to as Areas I-VI. The current breeding stock designations are southwestern Atlantic (A), southeastern Atlantic (B), southwestern Indian Ocean (C), southeastern Indian Ocean (D), southwestern Pacific (E), Oceania (E and F) and southeastern Pacific (G). These designations have been subdivided to reflect improved understanding of substructure within some of these regions: Gabon (B1) and Southwest Africa (B2) in the southeastern Atlantic; Mozambique (C1), the Comoros Archipelago (C2), Madagascar (C3) and the Mascarene Islands (C4) in the southwestern Indian Ocean, east Australia (E1), New Caledonia (E2), Tonga (E3), the Cook Islands (F1) and French Polynesia (F2) in the southwestern Pacific and Oceania (illustrated in Figure 3). The IWC has also chosen to include in this assessment, a year-round population of humpback whales found in the Arabian Sea, north of the equator in the northern Indian Ocean (formerly referred to as breeding stock X).

The BRT noted that the magnitude of genetic differentiation (as measured by F_{ST}) was generally lower among Southern Hemisphere breeding areas than it is in the Northern Hemisphere, indicating greater demographic connectivity among these areas. Even so, significant differentiation was present among major breeding areas, and the estimated number of migrants/generation among areas was small compared to the estimated sizes of the populations.

The BRT also discussed the potential for using photo-ID matching to evaluate isolation or interchange among breeding stocks, but variability in effort and availability of these data prevented a systematic comparison across all areas (IWC 2011). In contrast, analysis of several large and comparable datasets of mtDNA haplotype diversity and differentiation have been published or made available in reports to the IWC. These allow a standardized comparison of overall and stock-by-stock (pair-wise) differentiation.

Figure 3. Southern hemisphere humpback whale stock structure hypothesized by the IWC.

All boundaries are approximate. Dotted lines represent hypothetical connections between breeding and feeding areas, thin lines represent a small number of documented connections, and thick lines represent a large number of documented connections. Lines illustrate connections only, and are not necessarily indicative of actual migratory routes. Reproduced from IWC (2011) – see that document for details.



The BRT concluded that the seven breeding stocks of humpback whales currently recognized by the IWC meet the criteria for being discrete populations under the DPS policy guidelines, with the following modification. The BRT agreed that breeding stocks E and F represented at least two discrete populations, but that the primary division was between eastern Australia and Oceania (defined here to include New Caledonia, Tonga, Samoa, American Samoa, and French Polynesia), as there are large differences in the rates of recovery between these two regions indicating separation. Breeding population in New Caledonia and east Australia are separate but some overlap between the populations occurs: some whales bound for New Caledonia use the same migratory pathways as some whales headed past east Australia. There was consensus to divide the Southern Hemisphere into seven discrete units, listed below, and to remove the Arabian Sea from the Southern Hemisphere group, making it a separate category.

Following review of documents and discussion, the BRT agreed that the Arabian Sea population was clearly discrete from all other populations. Genetic samples (nuclear microsatellites and mitochondrial control region), fluke pigmentation markings, and data on the reproductive cycle indicate that this breeding population is significantly differentiated from all other Indian Ocean breeding populations. Levels of mitochondrial differentiation between Arabian Sea and Southern Hemisphere breeding populations are around ten times greater than among these other breeding populations (Rosenbaum *et al.* 2009). Despite extensive comparisons of photo-identification catalogues and individual genotypes, no matches have been detected between the Arabian Sea and the ‘neighboring’ Southern Hemisphere breeding populations (*e.g.*, IWC breeding stock C; Rosenbaum *et al.* 2009). As stated elsewhere, connections with the Northern Hemisphere are highly unlikely as there is no northward passage through the Arabian Sea, the Indian Ocean population shares no mitochondrial haplotypes in common with the North Pacific, suggesting that whales from these populations have no recent biological connectivity. The

Philippines population has the highest likelihood of interchange with the Arabian Sea; however, the number of samples from this population is small.

Southern Hemisphere Discrete Units:

A. Brazil
B. Gabon/Southwest Africa
C. Southeast Africa/ Madagascar
D. West Australia
E. East Australia
F. Oceania*, including New Caledonia, Tonga, Cook Islands, Samoa, American Samoa and French Polynesia
G. Southeastern Pacific (Colombia and Ecuador)

* Differs from International Union for the Conservation of Nature and Natural Resources (IUCN) definition of Oceania in recognizing the distinction between East Australia and breeding population(s) to the east.

In summary, the BRT examined global humpback whale population structure and identified at least 15 discrete breeding units: 2 in the North Atlantic, 5 in the North Pacific, 7 in the Southern Hemisphere, and 1 in the Arabian Sea.

H. Determining Significance

Under the joint FWS/NMFS DPS policy, a population qualifies as a DPS if it is both discrete and significant relative to the taxon to which it belongs based on the criteria described in the introduction to this chapter. The BRT examined global humpback whale population structure and identified 15 discrete breeding units (two in the North Atlantic, five in the North Pacific, seven in the Southern Hemisphere and one in the Arabian Sea). These 15 discrete populations were then analyzed to determine if any or all of them met the significance criteria of the joint DPS policy based on their ecological characteristics, geographic range, genetics, or other factors as defined by the DPS policy.

The BRT concluded (see Section II B) that whales from the North Pacific, North Atlantic, Southern Hemisphere and Arabian Sea were markedly differentiated from each other at genetic, behavioral, morphological, and geographic factors to the degree that they could arguably be considered different subspecies. In evaluating the significance criterion, the BRT therefore largely focused on differentiation within major ocean basins and whether any of the 15 discrete units described above are "significant" with respect the other populations collectively within their respective ocean basin (i.e., the potential oceanic subspecies). Recognizing that formal subspecies of the humpback whale are not currently recognized, however, and that there was some uncertainty within the BRT about likely subspecies designations, the BRT also discussed whether the identified populations within ocean basins would be considered 'significant' with respect to the entire global species.

H.1 Ecological setting

Many of the 15 discrete humpback whale populations the BRT identified occupy different large marine ecosystems as defined by the National Oceanic and Atmospheric Administration (NOAA) (http://www.lme.noaa.gov), either in their breeding range, feeding range or both (Table 5). The BRT weighted ecological differences among feeding areas more heavily than among breeding areas, since the team concluded that the ecological characteristics of humpback whales in their breeding ranges were largely similar among populations. In contrast, the BRT concluded whales largely foraging in different large marine ecosystems inhabit different ecological settings and that this is relevant in evaluating the significance of these populations.

Table 5. Large Marine Ecosystems inhabited by humpback whale populations

	Large Marine Ecosystem	
Discrete Unit	Breeding range	Primary Feeding range
West Indies	Caribbean Sea	Scotian Shelf, Newfoundland-Labrador Shelf, Canadian Eastern Arctic-West Greenland, Iceland Shelf and Sea, Norwegian Sea
Cape Verde Islands + plus Northwest Africa	Eastern Atlantic/Canary Current?	Iceland Shelf and Sea, Norwegian Sea
Hawaii	Insular Pacific-Hawaiian	East Bering Sea, Gulf of Alaska
Central America	Pacific Central-America	California Current
Mainland Mexico	Pacific Central-American	California Current, Gulf of Alaska, East Bering Sea
Revillagigedos Islands	Revillagigedos Islands	Gulf of Alaska, East Bering Sea
Mexico – Baja	California Current	Gulf of Alaska, East Bering Sea
Okinawa/Philippines	Kuroshio Current	West Bering Sea
Second West Pacific	?	Aleutian Islands
West Australia	Northwest Australian Shelf	Antarctic
East Australia	Northeast Australian Shelf	Antarctic
Oceania	Oceania	Antarctic
Southeastern Pacific	Pacific Central-America	Antarctic
Brazil	East Brazil Shelf	Sub-Antarctic areas around the South Georgia and South Sandwich Islands
Gabon/Southwest Africa	Guinea Current, Benguela Current	Antarctic
Southeast Africa/ Madagascar	Agulhas Current	Antarctic
Arabian Sea	Arabian Sea	Arabian Sea

Within the North Atlantic, the West Indies and Cape Verde/Northwest Africa breeding populations both are believed to feed in largely overlapping areas, so BRT concluded that these two groups did not occupy unique ecological settings within the North Atlantic, although together they differ ecologically from other populations worldwide. Within the North Pacific, the Okinawa/Philippines, Hawaii, Mexican, and Central American populations tended to feed in different marine ecosystems, although there was some overlap. The Central American population's breeding habitat is also ecologically unique for the species as it is the only area where documented geographic overlap of populations that feed in different hemispheres occurs, potentially creating a conduit for genetic exchange between the two hemispheres. A minority of members believed that this was an example of temporal and geographic overlap, not a unique ecological setting, however.

The Arabian Sea population persists year-round in a monsoon driven tropical ecosystem with highly contrasting seasonal wind and resulting upwelling patterns. The BRT therefore concluded that this population persists in a unique ecological setting.

Within the Southern Hemisphere, most breeding populations feed in the same Antarctic marine ecosystem. One exception is the Brazil population, which feeds north of 60 degrees in the South Georgia and South Sandwich Islands area (IWC 2011). In addition to feeding in the Antarctic system, the Gabon/Southwest Africa population may also feed along the west the coast of South Africa in the Benguela Current, but this is uncertain (IWC 2011). Like the Central America population, the South Eastern Pacific breeding population may also be ecologically unique as it is the only population in the Southern Hemisphere to occupy an area also used by a Northern Hemisphere population.

H.2 Gap in the range

Most of the discrete breeding populations occupy non-overlapping areas during the winter months that, if lost, would arguable result in a significant gap in the range, certainly within an ocean basin and likely within the global distribution of the species. Possible exceptions are the Southeast Pacific and Central America breeding populations, which occupy a partially overlapping breeding range. The breeding range of the unidentified Western Pacific population is not known, so it is not clear if its loss would result in a significant gap.

The feeding areas of the discrete populations overlap more than the breeding areas do, but in many cases if lost would, in combination with the lost breeding area, contribute to a significant gap in the species' range. In the North Atlantic Ocean, the West Indies and Cape Verde Islands/Northwest Africa populations have a largely overlapping feeding range, so loss of either population would not necessarily create a significant gap in the feeding range as long as the other population remained. The BRT noted, however, that most of the whales feeding throughout the North Atlantic are from the West Indies population. If all North Atlantic humpback whales were extinct, this would also clearly create a gap within the range of the global species.

In the North Pacific Ocean, loss of the Hawaii breeding population would result not only in loss of humpbacks from the Hawaiian Islands but also from SE Alaska and Northern British Columbia. Similarly, loss of the Okinawa/Philippines population would likely result in a significant gap in Pacific feeding range as these individuals are the only breeding population to migrate primarily to Russia and loss of this population would therefore result in a loss of feeding range along the Russian coast. Loss of the Mexican and Central American populations would result in the loss of humpback whales in the California current along the coasts of California, Oregon and Washington.

For the Southern Hemisphere, determination of feeding range is more difficult since Antarctic feeding areas are less well studied and fewer connections between breeding and feeding populations have been made. However, some populations such as Brazil, Southwest Africa, Southeast Africa, and the Southeast Pacific are believed to have fairly discrete and non-overlapping feeding areas (Figure 3), suggesting that if any of these feeding areas were lost it would, in combination with the lost breeding area, result in a significant gap in the range. Finally, the Arabian Sea population segment does not migrate extensively, but instead feeds and breeds in the same geographic location. No other humpback whale populations occupy this area and hence, a loss of the Arabian Sea population would result in a significant gap in the range of the species.

H.3 Genetic differentiation

The BRT discussed whether there was evidence for marked genetic divergence among any of the discrete populations. Although there was not clear agreement on the definition of “marked”, the BRT concluded that strong patterns of genetic differentiation in mtDNA sequence among most of the North Pacific breeding populations indicated marked genetic divergence, consistent with the conclusions in Baker *et al.* (2013). The overall level of differentiation among breeding populations within the North Pacific ($F_{ST} = 0.09$) was similar to the level of divergence among ocean basins and is consistent with a relatively high degree of divergence of these populations.

In the Southern Hemisphere, the Southeastern Pacific population is the only breeding population that contains a genetic signal from Northern Hemisphere populations, giving it a unique genetic signature within the Southern Hemisphere (Baker *et al.* 1993; Baker and Medrano-González 2002). It is also the most divergent of any of the Southern Hemisphere populations (Olavarría *et al.* 2007). In addition, individuals in this region are morphologically distinct as they have darker pectoral fin coloration than other individuals in the Southern Hemisphere (Chittleborough 1965), although the genetic basis for this trait is not known. Nonetheless, a majority of the BRT concluded that the Southeastern Pacific population was sufficiently differentiated so as to differ ‘markedly’ in its genetic characteristics from other Southern Hemisphere populations. In contrast, all other Southern Hemisphere populations were characterized by generally low levels of differentiation among them, consistent with demographically discrete populations but not necessarily with marked genetic divergence associated with long-term isolation (Olavarría *et al.* 2007; Rosenbaum *et al.* 2009).

The BRT also concluded that the Arabian Sea population differed markedly in its genetic characteristics from other populations in the Indian Ocean and worldwide. The degree of genetic differentiation at multiple genetic markers between this population and other populations was similar to or greater than the degree of divergence among the North Pacific, North Atlantic, and Southern Hemisphere areas.

Summary

The BRT concluded that all 15 discrete populations met at least one and in most cases several of the factors for the significance criterion when evaluated with respect to the other populations within ocean basins, resulting in identification of 15 DPSs (Table 6).

The BRT also discussed whether any or all of these populations would also be considered discrete and significant if they were evaluated with respect to the entire global species, rather than to other populations collectively within the three major ocean basins considered by the BRT to be possible subspecies. The BRT concluded that most of the identified populations are clearly both discrete and significant, whether considered with respect to the potential ocean-basin based subspecies or the global species. In particular, the five North Pacific populations are characterized by marked genetic divergence both from each other and from all other populations within the species (Baker *et al.* 2013), and they tend to concentrate their feeding in different large marine ecosystems, although there is some overlap. Similarly, the West Indies population is marked by substantial genetic divergence from all populations in the Pacific and Southern Hemisphere, feeds in a distinct set of marine ecosystems, and if lost would result in the loss of humpback whales from much of the North Atlantic. The BRT was uncertain if the Cape Verde Islands/Northwest Africa population would be considered significant if evaluated against the global species. Its genetic characteristics and feeding ranges are not well understood and could overlap considerably with the West Indies population. It is possible, therefore, that if evaluated with respect to the global species, the West Indies and Cape Verde Islands/Northwest Africa populations might reasonably be combined into a single DPS. Similarly, the BRT was somewhat uncertain about whether the unidentified Western Pacific population would be considered a DPS with respect to the global species, due to many uncertainties about this population.

Likewise, the BRT was uncertain if all of the populations identified within the Southern Hemisphere would be considered significant if evaluated with respect to the global species. With the exception of the Southeast Pacific population, the Southern Hemisphere populations are characterized by relatively low levels of genetic divergence from each other and less ecological divergence among feeding areas. Nonetheless, loss of any of these populations would arguably result in a significant gap in the range of the global species based on breeding locations and hypothesized migration routes, and some of these populations also have distinct feeding areas.

The BRT unanimously concluded that the Arabian Sea population would be considered a DPS under any global taxonomic scenario, due to its marked genetic divergence from all other populations and unique ecological setting.

Table 6. Summary of information used to evaluate the significance criteria of the DPS policy.
Discrete populations were compared with respect to ecological differences/gap in range/genetics/coloration/behavior (respectively). A "1" indicates a difference between a pair of populations, and "0" indicates that the populations do not differ substantially in that factor, and "?" indicates a lack of information. This information was used to evaluate whether a discrete population was significant with respect to the taxon to which it belongs. See text for details.

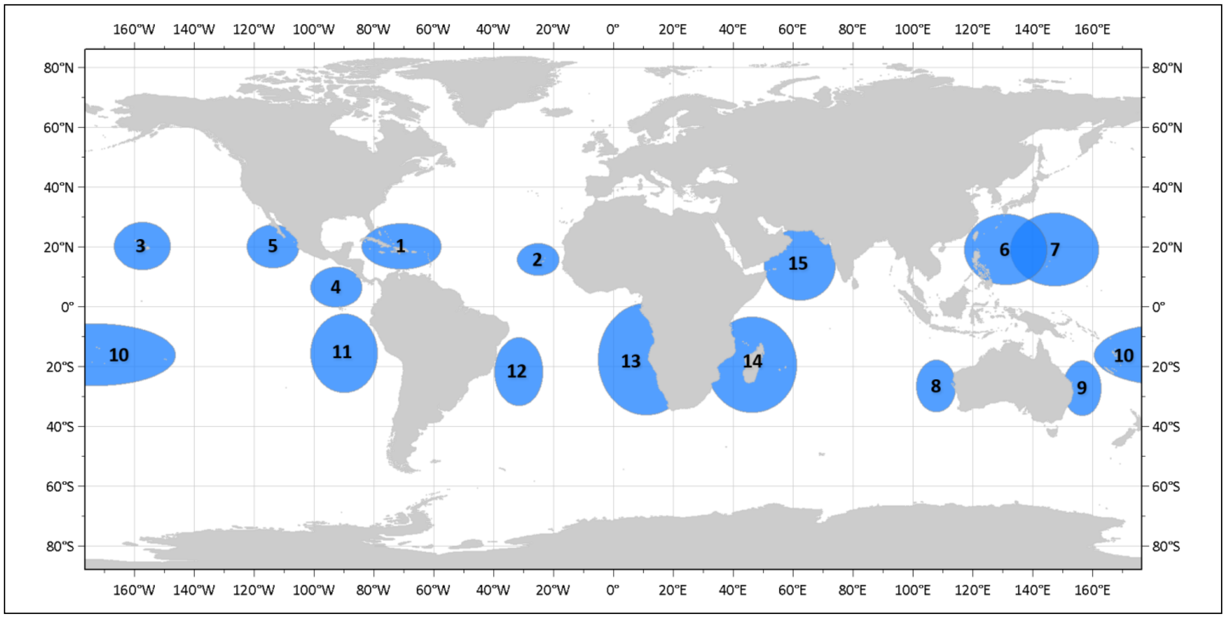
	North Atlantic		North Pacific					Southern Hemisphere							North Indian
	West Indies	Cape Verde	Hawaii	entral Americ	Mexico	Okinawa/P	Western P2	W Australia	E Australia	Oceania	SE Pacific	Brazil	SW Africa	SE Africa	Arabian Sea
West Indies		0 1 ? 0 0	1 1 1 0 0	1 1 1 0 0	1 1 1 0 0	1 1 1 0 0	1 1 1 0 0	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 ? 1 1
Cape Verde/NWA			1 1 1 0 0	1 1 1 0 0	1 1 1 0 0	1 1 1 0 0	1 1 1 0 0	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 ? 1 1
Hawaii				1 1 1 0 0	1 1 1 0 0	1 1 1 0 0	1 1 1 0 0	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 ? 1 1
Central America					1 1 1 0 0	1 1 1 0 0	1 1 1 0 0	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 ? 1 1
Mexico						1 1 1 0 0	1 1 1 0 0	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 ? 1 1
Okinawa/Philippines							? ? ? 0 0	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 ? 1 1
West Pacific1								1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 ? 1 1
West Australia									0 1 0 0 0	0 1 0 0 0	0 1 1 0 0	1 1 ? 0 0	0 1 ? 0 0	0 1 ? 0 0	1 1 ? 0 1
East Australia										0 1 0 0 0	0 1 1 0 0	1 1 ? 0 0	0 1 ? 0 0	0 1 ? 0 0	1 1 ? 0 1
Oceania											0 1 1 0 0	1 1 ? 0 0	0 1 ? 0 0	0 1 ? 0 0	1 1 ? 0 1
Southeastern Pacific												1 1 ? 0 0	0 1 ? 0 0	0 1 ? 0 0	1 1 ? 0 1
Brazil													1 1 0 0 0	1 1 0 0 0	1 1 1 0 1
Gabon/SWA														0 1 0 0 0	1 1 1 0 1
SEA/Madagascar															1 1 1 0 1
Arabian Sea															

H.4 Descriptions of the identified humpback whale Distinct Population Segments

The BRT examined the global humpback whale population and determined that 15 populations met the DPS Policy criteria and, therefore, qualify as DPSs (listed below, and illustrated in Figure 4).

1. West Indies
2. Cape Verde Islands plus Northwest Africa
3. Hawaii
4. Central America
5. Mexico
6. Okinawa/Philippines
7. Second West Pacific
8. West Australia
9. East Australia
10. Oceania
11. Southeastern Pacific
12. Brazil
13. Gabon/Southwest Africa
14. Southeast Africa/ Madagascar
15. Arabian Sea

Figure 4. Approximate breeding locations of humpback whale distinct population segments worldwide.



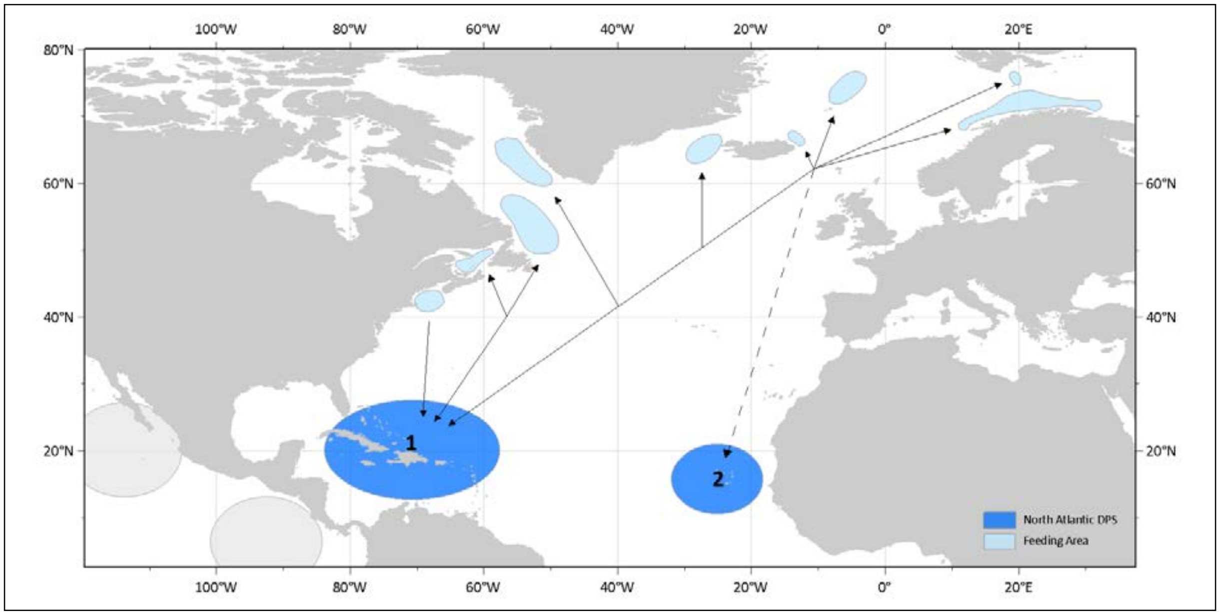
H.4.1 North Atlantic Distinct Population Segments

1. West Indies – The West Indies DPS consists of the humpback whales whose breeding range includes the Atlantic margin of the Antilles from Cuba to northern Venezuela, and whose feeding range primarily includes the Gulf of Maine, eastern Canada, and western Greenland. While many West Indies whales also use feeding grounds in the central (Iceland) and eastern (Norway) North Atlantic, many whales from these feeding areas appear to winter in another location. The West Indies population was determined to be discrete based upon genetic evidence and on a lack of evidence for exchange with the eastern Atlantic breeding population (or any other population) based on re-sighting data. This population was determined to be significant with respect to other North Atlantic populations due to the significant gap in the breeding range of the unnamed North Atlantic subspecies that would occur if it went extinct. Loss of the West Indies population would result in the loss of humpback whales from the Northwest Atlantic breeding (Caribbean/West Indies) and feeding grounds (United States, Canada, Greenland) and would also result in the loss of a significant portion of whales occupying feeding grounds in the Northeast Atlantic.

2. Cape Verde Islands plus Northwest Africa – This DPS consists of the humpback whales whose breeding range includes waters surrounding the Cape Verde Islands as well as an undetermined breeding area in the eastern tropical Atlantic which may be more geographically diffuse than the West Indies breeding ground. The population of whales breeding in the Cape Verde Islands plus this unknown area likely represent the remnants of a historically larger population breeding around Cape Verde Islands and northwestern Africa (Reeves *et al.* 2002). There is no known overlap in breeding range with North Atlantic humpback whales that breed in the West Indies, although overlap occurs among feeding aggregations from different breeding populations.

The population was determined to be discrete based upon genetic evidence that suggests a second breeding ground occupied by whales that feed primarily off Norway and Iceland, as well as the gap that would exist in the breeding range of the unnamed North Atlantic subspecies if it became extinct. Loss of this unit would result in a loss of this unique breeding ground as well as a significant number of whales that feed in Iceland and Norway.

Figure 5. North Atlantic Ocean Distinct Population Segments.



H.4.2 North Pacific Distinct Population Segments

3. Hawaii – The Hawaii DPS consists of humpback whales that breed within the main Hawaiian Islands. Whales from this breeding population have been observed in most known feeding grounds in the North Pacific, but about half of the whales from the population migrate to Southeast Alaska and Northern British Columbia. They also commonly utilize northern British Columbia, northern Gulf of Alaska and Bering Sea feeding grounds. This population was determined to be discrete based on significant genetic differentiation from populations in other North Pacific breeding areas and evidence for low rates of movement among breeding areas in the North Pacific based on sighting data. The Hawaii population was determined to be significant due to the gap that would result in breeding and feeding ranges if it were to go extinct, ecological uniqueness of feeding areas, and marked levels of genetic divergence when compared to the other North Pacific populations.

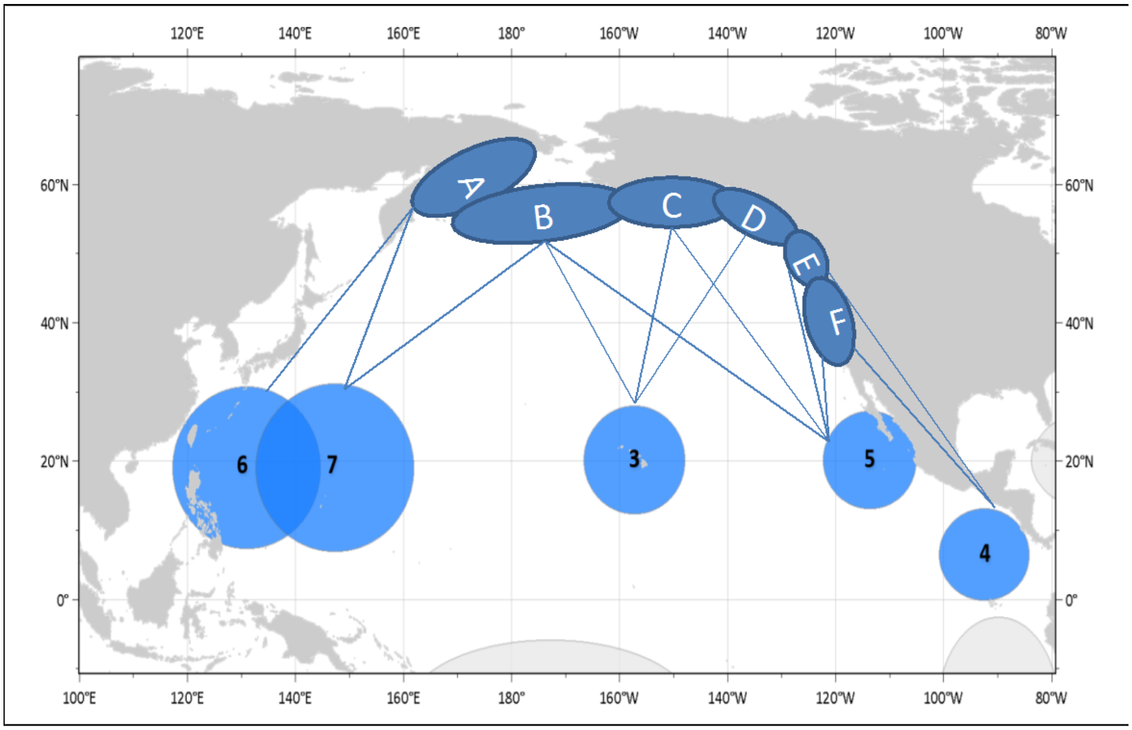
4. Central America – The Central America DPS is composed of whales that breed along the Pacific coast of Costa Rica, Panama, Guatemala, El Salvador, Honduras and Nicaragua. Whales from this breeding ground feed almost exclusively offshore of California and Oregon in the eastern Pacific, with only a few individuals identified at the northern Washington –southern British Columbia feeding grounds. This population was determined to be discrete based on re-sight data as well as findings of significant genetic differentiation between it and other populations in the North Pacific. The genetic composition of the DPS is also unique in that it shares mtDNA haplotypes with some Southern Hemisphere DPSs, suggesting it may serve as a conduit for gene flow between the North Pacific and Southern Hemisphere, although there was some disagreement within the BRT on whether this was a strong indicator of significance. The breeding ground of this population occupies a unique ecological setting, and its primary feeding ground is in a unique marine ecosystem for the North Pacific. Loss of this population would also result in a significant gap in the range of the species.

5. Mexico – The Mexican DPS consists of whales that breed along the Pacific coast of mainland Mexico, the Baja California Peninsula and the Revillagigedos Islands. The Mexican DPS feeds across a broad geographic range from California to the Aleutian Islands, with concentrations in California-Oregon, northern Washington – southern British Columbia, northern and western Gulf of Alaska and Bering Sea feeding grounds. This population was determined to be discrete based on significant genetic differentiation as well as evidence for low rates of movements among breeding areas in the North Pacific based on sighting data. It was determined to be significant due to the gap in breeding grounds that would occur if this population were to be extirpated and the marked degree of genetic divergence from other populations in the North Pacific.

6. Okinawa/Philippines – The Okinawa/Philippines DPS consists of the whales' breeding/wintering in the area of Okinawa and the Philippines. Animals transiting the Ogasawara area are believed to be a mixture of whales from this DPS and the second West Pacific DPS (# 7, below). The Okinawa/Philippines DPS migrates to feeding grounds in the northern Pacific, primarily off the Russian coast.   The population was determined to be discrete based upon both significant genetic differentiation from other North Pacific populations and apparently limited exchange with other breeding populations in the North Pacific based on re-sighting data. The population was determined to be significant due to the gap in both the breeding and feeding ranges that would arise if the population were to go extinct, marked levels of genetic differentiation from other population in the North Pacific, and a primary feeding area that is unique in its ecological characteristics compared to other populations in the North Pacific. The relationship between this DPS and the Second West Pacific DPS is somewhat uncertain, however, due to the latter's unknown breeding location.

7. Second West Pacific DPS – The existence of this breeding population is inferred from sightings of whales in Aleutian Islands area feeding grounds that cannot be linked to any known breeding population and from the significant genetic differences that were found between Ogasawara whales and the Okinawa/Philippines DPS. Some of these whales may transit the Ogasawara area in route to unknown breeding grounds farther south. This inferred breeding population was considered to be discrete based primarily upon the apparent low exchange with other breeding populations in the North Pacific. Its significance was hard to assess, but it appears to feed primarily in a marine ecosystem (the Aleutian Islands) that is rarely used by whales from other populations. Loss of this population was also considered likely to result in a gap in the range, based on a discrete feeding area and an unknown breeding area.

Figure 6. North Pacific Ocean Distinct Population Segments.
Breeding areas are numbered, with linkages to predominant feeding areas (letters) illustrated. Only the general locations of areas are shown. Information primarily from Calambokidis *et al.* (2008) and Barlow *et al.* (2011).



H.4.3 Southern Hemisphere Distinct Population Segments

8. West Australia – The West Australia DPS consists of the humpback whales whose breeding/wintering range includes the West Australia coast, primarily in the Kimberly Region. Individuals in this population migrate to feeding areas in the Antarctic, primarily between 80°E and 110°E based on tagging data. The population was considered discrete based upon lack of evidence for exchange with other breeding populations as well as significant genetic differentiation from other populations in the Southern Hemisphere. It was considered significant due to the gap in both the breeding and feeding range that would be created should the population become extirpated.

9. East Australia – The East Australia DPS consists of the whales' breeding/wintering along the eastern and northeastern Australian coast. Based upon tagging, telemetry, and re-sighting data, individuals in this population migrate to Antarctic feeding areas ranging from 100°E to 180°E, but concentrate mostly between 120°E and 180°E. The population was considered discrete based upon its distribution and level of genetic differentiation from other populations. It was considered significant due to the gap in the range that would occur should the population become extirpated.

10. Oceania – The Oceania DPS consists of whales that breed/winter in the South Pacific Islands between ~160°E (west of New Caledonia) to ~120°W (east of French Polynesia), including American Samoa, the Cook Islands, Fiji, French Polynesia, Republic of Kiribati, Nauru, New Caledonia, Norfolk Island, New Zealand, Niue, the Independent State of Samoa, Solomon

Islands, Tokelau, Kingdom of Tonga, Tuvalu, Vanuatu, Wallis and Futuna. Individuals in this population are believed to migrate to a largely undescribed Antarctic feeding area. The population was considered discrete based on its breeding distribution and level of genetic differentiation from other populations. It was considered significant based upon the gap in the range that would occur should the population become extirpated.

11. Southeastern Pacific – The Southeastern Pacific DPS consists of whales that breed/winter along the Pacific coasts of Panama to northern Peru (9°N-6°S), with the main wintering areas concentrated in Colombia. Feeding grounds for this DPS are thought to be concentrated in the Chilean Magellan Straits and the western Antarctic Peninsula. These cross-equatorial breeders feed in the Southern Ocean during much of the austral summer. The population was considered discrete based on its breeding distribution and level of genetic differentiation from other populations. It was considered significant based on the gap in the range that would occur should it become extirpated, the marked level of genetic divergence for the Southern Hemisphere, and the unique ecological setting of its breeding area.

12. Brazil – This DPS consists of whales that breed between approximately 3°S and 23°S in the southwestern Atlantic along the coast of Brazil with a prominent concentration around the Abrolhos Bank (15°-18°S) and feed off South Georgia and the South Sandwich Islands. The population was considered discrete based on its breeding distribution and level of genetic differentiation from other populations. It was considered significant based upon the gap in range that would occur should the population become extirpated and its feeding location in a distinct marine ecosystem.

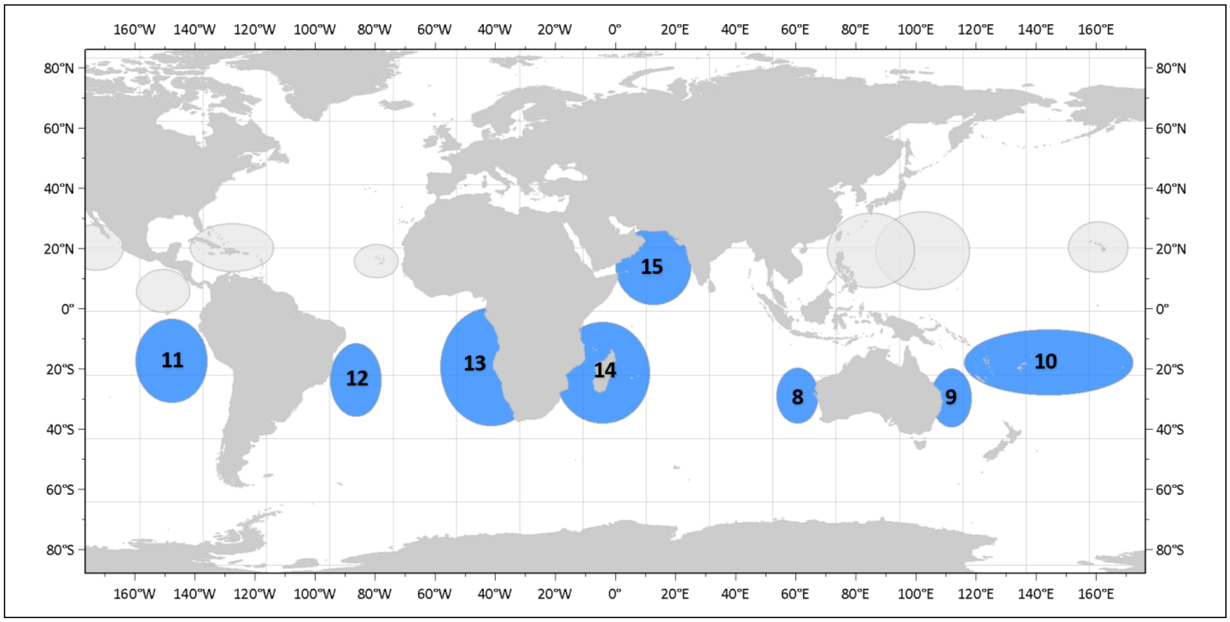
13. Southwest Africa – The Southwest Africa DPS consists of whales that breed and calve off central western Africa between ~6°S and ~6°N in the eastern Atlantic, including the coastal regions of northern Angola, Congo, Togo, Gabon, Benin, other coastal countries within the Gulf of Guinea and possibly farther north. This DPS is thought to feed offshore of west South Africa and Namibia south of 18°S and in the Southern Ocean beneath west South Africa (20°W – 10°E). The population was considered discrete based on its breeding distribution, which is geographically separated from other breeding distributions, and level of genetic differentiation from other populations. It was considered significant based upon the gap in the range that would occur should the population become extirpated.

14. Southeast Africa/ Madagascar– The Southeast Africa/ Madagascar DPS includes whales breeding in at least three different areas in the western Indian Ocean: one associated with mainland coastal waters of southeastern Africa, extending from Mozambique to as far north as Tanzania and southern Kenya, a second found in the coastal waters of the northern Mozambique Channel Islands and the southern Seychelles and the third found in the coastal waters of eastern Madagascar. The feeding grounds of this DPS in the Southern Ocean are not well defined but are believed to include multiple localities to the west and east of the region bounded by 5°W – 60°E. The population was considered discrete based on its breeding distribution, which is geographically separated from other breeding grounds and level of genetic differentiation from other populations. It was considered significant based upon the gap in the range that would occur should the population become extirpated.

15. Arabian Sea – The Arabian Sea DPS includes those whales that are currently known to breed and feed along the coast of Oman. However, historical records from the eastern Arabian Sea

along the coasts of Pakistan and India indicate its range may also include these areas. The population was considered discrete based upon its unique breeding and feeding distribution which is geographically separated from other breeding distributions, and level of genetic differentiation from other populations. It was considered significant based upon the gap in the range that would occur should the population become extirpated, its unique ecological setting, and marked degree of genetic differentiation from other population in the Southern Hemisphere.

Figure 7. Southern Hemisphere and Arabian Sea Distinct Population Segments.



III. Assessment of Extinction Risk

The BRT was charged with assessing the risk of extinction for each DPS identified. The information considered in evaluating a DPS's status can be grouped into two general categories: (1) demographic information reflecting the past and present status (*e.g.*, data on population abundance or density, population trends and growth rates, exchange rates of individuals among populations, and the ecological, life-history, or genetic diversity among populations); and (2) information on threats faced by the DPS (*e.g.*, overutilization, disease, climate change). The demographic and threats data reviewed by the BRT are thoroughly described in the Background Report (Fleming and Jackson 2011) and summarized in this chapter.

Evaluating extinction risk of a species includes considering the available information concerning the abundance, growth rate/productivity, spatial structure/connectivity, and diversity of a species and assessing whether these demographic criteria indicate that it is at high risk of extinction; at moderate risk; or neither. The demographic risk criteria described above were evaluated based on the present species status in the context of historical information, if available, and threats that might alter the determination of the species' overall level of extinction risk. These threats are critical considerations in evaluating a species' extinction risk; forecasting the effects of threats into the foreseeable future usually necessitates qualitative evaluations and the application of informed professional judgment. This evaluation highlights factors that may exacerbate or ameliorate demographic risks so that all relevant information may be integrated into the determination of overall extinction risk for the species.

Section A of this chapter describes the process used by the BRT to analyze threats as they relate to the current status of the 15 identified humpback whale DPSs. Section B presents a general description of the past, current, or potential threats for humpback whales under the relevant section 4(a)(1) factor to avoid duplication.

Section C of this chapter describes the BRT's approach to analyzing demographic factors and extinction risk. Section D evaluates the threats specific to each DPS and, taken in consideration with demographic factors, assesses the risk of extinction for each DPS.

Analysis of Factors Listed Under ESA Section 4(a)(1)

Under Section 4(a)(1) of the ESA, NMFS and FWS are required to determine whether any species is an endangered or threatened species because of any of the following factors. These factors are:

A. The present or threatened destruction, modification, or curtailment of its habitat or range;
B. Overutilization for commercial, recreational, scientific, or educational purposes;
C. Disease or predation;
D. The inadequacy of existing regulatory mechanisms; or
E. Other natural or manmade factors affecting its continued existence.

The BRT qualitatively assessed the severity, geographic scope, and level of certainty of 16 potential threats to humpback whales for each DPS. Because the severity and scope of individual threats may change through time, each threat was evaluated based on its current and/or future potential for impact.

A. Overview of Threats Analysis

The BRT began its qualitative assessment of threats by defining the following threat severity levels:

> 4 = Very high: the threat is likely to on its own create a high risk of extinction.
> 3 = High: the threat is likely to seriously reduce the population size or its growth rate.
> 2 = Medium: the threat is likely to moderately reduce the population size or its growth rate.
> 1 = Low or none: the threat is likely to have no or minor impact on the population size or growth rate.
> U = Unknown: the severity of the threat is unknown.

The BRT focused on threats that are acting currently or that will have predictable impacts in the future. For example, in almost all DPSs whaling was considered to be a low threat currently since present-day whaling is not known to kill more than a few individual whales, despite the fact that whaling was clearly a severe threat in the past.

The BRT collectively evaluated the threats posed to each DPS individually and then examined and discussed the results across all DPSs to ensure that the assigned threat level was evaluated consistently across each DPS. The BRT noted because the threat levels encompass fairly broad categories, not all threats of the same level are necessarily exactly equal in severity.

B. General Description of Threats

B.1 Present or threatened destruction, modification, or curtailment of its habitat or range

Coastal Development
Substantial coastal development is occurring in many regions, and may include construction of ports that can cause increased turbidity of coastal waters, higher volume of ship traffic, and physical partitioning or disruption of the marine environment. Noise associated with construction (*e.g.,* pile driving, blasting, or explosives) and dredging has the potential to affect whales by generating sound levels believed to disturb marine mammals under certain conditions. The majority of the sound energy associated with both pile driving and dredging is in the low frequency range (<1,000 Hz; Illingworth and Rodkin Inc. 2001; Reyff 2003; Illingworth and Rodkin Inc. 2007). Because humpback whales would only be affected when close to shore, the BRT believed that these effects on the whales would generally be low. However, if coastal development occurred in seasonal areas or migration routes where whales concentrate, individuals in the area could be more seriously affected. Scheduling in-water construction activities to avoid those times when whales may be present would likely minimize the disturbance.

The BRT was unaware of any circumstance of coastal development resulting in humpback whale serious injury or mortality and therefore determined that in general coastal development likely poses a low level threat to humpback whales.

Contaminants

For purposes of this Status Review, the BRT agreed to consider as contaminants heavy metals, persistent organic pollutants, effluent, airborne contaminants, plastics, and other marine debris and pollution with the exception of oil spills, which is evaluated under 'energy exploration and development'. Numerous regions were highlighted as having known or hypothesized high contaminant levels from run-off, large human populations, and low levels of regulatory control.

Halogenated organic pollutants (including dichloro-diphenyl-trichloroethane (DDT)), hexachlorocyclohexane (HCH) and chlordane (CH) insecticides, polychlorinated biphenyl (PCB) coolants and lubricants, and polybrominated diphenyl ether (PBDE - flame retardants) can persist in the environment for long periods. Air-borne pollutants are particularly concentrated in areas of industrialization, and in some high latitude regions (Aguilar *et al.* 2002). While the use of many pollutants is now either banned or strictly regulated in some countries (*e.g.,* DDTs and PCBs), their use is still unregulated in many parts of world, and they can be transported long distances via oceanographic processes and atmospheric dispersal (Aguilar *et al.* 2002).

Humpback whales can accumulate lipophilic compounds (*e.g.*, halogenated hydrocarbons) and pesticides (*e.g.,* DDT) in their blubber, as a result of feeding on contaminated prey (bioaccumulation) or inhalation in areas of high contaminant concentrations (*e.g.,* regions of atmospheric deposition; Barrie *et al.* 1992; Wania and Mackay 1993). Some contaminants (*e.g.*, DDT) are passed on maternally to young during gestation and lactation (*e.g.,* fin whales, Aguilar and Borrell 1994).

Elfes *et al.* (2010) described the range and degree of organic contaminants accumulated in the blubber of humpback whales sampled on Northern Hemisphere feeding grounds. Concentrations were high in some areas (Southern California and Northern Gulf of Maine), possibly reflecting proximity to industrialized areas in the former case, and prey choice in the latter (Elfes *et al.* 2010). There were also higher levels of PCBs, PBDEs, and CH insecticides in the North Atlantic Ocean (Gulf of Maine and Bay of Fundy) than the North Pacific (California, South East Alaska, Aleutian Islands). The highest levels of DDT were found in whales feeding off Southern California, a highly urbanized region of the coast with substantial discharges (Elfes *et al.* 2010). This same study found a linear increase in PCB, DDT and chlordane concentration with age of the whales sampled. Generally, concentrations of these contaminants in humpback whales were low relative to levels found in odontocetes (O'Shea and Brownell 1994). Little information on levels of contamination is available from humpback whales on Southern Hemisphere feeding grounds.

The health effects of different doses of contaminants are currently unknown for humpback whales (Krahn *et al.* 2004c). There is evidence of detrimental health effects from these compounds in other mammals, including disease susceptibility, neurotoxicity, and reproductive and immune system impairment (Reijnders 1986; DeSwart *et al.* 1996; Eriksson *et al.* 1998). Contaminant levels have been proposed as a causative factor in lower reproductive rates found among humpback whales off Southern California (Steiger and Calambokidis 2000), but at present the threshold level for negative effects, and transfer rates to calves, are unknown for humpback whales. Metcalfe *et al.* (2004) found in biopsy sampled humpback young of the year in the Gulf of St. Lawrence PCB levels similar to that of their mothers and other adult females, indicating that bioaccumulation can be rapid, and that transplacental and lactational partitioning did little to reduce contaminant loads.

Although there has been substantial research on the identification and quantification of such contaminants on individual whales, no detectable effect from contaminants has been identified in baleen whales. There may be chronic, sub-lethal impacts that are currently unknown. The difficulty in identifying contaminants as a causative agent in humpback whale mortality and/or decreased fecundity led the BRT to conclude the severity of this threat was low in all regions, except where lack of data indicated a finding of unknown.

Energy Exploration and Development

The BRT defined identified threats from energy exploration and development to include oil spills from pipelines, rigs or ships, increased shipping, and construction surrounding energy development (oil, gas, or alternative energy). This category does not include noise from energy development, which is considered under 'anthropogenic noise'.

Little is known about the effects of oil or petroleum on cetaceans and especially on mysticetes. Oil spills that occur while whales are present could result in skin contact with the oil, baleen fouling, ingestion of oil, respiratory distress from hydrocarbon vapors, contaminated food sources, and displacement from feeding areas (Geraci *et al.* 1989). Actual impacts would depend on the extent and duration of contact, and the characteristics of the oil. Most likely, the effects of oil would be irritation to the respiratory membranes and absorption of hydrocarbons into the bloodstream (Geraci *et al.* 1989). Polycyclic aromatic hydrocarbons (PAHs) are components of crude oil which are not easily degraded and are insoluble in water, making them quite detrimental in the marine environment (Pomilla *et al.* 2004). PAHs have been associated with proliferative lesions and alteration to the immune and reproductive systems (Martineau *et al.* 2002). Long term ingestion of pollutants, including oil residues, could affect reproduction, but data are lacking to determine how oil may fit into this scheme for humpback whales.

Although the risk posed by operational oil rigs is likely low, failures and catastrophic events that may result from the presence of rigs pose high risks. Since the BRT had already determined that threat assessments would focus on present threats, the mere presence of oil rigs was not interpreted to warrant a threat level above low. However, the level of impact that such a catastrophic event may have on a population was considered in the evaluations.

Harmful Algal Blooms (HABs)

Some algal blooms are harmful to marine organisms and have been linked to pollution from untreated industrial and domestic wastewater. Toxins produced by different algae can be concentrated as they move up the food chain, particularly during algal blooms. Naturally occurring toxin poisoning can be the cause of whale mortalities and is particularly implicated when unusual mortality events[4] (UME) occur. The best documented UME for humpback whales attributable to disease occurred in 1987-1988 in the North Atlantic, when at least 14 mackerel-feeding humpback whales died of saxitoxin poisoning (a neurotoxin produced by some dinoglagellate and cyanobacteria species) in Cape Cod, Massachusetts (Geraci *et al.* 1989). In the Gulf of Maine in 2003, a few sampled individuals among 16 humpback whale carcasses were found with saxitoxin and domoic acid (produced by certain species of diatoms, a different type of algae) and the situation was declared to be an Unusual Mortality Event (Gulland 2006).

Despite the UMEs described above, harmful algal blooms (HABs) were determined to represent a minor threat to most humpback whale populations. HABs may be increasing in Alaska, but the BRT was unaware of records of humpback whale mortality resulting from HABs in this region. The BRT discussed the possible levels of unobserved mortality that may be resulting from HABs and determined that as the West Indies population had been affected by HABs in the past it is likely experiencing a higher level of HAB-related mortality than is detected.

B.2 Overutilization for commercial, recreational, scientific, or educational purposes

Whaling

Direct hunting, although rare today, was the main cause of initial depletion of humpback whales and other large whales. An international moratorium on commercial whaling for all large whale species was established by the International Whaling Commission (IWC) in 1982, which took effect in 1986 and affected all member (signatory) nations (paragraph 10e, IWC 2009a). However, the moratorium can be circumvented by any country that lodged an objection to the decision, or through special permit whaling (so-called “scientific whaling”). Norway and Iceland both maintain objections, while Japan has extensively utilized the scientific whaling.

<u>Commercial Whaling</u>

Iceland and Norway currently hunt a number of whale species commercially under objection to the IWC moratorium, although humpback whales have not been hunted by either nation in recent years. The present international moratorium on commercial whaling will remain in place unless a 75% majority of IWC signatory members vote to lift the moratorium. Following this, under current IWC management procedures, humpback whale stocks considered to have recovered to over 54% of their pre-whaling levels (based on a detailed “comprehensive assessment” of their population status) could be subject to commercial whaling, with a quota that in theory would be determined by the Revised Management Procedure. This procedure implements a quasi-Bayesian Catch Limit Algorithm to calculate allowable catches for each stock (Cooke 1992). The effects of these catches on population abundance would be simulated via a series of Implementation Simulation Trials prior to agreement of quotas for commercial hunting. Since whaling is carried out under objection by Iceland and Norway, they are not subject to this management scheme for allocating quotas for any species.

The BRT believed that the likelihood of a resumption of commercial whaling is currently low; however, if hunting were to resume (either through objection, scientific research takes or commercial quotas), the impact on the DPSs concerned would have to be evaluated at that time.

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4 Unusually large numbers of whales stranding in close proximity and in a relatively short time frame, exhibiting similar or unusual pathological or clinical states or an abnormal physical condition

Scientific Whaling

Since implementation of the international moratorium of whaling, some nations have continued to hunt whales under Article VIII of the International Convention for the Regulation of Whaling 1946, which allows the killing of whales for scientific research purposes. Three nations originally conducted scientific whaling; Iceland, Norway, and Japan. Presently only Japan pursues scientific whaling, under the programs JARPAII and JARPNII ('Japanese Whale Research Program under Special Permit in the Antarctic' and 'North Pacific' respectively) while Iceland and Norway hunt whales commercially under objection to the moratorium. Scientific whaling is presently unregulated, and no quotas are enforced for this activity (Clapham *et al.* 2003b). In 2012 the Government of Japan issued Special Permits authorizing the implementation of a take of Antarctic minke, fin and humpback whales for scientific purposes in the Southern Ocean; research take of up to 50 humpbacks is included in the Special Permits. However, at the time of this review Japan had informed the Secretariat that it will continue to suspend the capture of humpback whales for the 2013 season (IWC 2013).

Subsistence Hunting

Subsistence hunting in the North Atlantic is conducted on the island of Bequia in St. Vincent and the Grenadines in the Lesser Antilles (Reeves 2002). In 1986, St Vincent and the Grenadines asked for a humpback quota from the IWC based on their history of artisanal whaling in the community and the small number of whales taken (Reeves 2002). Bequia currently retains an IWC "block" quota of up to 24 whales over a six-year period (2013-2018) (IWC 2012).

A small hunt, not regulated by the IWC, is also thought to exist in the Gulf of Guinea at the island of Pagalu (Aguilar 1985; Reeves 2002). No information exists on the fishery since 1975, but as of 1970 whales were still being taken in the area.

It does not appear that Tonga hunted whales before Europeans arrived in the region in the 19th century (Reeves 2002). Tonga was used as a provisioning station for whaling vessels from the Northern Hemisphere while they operated in the South Pacific. Tongans then began conducting shore-based whaling in the late 1880s or early 1900s and developed a taste for whale meat, increasing demand and prompting new boats and whalers to enter the growing industry (Reeves 2002). Catch rates (whales landed) were estimated at 10-20 whales/year for the 1950s and 1960s and at least 3-8 whales/year for the mid 1970s (Reeves 2002). In 1979, the Tonga Whaling Act was passed after a Royal Decree in 1978, prohibiting the catch of whales on what was originally designated as a temporary basis pending an assessment of the population by the International Whaling Commission (Keller 1982; Reeves 2002; Kessler and Harcourt 2012). However, no whaling has been carried out in Tonga since then.

Greenland began hunting humpback whales before 1780 (Reeves 2002). As the take of bowhead whales decreased from 1750 to 1850, humpback whales became a more frequent target (Reeves 2002). The hunting of humpback whales by Greenland was banned by the IWC beginning in 1986, although 14 whales were taken illegally over the period 1988-2006. In 2010, a quota was reinstated, and 27 humpbacks were killed between 2010 and 2012.

Other "hunts"

Genetic monitoring of Japanese markets (1993-2009) identified humpback whale as the source of 17 whale meat products. These are believed to have been killed through direct or indirect fisheries entanglement (Steel *et al.* 2009). In Japan, it is legal to kill and sell any entangled whale as long as the take is reported; there is suspicion that this provides a cover for intentional "entanglements", although the level of such takes in currently unknown.

In summary, the current impact of whaling activities on global humpback whale populations is very low, with only a handful of humpback whales taken annually in two known aboriginal fisheries. The BRT discussed the possibility of expanded commercial whaling of humpback whales in the Southern Ocean but determined that new whaling action in the near future was unlikely. Therefore, the BRT attributed a low level risk of whaling for all but one DPS. Poaching is suspected to occur in Korean waters and off Japan, and for this reason the threat of whaling to the Okinawa/Philippines DPS was determined to be medium.

Whale-watching

Whale-watch tourism is a global industry with major economic value for many coastal communities (O'Connor *et al.* 2009). The industry has been expanding rapidly since the 1980s (estimated 3.7% global increase in whale watchers per year between 1998-2008, O'Connor *et al.* 2009; Kessler and Harcourt 2012). Whale-watching operations have been documented in 119 countries worldwide as of 2008, including on many humpback whale feeding grounds, breeding grounds and migratory corridors (O'Connor *et al.* 2009).

The most common reported response of humpback whales to whale-watching boats was increased swimming speed during exposure; there was little evidence of significant effects on inter-breath intervals and blow rates (Weinrich *et al.* 2008). Passive acoustic monitoring and localization of humpback whale songs in the presence of whale-watching boats on Brazilian breeding grounds also found that whales moved away from the boat in the majority of cases (68.4% of the time when boats were less than 2.5 miles distant, Sousa-Lima and Clark 2009).

Only one study has attempted to assess the population-level effects of whale-watching on humpback whales, as the relevant parameters are very difficult to measure. Weinrich and Corbelli (2009) reported that calving rate and calf survival to age two did not seem to be negatively affected by whale-watching on a subset of the Gulf of Maine feeding ground (Stellwagen Bank). The authors noted that in areas of heavy ship traffic, isolating the impacts of whale-watching on biological parameters is difficult and may not be conclusive (Weinrich and Corbelli 2009) and is difficult to determine at either the individual or population level.

Efforts to manage whale-watching operations have included limiting the number of whale-watching vessels, limiting the time vessels spend near whales, specifying the manner of operating around whales, and establishing limits to the period of exposure of the whales. In some areas, whale-watching industries operate under regulations while others operate under guidelines or are still unregulated, and this industry is still growing rapidly in many areas (over 10% per year in Oceania, Asia, South America, Central America and the Caribbean) (Carlson 2009; O'Connor *et al.* 2009).

The BRT discussed the available evidence regarding the impact of whale-watching on humpback whale populations. All available evidence supports the negligible impact of these activities, and the BRT determined this threat is low for all DPSs.

Scientific Research
Humpback whales have been the subject of field research studies for decades. The primary objective of many of these studies has generally been to gather data for behavioral and ecological studies. In the U.S., permits authorize investigators to make close approaches to endangered whales for photographic identification, biopsy sample collection, behavioral observations, passive acoustic recording, aerial photogrammetry, satellite tagging, and underwater observations. Research on humpback whales is likely to continue and increase in the future, especially for the collection of genetic information, photographic studies, and acoustic studies. Research activities could result in disturbance to humpback whales, but are closely monitored and evaluated in the U.S. in an attempt to minimize any necessary impacts of research.
The BRT discussed the available evidence regarding the impact of scientific research on humpback whale populations. All available evidence supports the negligible impact of these activities, and the BRT determined this threat is low for all DPSs.

B.3 Disease or predation

Disease and Parasites
Information on disease or parasites is unavailable for many humpback whale populations. Direct monitoring of species biochemistry and pathology, used to determine the state of health in humans and domestic animals, is very limited for humpback whales as for most marine mammals and there is little published on humpback whale disease as a result. Humpback whales carry a crustacean ectoparasite (cyamid *Cyamus boopis*). While the whale is the main source of nutrition for this parasite (Schell *et al.* 2000), there is little evidence that they contribute to whale mortality. Humpback whales can also carry the giant nematode *Crassicauda boopis* (Bayliss 1920), which is known to cause a serious inflammatory response (leading to vascular occlusion and kidney failure) in a few balaenopterid species (Lambertsen 1992).

Individual humpback whales in Hawaiian waters have a high occurrence of skin lesions but it is unclear whether this is due to a parasite or disease. It is estimated that approximately 60% of adults in Hawaii and Oceania have these skin lesions. Whether the lesions are entirely benign is unknown. The BRT concluded that where some information is available, disease and parasites do not pose a substantial threat to humpback whale populations.

Predation
The most common predator of humpback whales is the killer whale (*Orcinus orca*, Jefferson *et al.* 1991), although predation by large sharks may also occur. Attacks by false killer whales (*Pseudorca crassidens*) have also been reported or inferred on rare occasions. Attacks by killer whales on humpback whale calves has been inferred by the presence of distinctive parallel ‘rake’ marks from killer whale teeth across the flukes (Shevchenko 1975). While killer whale attacks of humpback whales are rarely observed in the field (Ford and Reeves 2008), the proportion of photo-identified whales bearing rake scars is between zero and 40%, with the greater proportion of whales showing mild scarring (1-3 rake marks) (Wade *et al.* 2007; Steiger *et al.* 2008). This suggests that attacks by killer whales on humpback whales vary in frequency across regions. It also suggests either most killer whale attacks result in mild scarring, or those resulting in severe scarring (4 or more rakes, parts of fluke missing) are more often fatal. Most observations of humpback whales under attack from killer whales reported vigorous defensive behavior and tight grouping when more than one humpback whale was present (Ford and Reeves 2008).

Photo-identification data indicate that rake marks are usually acquired in the first year of life, although attacks on adults also occur (Wade *et al.* 2007; Steiger *et al.* 2008). Killer whale predation may influence survival during the first year of life (Wade *et al.* 2007). There has been some debate as to whether killer whale predation (especially on calves) is a motivating factor for the migratory behavior of humpback whales (Corkeron and Connor 1999; Clapham 2001). How significantly motivating this factor is also depends on the importance of humpback whales in the diet of killer whales, another debated topic that remains inconclusive in the published literature (Springer *et al.* 2003; Wade *et al.* 2007; Kuker and Barrett-Lennard 2010). No analyses of killer whale stomach contents have revealed remains of humpback whales (Shevchenko 1975), suggesting that if humpback whales are taken at all, they comprise at most a small part of the diet. However these analyses took place during the height of the whaling period, when humpback whales were at a low density, and may therefore have been less available for predation.

There is also evidence of shark predation on calves and entangled whales (Mazzuca *et al.* 1998). Shark bite marks on stranded whales may often represent post-mortem feeding rather than predation *i.e.,* scavenging on carcasses (Long and Jones 1996).

The BRT noted that 44% of all flukes photographed from the humpback whale population off Mexico are scarred with killer whale tooth rakes. Even for this population, the BRT determined that the actual impact of predation at the population level is likely quite low and noted that although scarring is a useful assessment, the level of mortality is unknown but is likely not prohibiting population growth. The threat of predation was therefore ranked as low or unknown for all DPSs.

B.4 Adequacy of Existing Regulatory Mechanisms

Most of the threats the BRT evaluated are subject to various national, international and/or local regulations, and the BRT determined that the adequacy of these regulations is, at least to a large degree, reflected in the overall biological status of the species. The BRT also considered the adequacy of the major regulations governing these threats when making predictions about future status. For example, the International Convention for the Regulation of Whaling and the Marine Mammal Protection Acts provide a regulatory context for evaluating the likelihood that overutilization will become a significant threat in the future, assuming these or equivalent laws or agreements remain in effect in the future.

Here, we summarize key regulatory mechanisms identified as potentially affecting the conservation of humpback whales. Some additional area-specific information is presented in the relevant DPS-specific sections as appropriate.

B.4.1 International agreements

International Convention for the Regulation of Whaling
The International Whaling Commission was set up under the International Convention for the Regulation of Whaling, signed in 1946. The organization describes its functions as follows:

> *The main duty of the IWC is to keep under review and revise as necessary the measures laid down in the Schedule to the Convention which govern the conduct of whaling throughout the world. These measures, among other things, provide for the complete protection of certain species; designate specified areas as whale sanctuaries; set limits on the numbers and size of whales which may be taken; prescribe open and closed seasons and areas for whaling; and prohibit the capture of suckling calves and female whales accompanied by calves. The compilation of catch reports and other statistical and biological records is also required.*
>
> *In addition, the Commission co-ordinates and funds conservation work on many species of cetaceans. This includes work to reduce the frequency of ship strikes, to co-ordinate disentanglement events and to establish Conservation Management Plans for key species and populations. Recently, the Commission has adopted a Strategic Plan for Whale Watching so as to facilitate the further development of this activity in a way which is responsible and consistent with international best practice.* [http://iwc.int/history-and-purpose, accessed February 10, 2014].

Part of the IWC's function is to set catch limits for commercial whaling. These have been set at zero since 1985, an action known as the commercial whaling moratorium. Since that time, the IWC's Scientific Committee has developed a stock assessment and catch limit methodology called the "revised management procedure", with the goal of providing information on catch limits consistent with maintaining sustainable populations. As of 2014, the IWC has maintained the zero catch limit, however, a policy which has engendered considerable debate within the organization. The IWC's regulations provide a process by which countries may object to specific provisions, and Norway and Iceland currently allow commercial whaling based on these objections. The IWC also develops catch limits for aboriginal whaling, including take of humpback whales in coastal areas of Greenland and the West Indies. The ICRW allows for signatory nations to harvest whales for scientific purposes through their own national permit process, although humpback whales have not been reported to have been taken under this process.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is aimed at protecting species at risk from unregulated international trade. CITES regulates international trade in animals and plants by listing species in one of its three appendices. The level of monitoring and control to which an animal or plant species is subject depends on which appendix the species is listed in. Appendix I includes species threatened with extinction which are or may be affected by trade; trade of Appendix I species is only allowed in exceptional circumstances. Appendix II includes species not necessarily threatened with extinction presently, but for which trade must be regulated in order to avoid utilization incompatible with their survival. Appendix III includes species that are subject to regulation in at least one country,

and for which that country has asked other CITES Party countries for assistance in controlling and monitoring international trade in that species. Humpback whales are currently listed in Appendix I under CITES.

The International Union for the Conservation of Nature and Natural Resources Red List
The IUCN Red List identifies and documents those species most in need of conservation attention if global extinction rates are to be reduced. It is widely recognized as the most comprehensive, apolitical global approach for evaluating the conservation status of plant and animal species. In order to produce Red Lists of threatened species worldwide, the IUCN Species Survival Commission draws on a network of scientists and partner organizations, which use a scientifically standardized approach to determine species' risks of extinction. Humpback whales are currently classified by the IUCN as "least concern" (IUCN 2013; IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 11 February 2014).

International Maritime Organization (IMO)
The International Maritime Organization (IMO), a branch of the United Nations and the recognized international authority on shipping and safety at sea, participates in reducing the shipping industry's impacts to the sea from pollution (oil, garbage, noxious substances). Regulations to address pollution from maritime vessels include MARPOL (International Convention for the Protection of Pollution from Ships), MARPOL Annexes, International Conventions on Oil Pollution Preparedness Response and Co-operation, and Prevention of Marine Pollution by Dumping of Wastes and Other Matter. The IMO's Marine Environment Protection Committee designates regions as "Particularly Sensitive Sea Areas" (PSSA) and "Areas to be Avoided" for various ecological, economic or scientific reasons. PSSA regions include The Great Barrier Reef (Australia), the Galapagos Islands (Ecuador), and the Papahanaumokuakea Marine National Monument (North Pacific). The IMO was approached for the first time regarding conservation of an endangered whale species in 1998 – a protective measure for North Atlantic right whales (Silber *et al.* 2012). Since then, the IMO has been approached over a dozen times with nations' proposals to establish or amend routing measures in various locations to reduce the threat of vessel collisions with endangered whales, including humpback whales (Silber *et al.* 2012). For example, the IMO has endorsed Areas To Be Avoided in U.S. and Canadian waters to reduce the threat of ship strikes of right whales (Fleming and Jackson 2011, pp. 28-29), measures that also benefit humpback whales. IMO-endorsed modifications to Traffic Separation Schemes (TSS) have been established in areas off Boston, San Francisco, near Santa Barbara (the latter two primarily for humpback whales); and a new TSS, along with vessel speed advisories, have been proposed for the Pacific side of the Panama Canal to protect large whale species from vessel collisions.

Convention on the Conservation of Migratory Species of Wild Animals (CMS) or Bonn Convention
Convention on the Conservation of Migratory Species of Wild Animals (CMS) is an intergovernmental treaty which requires range states to protect migratory species including humpback whales where they occur, conserve or restore habitats, mitigate obstacles to migration and control other endangering factors. The humpback whale is listed in Appendix I of the CMS (species in danger of extinction throughout all or a significant portion of their range). Parties to CMS are required to prohibit take of Appendix I species. The CMS has developed binding

Agreements and nonbinding Memoranda of Understanding (MOU). An MOU for the Conservation of Cetaceans and their Habitats in the Pacific Islands Regions became effective in 2006 and offers a level of protection to the Southern Hemisphere populations of humpback whales and their habitats in this region. The CMS Agreements on the Conservation of a) Small Cetaceans in the Baltic, North East Atlantic, Irish and North Seas (29.03.1994) and b) Cetaceans of the Black Seas, Mediterranean and Contiguous Atlantic Area are not designed specifically for the humpback whale but may provide incidental protection to the species.

Council of Europe's Bern Convention on the Conservation of European Wildlife and Habitats
The Bern Convention is a regional European treaty on conservation of wild flora and fauna and their natural habitats and calls for signatories to provide special protection for fauna species listed in Appendix II and III to the convention. The convention is a binding agreement for participating parties, and its aim is to ensure conservation by means of cooperation, including efforts to protect migratory species. The Parties promote national policies and education for the conservation of nature and the integration of conservation into environmental policies.

The humpback whale is listed in Appendix II - fauna species to be strictly protected – which prohibits deliberate capture and killing, damage to or destruction of breeding sites, deliberate disturbance of animals during breeding and rearing, and the possession of and internal trade in these animals alive or dead (Council of Europe's Bern Convention 2013).

Council of the European Union (EU) Directive 92/43 on the Conservation of Natural Habitats and of Wild Fauna and Flora (EU Habitats Directive)
The provisions of the EU Habitats Directive are intended to promote the conservation of biodiversity in EU member countries. EU members meet the habitat conservation requirements network known as Natura 2000. Humpback whales are listed in Annex IV of the convention which identifies species determined to be in need of strict protection across the European region. Twenty-seven member states work with the same legislative framework to protect species. Actions originating from the EU Habitats Directive that may provide protection to humpback whales in the region include a) coordinated development of a European Red List of species threatened at the European level (parallel with the IUCN listings), and b) guidance documents on the protection of species listed under the Directive, and on the development of a network of conservation areas in the offshore marine environment and c) species assessment reports. While not regulatory in nature, these actions are designed to reduce threats and provide a conservation benefit to the Atlantic humpback whales.

Numerous additional international or regional treaties, conventions and agreements offer some degree of protection for humpback whales and their habitat (reviewed by Hoyt 2011).

Commission for the Conservation of Antarctic Marine Living Resources

This commission was established in 1982 with 25 member countries. Its objective is the conservation of Antarctic marine life, particularly krill and the Antarctic marine ecosystems that depend on krill. The commission manages fisheries for Antarctic krill and several finfish species with the goal of ensuring long-term sustainability and existing ecological relationships.

B.4.2 Domestic Regulatory Mechanisms

Marine Mammal Protection Act of 1972, as amended (MMPA)
In U.S. waters, humpback whales are protected by the MMPA (16 U.S.C. 1361 *et seq*.). The MMPA was enacted in response to growing concerns among scientists and the general public that certain species and populations of marine mammals were in danger of extinction or depletion as a result of human activities. The MMPA set forth a national policy to prevent marine mammal species or population stocks from diminishing to the point where they are no longer a significant functioning element of the ecosystems. The lead federal agencies for implementing the MMPA are FWS and NMFS.

The MMPA places an emphasis on habitat and ecosystem protection. The habitat and ecosystem goals set forth in the MMPA include: (1) management of marine mammals to ensure they do not cease to be a significant element of the ecosystem to which they are a part; (2) protection of essential habitats, including rookeries, mating grounds, and areas of similar significance "from the adverse effects of man's action"; (3) recognition that marine mammals "affect the balance of marine ecosystems in a manner that is important to other animals and animal products" and that marine mammals and their habitats should therefore be protected and conserved; and (4) directing that the primary objective of marine mammal management is to maintain "the health and stability of the marine ecosystem." Congressional intent to protect marine mammal habitat is also reflected in the definitions section of the MMPA. The terms "conservation" and "management" of marine mammals are specifically defined to include habitat acquisition and improvement.

The MMPA includes a general moratorium on the taking and importing of marine mammals, which is subject to a number of exceptions. Some of these exceptions include take for scientific purposes, public display, subsistence use by Alaska Natives, and unintentional incidental take coincident with conducting lawful activities. Take is defined in the MMPA to include the "harassment" of marine mammals. "Harassment" includes any act of pursuit, torment, or annoyance which "has the potential to injure a marine mammal or marine mammal stock in the wild" (Level A harassment), or "has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering" (Level B harassment).

The Secretaries of Commerce and of the Interior have primary responsibility for implementing the MMPA. The Department of Commerce, through the NMFS, has authority with respect to whales, porpoises, seals, and sea lions. The remaining marine mammals, including polar bears, walruses, and sea otters, are managed by the Department of the Interior through the FWS. Both agencies are responsible for the promulgation of regulations, the issuance of permits, the conduct of scientific research, and enforcement as necessary to carry out the purposes of the MMPA.

U.S. citizens who engage in a specified activity other than commercial fishing (which is specifically and separately addressed under the MMPA) within a specified geographical region may petition the Secretaries to authorize the incidental, but not intentional, taking of small numbers of marine mammals within that region for a period of not more than five consecutive years (16 U.S.C. 1371(a)(5)(A)). The Secretary "shall allow" the incidental taking if the Secretary finds that ``the total of such taking during each five-year (or less) period concerned will have a negligible impact on such species or stock and will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses." If the Secretary makes the required findings, the Secretary also prescribes regulations that specify: (1) permissible methods of taking, (2) means of effecting the least practicable adverse impact on the species, their habitat, and their availability for subsistence uses, and (3) requirements for monitoring and reporting. The regulatory process does not authorize the activities themselves, but authorizes the incidental take of the marine mammals in conjunction with otherwise legal activities described within the regulations.

Similar to promulgation of incidental take regulations, the MMPA also established an expedited process by which U.S. citizens can apply for an authorization to incidentally take small numbers of marine mammals where the take will be limited to harassment (16 U.S.C. 1371(a)(5)(D)). These authorizations are limited to one-year and as with incidental take regulations the Secretary must find that the total of such taking during the period will have a negligible impact on such species or stock and will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses. NMFS refers to these authorizations as Incidental Harassment Authorizations.

Certain exceptions from the prohibitions on taking are provided. The MMPA exempts coastal-dwelling Alaska Natives from the prohibitions on the taking of marine mammals for subsistence purposes. Sections 101(b)(3) and 103 of the MMPA provide for subsistence harvest regulations for marine mammal stocks designated as depleted under that Act, after notice and administrative hearings as prescribed by the MMPA. Section 119 of the MMPA allows the Secretary of Commerce to enter into cooperative agreements with Alaska Native organizations to conserve marine mammals and provide co-management of subsistence uses.

Under the MMPA, NMFS also evaluates and provides permits for the "taking" of large whale species for those engaged in scientific research focused on those species.

Under the authority of the ESA and the MMPA, NMFS issued a final rule (66 FR 29502, May 31, 2001) effective in 2001 in waters within 200 nautical miles of Alaska making it unlawful for a person subject to the jurisdiction of the United States to a) approach within 100 yards of a humpback whale, b) cause a vessel or other object to approach within 100 yards of a humpback whale or c) disrupt the normal behavior or prior activity of a whale. Exceptions to this rule include approaches permitted by NMFS; vessels which otherwise would be restricted in their ability to maneuver; commercial fishing vessels legally engaged in fishery activities; state, local and Federal government vessels operating in official duty; and the rights of Alaska Natives. Additional regulations such as the NMFS right whale regulations in the U.S. North Atlantic and other regional or local maritime speed zones help reduce the threat of vessel collisions involving humpback whales. The ship collision reduction rule established regulations to limiting vessel speeds to no more than 10 knots applicable to all vessels 65 feet (19.8m) or greater in length in certain locations and at certain times of the year along the east coast of the U.S. Atlantic seaboard (73 FR 60173). NMFS has the authority under the MMPA and the ESA to promulgate further regulations to address the threat of vessel collisions with endangered large whale species.

Endangered Species Act (ESA)
The ESA (16 U.S.C. 1531 et seq.) provides a program for the conservation of imperiled species and the ecosystems upon which they depend. The lead federal agencies for implementing the

ESA are the FWS and the NMFS. Under the ESA, species may be listed as either endangered or threatened. "Endangered" means a species is in danger of extinction throughout all or a significant portion of its range. "Threatened" means a species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. For the purposes of the ESA, species are defined to include subspecies, varieties, and for vertebrates, distinct population segments. The ESA requires federal agencies to conduct their activities in such a way as to conserve listed species. Section 7 of the ESA also requires federal agencies, in consultation with the FWS and/or NMFS, to ensure that activities they authorize, fund or carry out are not likely to jeopardize the continued existence of any listed species (or species proposed for listing) or result in the destruction or adverse modification of designated or proposed critical habitat of such species. NMFS has conducted scores of Section 7 consultations with the United States Coast Guard (USCG), the Army Corps of Engineers, the Bureau of Ocean Energy Management and other agencies to ensure actions by these agencies do not adversely affect listed large whale species, including humpback whales. The ESA forbids the import, export, or interstate or foreign sale of species listed as endangered without a special permit. It also makes "take" of species listed as endangered illegal—forbidding the killing, harming, harassing, pursuing, or removing the species from the wild. Any or all of these protections may be provided to a species listed as threatened through regulations issued under ESA section 4(d).

Outer Continental Shelf Lands Act (OCSLA)
The Outer Continental Shelf Lands Act (OCSLA) established federal jurisdiction over submerged lands on the outer continental shelf (OCS) seaward of the state boundaries (3-mile limit) in order to expedite exploration and development of oil and gas resources on the OCS. Implementation of OCSLA is delegated to the Minerals Management Service (now known as the Bureau of Ocean Energy Management, Regulation and Enforcement) of the Department of the Interior. OCSLA mandates that orderly development of OCS energy resources be balanced with protection of human, marine and coastal environments. Through consistency determinations, the OCSLA helps to ensure that OCS projects do not adversely impact humpback whales or humpback whale habitat.

Pelly Amendment to the Fisherman's Protection Act
Section 8 of the Fishermen's Protective Act, also known as the Pelly Amendment, was added to this 1954 statute by P.L. 92-219 (85 Stat. 786) in December 1971. The section originally required the Secretary of Commerce to report to the President when he or she determines that nationals of a foreign country are diminishing the effectiveness of an international fishery conservation program. The President is then authorized to direct the Secretary of the Treasury to prohibit the importation of fish products from the offending nation for such duration as he or she determines appropriate and to the extent that such prohibition is consistent with the General Agreements on Trade and Tariffs.

The Pelly Amendment was expanded by P.L. 95-376 (92 Stat. 714), September 18, 1978, to authorize the President to embargo wildlife products (including all fish not previously covered) whenever the Secretary of Commerce or the Secretary of the Interior certifies that nationals of a foreign country are engaging in trade or taking that diminishes the effectiveness of an international program in force with respect to the United States for the conservation of endangered or threatened species.

The Secretary of Commerce and Secretary of the Interior began certifying nations in 1974 for whaling violations (Japan and USSR). Norway was certified in 1987 and several times thereafter. Japan has been certified three times, the last being in 2000, and Iceland has been certified several times, including 2011 for whaling activities. Economic sanctions on marine products have not been imposed by the U.S. against these nations.

Coast Guard Activities

On February 18, 2005, the USCG announced a Port Access Route Study (PARS) of Potential Vessel Routing Measures to Reduce Vessel Strikes of North Atlantic Right Whales (Department of Homeland Security USCG, 70 FR 8312). Potential vessel routing measures were analyzed and considered to adjust existing vessel routing measures in the northern region of the Atlantic Coast, which included Cape Cod Bay, the area off Race Point at the northern end of Cape Cod, and the Great South Channel. The USCG used the information from the PARS to prepare and submit a report to Congress on May 8, 2006. The USCG announced the results of the PARS on May 24, 2006 (71 FR 29876). NMFS recommended realigning and amending the location and size of the western portion of the TSS in the approach to Boston, Massachusetts. The TSS was revised in 2007 and the new configuration appeared on nautical charts soon thereafter.

On November 19, 2007, the USCG announced a second PARS to Analyze Potential Vessel Routing Measures to Reduce Vessel Strikes of North Atlantic Right Whales while also Minimizing Adverse Effects on Vessel Operations (72 FR 64968). The study area included approaches to Boston, MA, specifically, a northern right whale critical habitat in the area east and south of Cape Cod, MA, and the Great South Channel, including Georges Bank out to the exclusive economic zone boundary. In the second PARS, the USCG recommended establishing a seasonal Area to be Avoided (ATBA) and amending the southeastern portion of the TSS to make it uniform throughout its length. On behalf of the United States, the USCG submitted a series of proposals to the IMO to modify the TSS and to establish an ATBA which were subsequently endorsed by the IMO (Silber *et al.* 2012) and as described in the IMO's publication, "Ships' Routing", 2008. In 2009, the TSS was revised and the ATBA was established. This was followed by a notice in the Federal Register announcing these changes (75 FR 77529) and NOAA added the changes to applicable nautical charts. While the measures are designed specifically for the North Atlantic right whale, they are expected to benefit humpback whales co-occurring in these areas.

In 2007, a program of auto-detection buoys and real-time whale vocalization detection information was incorporated into the Boston TSS as mitigation for liquefied natural gas (LNG) ship strike risk, primarily as a result of an ESA Section 7 consultation with the Maritime Administration. This program, stipulated as a condition of the consultation, was designed to reduce the threat of vessel collisions with right whales and other listed large whale species, including humpback whales in and around the boundaries of Stellwagen Bank National Marine Sanctuary. When right whales are auto-detected in the vicinity, LNG vessels are required to travel at speeds of 10 knots or less, a measure that almost certainly reduces the likelihood of vessel strikes of humpback whales occurring in the area as well.

TSSs are in place for San Francisco Bay and the Santa Barbara Channel to ensure safety of navigation. These TSSs were amended in June 1, 2013 to lessen the possibility of fatal vessel collisions with humpback whales and other listed large whale species. Modifications include narrowing and extending the Northern and Western approaches while the inbound lane of the Santa Barbara Channel TSS has been shifted shoreward to reduce the co-occurrence of ships and whales and reduce the likelihood of a vessel/whale collision.

National Park Service Activities
The U.S. Park Service has jurisdiction of marine waters (through the Fish and Wildlife Coordination Act) in Glacier Bay National Park and Preserve (established 1980; modified 1985). The following regulations are in place to protect humpback whales occurring there in the summer: restrictions on the number of vessels entering park waters; restrictions on vessel operating conditions in the known presence of humpback whales, mandatory vessel operating requirements in certain designated "whale waters", mandatory vessel speed limits at certain times and locations; mandatory boater education for boaters entering the area, regulations restricting the harvest of humpback whale prey species and ship board observers to quantify ship strikes and interactions between cruise ships and whales.

National Marine Sanctuary Act - Marine Sanctuaries and Marine Protected Areas (MPA)
Under the National Marine Sanctuaries Act, NOAA has broad discretion to enact guidelines and regulations provide protection to a number of large whale species, including the humpback whale in key aggregation locations. Humpback whales routinely occur in Stellwagen Bank; Gulf of the Farrallones, Channel Islands, Monterey Bay, Cordell Bank, and Olympic Coast National Marine Sanctuaries. The Hawaiian Islands Humpback Whale National Marine Sanctuary was established primarily to provide protections to a key North Pacific humpback whale breeding/nursery area. The Stellwagen Bank and Gulf of the Farallones National Marine Sanctuaries, in particular, have active humpback whale research programs and/or have established vessel speed advisories, whale approach guidelines, and other measures to reduce human threats to humpback and other large whale species.

B.4.3 Regional or National Regulations other than United States

Numerous nations have defined marine protected areas and sanctuaries that provide some protection to humpback whales (Hoyt 2011), and various nations have developed local regulations or guidelines governing whale watching activities (O'Connor *et al.* 2009). Hundreds of national laws also exist related directly or indirectly to the conservation of marine mammals (Appendix B). Where appropriate, some of these are discussed in more detail in the DPS-specific sections.

B.5 Other natural or manmade factors affecting its continued existence

Competition with Fisheries
The BRT discussed the issue of competition with fisheries at length. In some areas, (*e.g.,* Northern Gulf of Maine and Southeast Alaska) fishermen encircle feeding humpback whales and harvest fish from the bait balls upon which humpback whales feed (D. Matilla, unpublished observation). However, there is no evidence that this impacts the individuals or significantly depletes the food source. In a review of the evidence for interspecific competition in baleen whales, Clapham and Brownell (1996) found it to be extremely difficult to prove that inter-specific competition comprises an important factor in the population dynamics of large whales.

The BRT discussed the high level of fishing pressure in the region occupied by the Okinawa/Philippines population (a small humpback whale population). Although specific information on prey abundance and competition between whales and fisheries is not known in this area, overlap of whales and fisheries has been indicated by the bycatch of humpback whales in set-nets in the area. The BRT determined that competition with fisheries is a medium threat for this DPS given the high level of fishing and small humpback whale population, and a low or unknown threat for all other DPSs.

Aquaculture
Aquaculture is not known to be a significant threat to humpback whales. Some entanglements have been recorded off Australia. Colombia has substantial aquaculture activity in inshore areas, but there is no information regarding the impact of this activity on humpback whales. The BRT determined that for most areas aquaculture does not pose a significant threat to humpback whales and should be assigned a low threat level. For Okinawa/Philippines, the Arabian Sea and the 2nd western North Pacific population, sufficient information was not available for the threat level to be determined.

Anthropogenic Noise
Humans introduce sound intentionally and unintentionally into the marine environment for navigation, oil and gas exploration and acquisition, research, and military activities, to name a few. Noise exposure can result in a range of impacts, from those causing little or no impact to those being potentially severe, depending on the source, level, and various other factors. Response to noise varies by many factors, including the type and characteristics of the sound source, distance between the source and the receptor, characteristics of the animal (*e.g.*, hearing sensitivity, behavioral context, age, sex, and previous experience with sound source) and time of day or season. Noise may be intermittent or continuous, steady (non-impulsive) or impulsive, and may be generated by stationary or moving sources. As one of the potential stressors to marine mammal populations, noise may seriously disrupt communication, navigational ability, and social patterns. Humpback whales use sound to communicate, navigate, locate prey, and sense their environment. Both anthropogenic and natural sounds may cause interference with these functions.

Anthropogenic sound has increased in all oceans over the last 50 years and is thought to have doubled each decade in some areas of the ocean over the last 30 or so years (Croll *et al.* 2001; Weilgart 2007). Low-frequency sound comprises a significant portion of this increase and stems from a variety of sources including that primarily from shipping, and an increasing amount from oil and gas exploration in some areas, as well as research and naval activities. Understanding the specific impacts of these sounds on mysticetes is difficult. However, it is clear that the geographic scope of potential impacts is vast as low-frequency sounds can travel great distances under water, but these sound have the potential to reduce communication space (e.g., Shipping was predicted to reduce communication space of singing humpback whales in the northeast by 8%; Clark *et al.* 2009).

Humpback whales do not appear to be often involved in strandings related to noise events. There is one record of two whales found dead with extensive damage to the temporal bones near the site of a 5,000kg explosion which likely produced shock waves that were responsible for the injuries (Ketten *et al.* 1993; Weilgart 2007). Other detrimental effects of anthropogenic noise include masking and possible temporary threshold shifts. Masking results from noise interfering with cetacean social communication, which may range greatly in intensity and frequency. Some adjustment in acoustic behavior is thought to occur in response to masking and humpback songs were found to lengthen during low-frequency active (LFA) sonar activities (Miller *et al.* 2000). This altered song length persisted two hours after the sonar activities stopped (Fristrup *et al.* 2003). Researchers have also observed diminished song vocalizations in humpback whales during remote sensing experiments 200 km away from the whales' location in the Stellwagen Banks National Marine Sanctuary (Risch *et al.* 2012). Hearing loss can also possibly be permanent if the sound is intense enough but there is great variability across individuals and other factors making it difficult to determine a standardized threshold.

Excessive noise exposure may be damaging during early individual development, may cause stress hormone fluctuations, and/or may cause whales to leave an area or change their behavior within it (Weilgart 2007). Some responses are subtle and may occur after the exposure. Humpback whales exposed to underwater explosions and drilling associated with construction activities did not appear to change their behavior in reaction to the surveys but did appear to have reduced orientation abilities. Higher rates of fatal entanglement in fishing gear were observed in the area when whales were exposed to excessive noise, although the cause for this elevated entanglement rate was unclear (Ketten *et al.* 1993; Todd 1996). Some studies have found little reaction to noise and indicate potential tolerances to anthropogenic sound over short time and small spatial scales (Croll *et al.* 2001).

There is likely an important distinction between immediate individual reactions to noise and long-term effects of noise exposure to populations. The cumulative and synergistic effects may be more harmful than studies to date have been able to assess. Though some researchers have argued that habituation to sound may occur, this can easily be confused with hearing loss or individual differences in tolerance levels (Bejder *et al.* 2006). Scientifically recommended mammal sound exposure levels have been made and vary depending on the sound source strength and the species of marine mammal(s) present (Southall *et al.* 2007). NMFS has recently updated guidance for temporary threshold shifts and permanent threshold shifts (see: http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm).

The issue of anthropogenic noise has been an area of intensive research but population-level impacts on cetaceans have not been confirmed. There is little definite information regarding, for example, the interruption of breeding and other behaviors or a resulting reduction in population growth or mortality of individuals. Therefore, the BRT considered this to be a low threat for all DPSs.

Vessel Collisions

Collisions between vessels and whales, or ship strikes, often result in life-threatening trauma or death for the cetacean. Impact is often initiated by forceful contact with the bow or propeller of the vessel. Ship strikes of humpback whales are typically identified by evidence of massive blunt trauma (fractures of heavy bones and/or hemorrhaging) in stranded whales, propeller wounds (deep slashes or cuts) and fluke/fin amputations on stranded or live whales (*e.g.* Wiley and Asmutis 1995).

Laist *et al.* (2001), Jensen and Silber (2003), Vanderlaan and Taggart (2007), and VanWaerebeek and Leaper (2008) compiled information available worldwide regarding documented collisions between ships and large whales (baleen whales and sperm whales). Humpback whales were the second-most commonly reported victims of vessel strikes (following fin whales). Of 292 recorded strikes contained in the Jensen and Silber (2003) database, 44 were of humpback whales. As of 2008, there were >143 recorded ship strikes involving humpback whales worldwide (Van Waerebeek and Leaper 2008); however the reported number is likely not a full representation of the actual number (particularly in the Southern Hemisphere) as many likely go undetected or unreported (Williams *et al.* 2011). Reporting of ship strikes is highly variable internationally, with reports required from vessels in the domestic waters of Australia, the U.S. and New Zealand but not in other countries. Measures to reduce ship strikes have been considered by the IMO Marine Environment Protection Committee and relevant IMO subcommittees (IWC 2010a).

Ship strike injuries were identified for 8% (10 of 123) of dead stranded humpback whales between 1975-1996 along the U.S. east coast, 25% (9 of 36) of which were along mid-Atlantic and southeast states (south of the Gulf of Maine) between Delaware Bay and Okracoke Island North Carolina (Wiley and Asmutis 1995). Ship strikes made up 4% of observed humpback whale mortalities between 2001-2005 (Nelson *et al.* 2007) and 7% between 2005-2009 (Henry *et al.* 2011) along the U.S. east coast, and the Canadian Maritimes. Among strandings along the mid and southeast U.S. coastline during 1975-1996, 80% (8 of 10) of struck whales were considered to be less the 3 years old based on their length (Laist *et al.* 2001). This suggests that young whales may be disproportionately affected. However, those waters are thought to be used preferentially by young animals (Swingle *et al.* 1993; Barco *et al.* 2002). It should be noted that ship strikes do not always produce external injuries and may therefore be underestimated among strandings that are not examined for internal injuries.

In 1999, NMFS and the United States Coast Guard established two Mandatory Ship Reporting systems aimed at reducing ship strikes of North Atlantic right whales. When ships greater than 300 gross tons enter two key right whale habitats--one off the northeast U.S. and one off the southeast U.S.--they are required to report to a shore-based station. In return, ships receive a message about whales, their vulnerability to ship strikes, precautionary measures the ship can take to avoid hitting a whale, and locations of recent sightings. While these systems were designed to protect right whales specifically, they are expected to also reduce the risk of ship strikes to other large whales, including humpback whales (National Marine Fisheries Service 2008).

Whale strike mitigation measures currently in place for some vessels and regions include using dedicated observers (Weinrich and Pekarik 2007), speed reduction in some important habitat areas (73 FR 60173, 10 October, 2008), and shifting of shipping lanes away from areas of whale concentration to accommodate humpback whales and other species. Passive acoustic monitoring in areas of high shipping traffic also has promise for notifying mariners of whales in the area, as this method is relatively inexpensive, although detection is limited to vocalizing whales and specific source locations can be hard to determine (Silber *et al.* 2009). Based on this information, the BRT considers the threat of vessel collisions to be low to moderate, depending on region, and generally increasing.

Fishing Gear Entanglements

Humpback whales may break through, carry away, or become entangled in fishing gear. Whales carrying gear may die at a later time, become debilitated or seriously injured, or have normal functions impaired, but with no assurance of the incident having been recorded. Of the nations reporting to the IWC between 2003-2008, 64.7% (n=11) noted humpback whale by-catch in their waters (Mattila and Rowles 2010). Whales have been documented carrying gear by fishery observer programs, opportunistic reports, and stranding networks. Some countries (*e.g.*, U.S., Canada, Australia, South Africa) have well-developed reporting and response networks that facilitate the collection of information on entanglement frequency and impacts. However, such programs do not guarantee that entanglements are detected; fewer than 10% of humpback whale entanglements involving Gulf of Maine humpback whales are reported, despite a strong outreach and response network (Robbins and Mattila 2004). Furthermore, opportunistic reports that are not screened by experts do not necessarily yield accurate information about events, including gear type, configuration and original site of entanglement (Robbins *et al.* 2007b). The likelihood of receiving reports likely varies world-wide due to differences in observer awareness, reporting mechanisms and possible negative implications for reporting fishermen (Mattila and Rowles 2010).

A study of gear removed from a subset of whales off the U.S. East Coast showed that 89% involved pots/traps or gillnet gear (Johnson *et al.* 2005). However, a wide range of gear types were represented and every part of the gear was found to be capable of entanglement (Johnson *et al.* 2005). The authors concluded that any line in the water column poses a potential risk of entanglement to humpback whales. This is further supported by the wide range of entangling gear reported in the South Pacific (Neilson 2006; Lyman 2009), Newfoundland (Lien *et al.* 1992) and member nations of the IWC (Mattila and Rowles 2010).

More than half of the humpback whale entanglements examined off the U.S. East Coast involved entanglements around the tail (Johnson *et al.* 2005). The mouth and flippers are also known attachment sites, but their frequency is more difficult to assess. Scar-based studies have been developed to systematically study the frequency of non-lethal entanglement involving the tail (Robbins and Mattila 2001; Robbins and Mattila 2004). These techniques have been used in the Gulf of Maine (e.g., Robbins and Mattila 2001; Robbins and Mattila 2004; Robbins *et al.* 2009), Southeast Alaska (Neilson *et al.* 2009) and more broadly across the North Pacific Ocean (Robbins *et al.* 2007a; Robbins 2009). All populations studied in this manner to date have detected individuals with entanglement-related injuries. Annual research in the Gulf of Maine since 1997 has shown that a high percentage of individuals exhibit entanglement injuries and that new injuries are acquired at an average annual rate of 12% (Robbins *et al.* 2009). A two-year study in Southeast Alaska confirmed frequencies of entanglement injuries that were comparable to the Gulf of Maine (Neilson *et al.* 2009). Research undertaken across the North Pacific as part of the SPLASH project further suggests that entanglement is pervasive, but that interaction rates may be highest among coastal populations (Robbins *et al.* 2007a; Robbins 2009).

Both eye-witness reports and scar-based studies suggest that independent juveniles are significantly more likely to become entangled than adults (Robbins 2009). Calves exhibit a lower frequency of entanglement, likely due to having less time in which to have encountered gear (Neilson *et al.* 2009). Sex differences in entanglement frequency have been observed in some locations and time intervals (Robbins and Mattila 2001; Neilson *et al.* 2009), but these effects have not persisted in longer studies (Robbins and Mattila 2004).

Entanglement may result in only minor injury, or potentially may significantly affect individual health, reproduction or survival. In one study, females with entanglement injuries produced fewer calves than females with no evidence of entanglement; such impacts on reproduction are still under investigation (Robbins and Mattila 2001). Mark-recapture studies of the fate of entangled whales in the Gulf of Maine suggest that juveniles are less likely than adults to survive (Robbins *et al.* 2008). Observed entanglement deaths and serious injuries in that region are known to exceed what is considered sustainable for the population (Glass *et al.* 2009). Most deaths likely go unobserved and preliminary studies suggest that entanglement may be responsible for 3-4% of total mortality, especially among juveniles (Robbins *et al.* 2009).

Much more is known about fishing gear entanglement in the Northern Hemisphere than in the Southern Hemisphere. The BRT noted the commercialization of bycatch off Japan, meaning an entangled whale is legally allowed to be killed and sold on the market (Lukoschek *et al.* 2009). Therefore, entanglement often leads to death for humpback whales in this region. While the number of reported bycaught animals is not large (3-5), the number of reports has been increasing and reports may not reflect the actual number caught. The BRT also noted that the Mexico population has one of highest scar rates from nets and lines in the North Pacific, indicating a high entanglement rate. Based on this information, the BRT concluded that the severity of the threat of fishing gear entanglements varies depending on region, ranging from low to high.

Climate Change

Climate change has received considerable attention in recent years, with growing concerns about global warming and the recognition of natural climatic oscillations on varying time scales, such as long-term shifts like the Pacific Decadal Oscillation or short-term shifts, like El Niño or La Niña. Evidence suggests that the biological productivity in the North Pacific (Lowry *et al.* 1988; Quinn and Niebauer 1995) and other oceans could be affected by changes in the environment. Recent work has found that copepod distribution has shown signs of shifting in the North Atlantic due to climate change (Hays *et al.* 2005). Increases in global temperatures are expected to have profound impacts on arctic and sub-arctic ecosystems, and these impacts are projected to accelerate during this century (ACIA 2004; IPCC 2007).

The IWC has held two workshops on the topic of climate change and cetaceans (IWC 1997; IWC 2010a) and the reports of these meetings provide useful summaries on the current state of knowledge on this issue, and on the large uncertainties associated with any projections of impact.

It is generally accepted that cetaceans are unlikely to suffer problems because of changes in water temperature *per se* (IWC 1997). Rather, global warming is more likely to effect changes in habitats that in turn potentially affect the abundance and distribution of prey in these areas. Factors such as ocean currents and water temperature may render currently used habitat areas unsuitable and influence selection of migration, feeding, and breeding locations for humpback and other whales. Changes in climate and oceanographic processes may also lead to decreased productivity of, or lead to different patterns in, prey distribution and availability. Such changes could affect whales that are dependent on this prey. While these regional or ocean basin-scale changes may occur, the actual magnitude and resulting impacts are not known.

All cetaceans have undoubtedly lived through considerable variation in climate (including multiple ice ages, and significant warming events) over the course of their evolutionary history. However, there is little knowledge regarding the ways in which cetaceans dealt with climate change in the past. Examination of bones related to Basque whaling in Canada indicate that the range of bowhead whales (*Balaena mysticetus*) in the North Atlantic shifted south during the so-called Little Ice Age in medieval times (McLeod *et al.* 2008). This almost certainly reflected a shift in the distribution of prey because of habitat and associated productivity changes, and it likely reflects the ability of large whales to adapt and extend their range when necessary.

There are no data on similar historical shifts by humpback whales. Considerable plasticity in the winter distribution of the species is suggested by the fact that the use of Hawai'i as a major breeding ground appears to be a relatively recent phenomenon which occurred sometime in the 20th century (Herman 1979); the reason for such a shift is not known, but it is important to recognize that the humpback's winter distribution is not tied to prey resources or biological productivity, a situation which presumably affords the species with flexibility in its colonization of breeding habitats.

Climate change may disproportionately affect species with specialized or restricted habitat requirements. The best-known example of this involves dependence upon sea ice, which is thought to represent a major problem for polar bears (*Ursus maritimus*), given that the species primarily hunts pagophilic ringed seals (*Phoca hispida*) (Schliebe *et al.* 2006). This represents a relatively simple and clear-cut example of cause and effect in the climate change debate; unfortunately, the situation for humpback whales and other cetaceans is not nearly as simple, given the complexity of the ecosystems in which they live. Climate change may exacerbate situations in which populations are already small and/or significantly affected by other anthropogenic impacts (such as entanglement or ship strikes). Species which possess little ability to disperse or colonize new habitats will also be particularly vulnerable.

None of these factors apply to humpback whales, with the possible exception of the Arabian Sea population, which is thought to be small and vulnerable to entanglement, shipping-related issues and possibly pollution. Furthermore, the uniquely restricted range of this non-migratory population is currently tied to seasonal monsoon-driven biological productivity in a relatively small region; the impact of climate change on this productivity is unknown, as is the ability of these humpback whales to shift their range as may be needed.

As noted by IPCC (2007), species in general potentially respond in one of three ways to major changes in climate: redistribution, adaptation, or extinction. Based upon what is known to date, redistribution is the most likely response for most humpback whales. Most large whales, including humpbacks, undertake extensive movements, both during a feeding season and on migration. These broad ranges (which routinely encompass much of an ocean basin), together with the animals' ability to withstand prolonged periods of fasting through utilization of fat reserves in their blubber, potentially provide the whales with a means to adapt their ranges in response to major climate-related spatial shifts in biological productivity, notably by seeking out new habitats. This may in fact already be occurring in some places; humpback whales have recently been observed in the eastern Chukchi and Beaufort Seas (Clarke *et al.* 2014 in review), north of their usual range; this could represent the beginnings of a response to habitat changes relating to diminishing sea ice in the Arctic, although it might also simply reflect a growing population expanding its range. Prior to extensive whaling, humpback whales appear to have been quite common in at least the western (Russian) Chukchi Sea (Zenkovich 1954; Tomilin 1967), and are still observed there today (Clarke *et al.* 2014 in review).

The BRT determined that the level of the threat of climate change facing the Southern Hemisphere populations was slightly better understood than the Northern Hemisphere populations. Warming waters are thought to be correlated with a decrease in krill production in the Southern Ocean, and this threat is likely to increase. The future negative impact implied by a low threat assignment is dependent on a *substantial* decrease in krill populations, a subsequent negative impact on prey resource availability to humpback whales, and lack of suitable alternate prey such as fish.

The Southern Ocean is regarded as a relatively simple ecosystem, but even here there are substantial problems in quantifying even the most basic parameters such as prey abundance. Changes in this ecosystem are also driven by cyclic variability on the scale of years to decades (Murphy *et al.* 2007). Disentangling climate change effects from other forms of variability including periodic physical forcing, requires time series of data that are typically scarce or non-existent in the Southern Ocean (Quetin *et al.* 2007). The responses of the Southern Ocean ecosystem to climate change are likely to be complex. Sea ice decreases may actually enhance overall primary production but could reduce ice algae production which occurs at a critical time for krill larvae (Arrigo and Thomas 2004). On the other hand, the location of upwelling of nutrient-rich deep water may change and result in enhanced primary production in areas that are otherwise unfavorable to krill (Prezelin *et al.* 2000).

The problems in assessing the relatively "simple" Southern Ocean illustrate the huge problems involved in predicting future changes in dynamic ecosystems, on scales that range from eddies and fronts to entire ocean basins. Ecosystem models are crude at best. Full ecosystem models involve innumerable parameters, yet data to quantify these - let alone interactions among them - frequently do not exist.

The second IWC climate change workshop (IWC 2010c) noted that data sets for use in assessing impact and modeling the effects of climate change must have: extensive duration (20-30 years or more of information); good temporal resolution to capture variability on inter-annual and longer scales; and sufficient spatial scale. Although long-term studies of humpback whales exist in various locations in both hemispheres, these are often compromised by issues such as sampling bias, data gaps and inconsistency of methods; furthermore, parallel data of sufficient resolution on environmental variables are often unavailable. The caveat above regarding the difficulty of disentangling climate change effects from other variables applies equally to determining the reasons for any observed changes in demographic parameters of humpback whales.

It is instructive and rather sobering to compare the conclusions of the two IWC climate change workshops, separated as they were by more than a decade. The report of the 1996 workshop (IWC 1997) notes that: "...given the uncertainties in modeling climate change at a suitable scale and thus modeling effects on biological processes... at present it is not possible to model in a predictive manner the effects of climate change on cetacean populations." Thirteen years later, the second workshop came to much the same conclusion (IWC 2010c), finding that: "...improvements in climate models, as well as models that relate environmental indices to whale demographics and distribution, had occurred. However, all models remain subject to considerable uncertainty."

The BRT assigned climate change a low threat level to all Southern Hemisphere populations based on current impacts to the populations. The threat posed by climate change to Northern Hemisphere humpback whale populations is very uncertain, but the BRT thought it unlikely that climate change was a major extinction risk factor. Melting and receding ice sheets may open more feeding habitat for humpback whales in the Northern Hemisphere. However, humpback whales in the Northern Hemisphere do not feed primarily in Arctic waters (which are likely to be the most significantly altered by climate change).

Overall, it is clear that humpback whales worldwide have exhibited considerable resilience despite a whaling history that removed the great majority of animals from most populations. This resilience, together with the species' flexibility in diet and apparent plasticity in its distribution, provides some optimism that humpbacks can adapt to significant environmental changes wrought by global warming. Although we cannot predict how climate change may affect humpback whales in the long term, at present most studied populations appear to be recovering well and it seems very unlikely that any population faces extinction as a result of climate issues. The primary question is not whether climate change could ever cause extinction, but rather whether climate change could drive a humpback whale DPS to extinction within some finite time frame (or could move a DPS from threatened to endangered in the foreseeable future). In this regard, it is essential to maintain and improve long-term research programs so that humpback whale populations can be monitored for changes that may occur as a result of future environmental changes.

C. Overview of Assessment of Extinction Risk

The BRT discussed at length the type of information relevant to extinction risk that is available for the 15 different humpback whale DPSs. This potentially includes information such as population size, population trends, age structure, diversity, recent fecundity, and survivorship, as well as external risk factors such as habitat degradation or potential catastrophic events. It is also possible to evaluate extinction risk through modeling scenarios of the future fate of a population; this is termed a Population Viability Analysis (PVA). The BRT discussed how extinction risk would be evaluated for each humpback whale population and how to define extinction risk. The BRT also evaluated whether PVAs would be a useful tool in the extinction risk evaluation of humpback whale populations.

C.1 Relationship between population size and trend and extinction risk

Populations that are declining or of small size are thought to be at greater risk of extinction (Gilpin and Soulé 1986). Small population size can be used as a measure of extinction risk because theoretical models show that small populations can have relatively high extinction risks solely from internal processes (Mace *et al.* 2008). Many different levels of low population size have been used as indicators of extinction risk in the literature, though no single number can serve as the standard for all cases and all factors. Mace *et al.* (2008) provide a concise summary of the relationship between population size and trends with extinction risk. From basic theory it is possible to draw broad generalizations about the relationships among population size, population growth rates, fluctuations in population growth rates, and extinction times (Lande 1993; Lande 1998). Populations that are seriously declining are always at risk of extinction, with population size having little effect on extinction risk. There is a steep ramping down of critical population sizes that reflects what is known from theoretical studies about the general relationships between population size and time to extinction under various kinds of environmental and demographic stochasticity (Lande 1993; Lande 1998), with smaller population sizes associated with shorter mean times to extinction, and vice versa.

Demographic stochasticity is the process whereby random variation in births and deaths among individuals alone can lead to population fluctuation and possible extinction (Goodman 1987; Lande 1993). There is little debate about the existence of demographic stochasticity and the extinction risk it causes. From theoretical models, populations of fewer than 100 individuals are at high risk of extinction from demographic stochasticity (Mace *et al.* 2008), whereas populations above 100 have decreasing levels of risk. Empirical data confirm that this is the case, as populations less than 100 have been documented to have a high risk of extinction. For example, Legendre *et al.* (Legendre *et al.* 1999) found that for introduced populations in New Zealand, extinction probability was very high for populations less than 100, and declined to relatively lower levels for populations greater than ~250; they attributed the primary cause of extinction to demographic stochasticity. Similarly, Berger (1990) found that populations of bighorn sheep greater than 100 persisted much longer than populations that were much less than 100.

Genetic effects can occur in smaller populations and can also contribute to extinction risk. Geneticists speak of the *effective population size*, which is the size of an ideal population of breeding organisms that would experience the effects of drift or inbreeding to the same degree as the population being studied (ideal refers to a hypothetical population in the Hardy Weinberg sense with a constant population size, equal sex ratio, and no immigration, emigration, mutation, or selection). A general guideline is that a minimum effective population size of at least 50 sexually mature individuals is required to prevent short-term ill effects of inbreeding, and an effective population size of 500 is needed to prevent the accumulation of deleterious recessive alleles and safeguard genetic variability over hundreds of years (Gilpin and Soulé 1986). Franklin (1980) and Soulé (1980) both also proposed 50 and 500 as threshold effective population levels (Wilcox 1986), where an effective population size of 50 protects from inbreeding and 500 maintains overall genetic variability for the long-term. Because effective population size is often about 1/5 to 1/3 of a population's actual size (Frankham 1995), total population sizes need to be considerably higher in order for the effective size to meet these guidelines. Assuming the lower value (1/5), this results in a 5 times multiplier to convert from effective population size to total population size. Therefore, effective population sizes of 50 and 500 convert to total population sizes of 250 and 2500, respectively. These total population levels have been proposed for use in conservation applications. For example, Allendorf *et al.* (1987) proposed (for declining populations) to use a threshold of 250 for total population size to categorize a population as having a *very high* risk of extinction, and a threshold for total population size of 2,500 for a *high* risk of extinction (corresponding explicitly to effective population sizes of 50 and 500, respectively).

Some authors have suggested that even larger effective population sizes on the order of 5,000 are needed to preserve quantitative trait variation over thousands of years (Lynch and Blanchard 1998; Lynch and Lande 1998; Frankham 1999). On the other hand, the guidelines are intended to apply to isolated populations, and even low levels of gene flow from other populations will greatly reduce the loss of genetic diversity due to small local effective size (e.g., Tajima 1990).

Small populations are also at risk of extinction from random environmental variation or catastrophes, and the risk becomes more significant as the variation becomes large in relation to the population growth rate (Goodman 1987). When environmental variance is incorporated into extinction risk models it has been found that expected persistence time, in contrast to models having only demographic variance, does not increase rapidly with larger population sizes (Goodman 1987). In general, population levels need to be higher (relative to levels considered safe from extinction risk from demographic stochasticity) to have a relatively low risk of extinction. The magnitude and frequency of environmental variance and catastrophes affecting a population can be hard to estimate, making prediction of future conditions less certain. Therefore, determining a population level that is safe from extinction risk from environmental variance is difficult. However, it is clear that to minimize extinction risk from environmental variance, population levels more on the order of the thresholds suggested for protection from genetic affects (250 and 2500) are necessary, rather than a level (e.g., 100) that protects only from demographic stochasticity. Some guidance can be found in a meta-analysis of trend data from 529 vertebrate species, where population models incorporating environmental variance were fit to the data extrapolated into the future (Brook *et al.* 2006). They found that the initial population size that provided relatively high persistence for 100 years had a median value of ~2,600 across all species.

In summary, it is generally recognized that small population size can be a useful proxy for extinction risk, particularly in concert with information about trends in abundance. As noted above, a variety of specific abundance level thresholds have been suggested in the literature as reference points for relative levels of extinction risk (Gilpin and Soulé 1986; Mace *et al.* 2008) (Allendorf *et al.* 1987). It is possible to identify multiple population thresholds, where higher thresholds correspond to greater mean times to extinction, and lower overall risk of extinction (Allendorf *et al.* 1987; Mace *et al.* 2008). As mentioned above, Allendorf *et al.* (1987) proposed thresholds of 250 for a *very high* risk of extinction and 2500 for a *high* risk of extinction. Similarly, Mace *et al.* (2008) proposed threshold levels of 50 mature individuals for an *extremely high* risk of extinction, 250 mature individuals for a *very high* risk of extinction, and 1000 mature individuals for a *high* risk of extinction. For whale populations approximately half of the population is mature, so the corresponding thresholds for total population size are approximately 100, 500, and 2000, respectively.

Various population thresholds suggested above have been proposed for use in species categorization or ranking schemes (e.g., Allendorf *et al.* 1987; Mace and Lande 1991; Mace *et al.* 2008), where population size is one of a number of possible metrics used to evaluate extinction risk. In particular, the system proposed by Mace and Lande (1991) has been used in a global evaluation of species extinction risk, and those standards, later modified by Mace *et al.* (2008) have become established in the scientific literature for over two decades. Keith *et al.* (2004), for example, used a retrospective analysis of data from eighteen pairs of species (one extinct and one extant) to test risk-ranking protocols, including the Mace *et al.* (2008) criteria. They found that those criteria were useful in forecasting actual extinction risk. Mace *et al.* (2008) note their proposed system and the criteria have been widely used by conservation practitioners and scientists. Those criteria are now one indicator being used to assess the biodiversity target established by the Convention on Biological Diversity 2010. Additionally, in a survey of 180 countries that are signatory to the Convention on Biological Diversity, Miller *et al.* (2007) found that of the countries that have or will develop a national threatened species list, 82% incorporated the Mace *et al.* (2008) criteria into national conservation strategies. The utility of the categorization scheme has also been evident in the use of the results of the scheme in further analyses, such as the worldwide review of drivers and hotspots of marine mammal extinction risk by Davidson *et al.* (2012).

Following the discussion above, although slightly different numbers have been used in different cases, it emerges that there is fairly widespread agreement on the utility of using threshold population levels such as these as indicators of relative extinction risk:

1. Total population size of > 100 – provides protection from extinction risk from demographic stochasticity;

2. Total population size of > 500 – provides protection from genetic risks of inbreeding and from moderate environmental variance;

3. Total population size > ~2,000-2,500 – provides maintenance of genetic diversity for long-term persistence and protection from substantial environmental variance and catastrophes.

Therefore, as part of the evaluation of extinction risk, the Humpback Whale BRT summarized information about population size for each DPS, as well as what is known about trends in abundance. The BRT agreed to categorize the abundance of each DPS relative to these thresholds, in decreasing order of the risk of extinction:

1. Total population size < 100;

2. Total population size < 500;

3. Total population size < 2,000;

4. Total population size > 2,000.

These categories are designed to concisely summarize one metric – the relative extinction risk of each DPS due to small population size alone. Where uncertainty in population size spans a range across a threshold, the DPS was identified as falling into a range of relative extinction risk, not just a single category. Various authors have equated these population thresholds to verbal descriptions of relative risk such as extremely high, very high, and high etc., recognizing that these risks actually exist upon a continuum (Allendorf *et al.* 1987; Mace *et al.* 2008). The BRT considered that a DPS with a total population size >2,000 was not likely to be at risk due to low abundance alone. The BRT considered any DPS with a population size <2,000 to be at increasing risk from factors associated with low abundance, and the lower the population size the greater the risk. Populations with an abundance <500 were considered by the BRT to be at high risk due low abundance, and populations <100 were considered to be extremely high risk due to low abundance. Some BRT members expressed concern about using a single threshold number as a quantitative decision, expressing the concern that appropriate numbers can be difficult to choose and decisions may be somewhat arbitrary. In light of this and the absence of strong quantitative data for some populations, the BRT decided to carefully consider the abundance of each DPS but would not use an abundance threshold as the sole criterion for evaluating extinction risk.

C.2 Applicability of Population Viability Analysis

PVA models are used to integrate various risks a population faces into an estimate of the probability the population will go extinct. PVAs sometimes involve fairly complex models, with many parameters that need to be specified, or sometimes they can be a fairly simple extrapolation of a trend. Population models used may include demographic and environmental variability, as well as factors such as Allee effects. Often an age-structured model is used and a variety of other factors are included, such as density dependence and catastrophes (large mortality events). Several papers have summarized best practices in the use of PVAs (Beissinger and Westphal 1998; White 2000). A workshop conducted by the U.S. Marine Mammal Commission concluded PVA was the preferred method for evaluating extinction risk in marine mammal populations, if sufficient information is available (Marine Mammal Commission 2008). PVAs have been used in some other recent status reviews of marine mammals (e.g., Krahn *et al.* 2004a; Oleson *et al.* 2010), but not in others (e.g., Boveng *et al.* 2009; Boveng *et al.* 2013).

After some discussion, the BRT concluded that developing and applying PVAs to the humpback whale DPSs would not provide much additional information beyond evaluation of abundance and trend data. The main reason for this is that those DPSs with sufficient abundance and trend information to conduct a quantitative PVA all have high abundance and positive trends such that a PVA is not necessary to evaluate extinction risk, and those DPSs that appear to be at lower abundance and higher risk do not have sufficient data to conduct a useful PVA.

C.3 Evaluation of Extinction Risk

The BRT evaluated extinction risk using the best available quantitative and qualitative information. In particular, the BRT carefully examined available information on abundance, trends in abundance, spatial distribution, genetic diversity, and threats for each DPS.

The BRT used the following definitions for overall extinction risk:

> High Risk: a species or DPS has productivity, spatial structure, genetic diversity, and/or a level of abundance that place(s) its persistence in question. The demographics of a species/DPS at such a high level of risk may be highly uncertain and strongly influenced by stochastic and/or small population effects. Similarly, a species/DPS may be at high risk of extinction if it faces clear and present threats (*e.g.*, imminent destruction, modification, or curtailment of its habitat; or disease epidemic) that are likely to create an imminent risk of extinction.

Moderate Risk: a species or DPS is at moderate risk of extinction if it exhibits characteristics indicating that it is likely to be at a high risk of extinction in the future. A species/DPS may be at moderate risk of extinction due to projected threats and/or declining trends in abundance, productivity, spatial structure or diversity.

Not at Risk: a species or DPS is not at risk of extinction.

The BRT discussed an appropriate time period over which to evaluate extinction risk. This is an important consideration, because over a sufficiently long time horizon all species will eventually go extinct. The risk of extinction within a specified time period can also be made to be arbitrarily small simply by choosing a very short time period over which to evaluate extinction risk. After some discussion, the BRT decided to evaluate extinction risk over a time frame of approximately 60 years, which corresponds to about three humpback whale generations. The BRT concluded it could be reasonably confident in evaluating extinction risk over this time period because current trends in both the biological status of the species and the threats it faces are reasonably foreseeable over this period of time.

The BRT used the structured decision making process described in the introduction to assess uncertainty among extinction risk categories. After evaluating and discussing all of the available information, each BRT member allocated 100 points into the three risk categories based on that BRT member's confidence that the extinction risk of the DPS was described by each category. For example, if a BRT member were entirely confident a DPS was at high risk of extinction, he or she would place all 100 points into the high risk category. Alternatively, distributing points between two or even all three risk categories would reflect uncertainty in whether a given category reflects the true status.

C.4 Assessment of a significant portion of its range

The ESA defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range…" and threatened species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." However, the ESA does not define the terms 'significant portion of its range' or 'foreseeable future.' The Services issued a ''Final Policy on Interpretation of the Phrase 'Significant Portion of Its Range' in the ESA's Definitions of 'Endangered Species' and 'Threatened Species'' (79 FR 37577; July 1, 2014). While the policy was in draft form, the Services were to consider the interpretations and principles contained in the Draft Policy as non-binding guidance in making individual listing determinations, while taking into account the unique circumstances of the species under consideration. The Draft Policy provided that: (1) If a species (the ESA definition of which includes DPSs) is found to be endangered or threatened in a significant portion of its range, the entire species is listed as endangered or threatened, respectively, and the ESA protections apply across the species' entire range; (2) a portion of the range of a species is ''significant'' if the portion's contribution to the viability of the species is so important that, without that portion, the species would be in danger of extinction[5]; (3) the range of a species is considered to be the general geographical area within

[5] The draft final policy adds to this statement, "or likely to become endangered in the foreseeable future", i.e., threatened, but the policy has not been finalized.

which that species can be found at the time FWS or NMFS makes any particular status determination; and (4) if the species is not endangered or threatened throughout all of its range, but it is endangered or threatened within a significant portion of its range, and the population in that significant portion of its range is a valid DPS, we will list the DPS rather than the entire taxonomic species (or subspecies).

The BRT reviewed the information on threats and extinction risk to portions of the range for each DPS. The BRT evaluated whether any portion of the range for each DPS, at present, has a substantially higher risk than any other part of the DPS and if these are significant. For most DPSs, the BRT concluded that 1) most threats were relevant to the entire DPS, and 2) the BRT could not identify specific portions of the range of a DPS that were significant per the draft policy. The "significant portion of its range" analyses under the final policy would not have resulted in different conclusions from the analyses conducted under the draft policy.

C.5 Humpback whale recovery plan

NMFS released a final recovery plan for the humpback whale in 1991 (NMFS 1991). The plan provides several types of recovery goals, focusing in particular on populations in the North Atlantic and North Pacific. The plan proposed that recovery would be biologically successful when humpback whales occupy all of their former range in sufficient abundance to buffer against normal environmental variation or anthropogenic catastrophes such as oil spills. The plan recommended that populations grow to at least 60% of their historical (pre-hunting) abundance to be considered recovered, but did not identify specific numerical targets due to uncertainty surrounding historical abundance levels. As an interim goal, the plan suggested a doubling of population sizes within 20 years, which corresponds to an annual exponential growth rate approximately 3.5%. In the sections on each DPS below we note where information is available to assess this criterion. Most DPSs where trend data are available have an estimated population growth rate of > 3.5%, although the period of measurement doesn't always correspond to precisely 20 years.

In its risk assessment, the BRT considered the threats and biological risk factors discussed in the recovery plan. For example, the abundance thresholds considered by the BRT are based on the levels necessary to buffer populations against stochastic variation, and the BRT considered and made use of statistical information on abundance and trends as recommended by the plan. The BRT also evaluated the threats identified in the recovery plan based on information obtained and updated in the intervening 20 years. Two decades after the recovery plan was finalized, the historical size of humpback whales populations continues to be uncertain (see e.g. Ruegg *et al.* 2013 and references therein). The BRT therefore focused its biological risk analysis primarily on recent abundance trends and whether absolute abundance was sufficient for biological viability.

The BRT considered the information in the recovery plan, but also updated this information in some important ways. Most notably, although the recovery plan discussed stock structure and discussed goals for specific major breeding populations in the North Atlantic and North Pacific, it did not identify DPSs, noting that further evaluation of the stock structure would require more detailed genetic analysis than was available at the time. In addition, the recovery plan focused exclusively on the North Atlantic and North Pacific populations, whereas the BRT was charged with evaluating status worldwide.

D. Threats and Extinction Risk Analysis Results, by DPS

Abundance and trend information available for each DPS is summarized in (Table 7 and Table 8), along with information on the severity of each threat (Table 9). Details on the abundance, trends and risk factors for each DPS are described below.

D.1 West Indies

D.1.1 Abundance

As discussed above, this DPS consists of the humpback whales whose breeding range includes the West Indies and whose feeding range primarily includes the Gulf of Maine, eastern Canada, and western Greenland. While many West Indies whales also use feeding grounds in the central (Iceland) and eastern (Norway) North Atlantic, many whales from these feeding areas appear to winter in another location. The breeding range of this DPS within the West Indies is the entire Antillean arc, from Cuba to the Gulf of Paria, Venezuela. However, within this range local densities vary widely. By far the largest concentrations occur in the Atlantic waters of the Dominican Republic, notably the offshore platform reef systems of Silver and Navidad Banks; local abundance elsewhere in the West Indies is one or two orders of magnitude lower (Clapham and Mead 1999).

An abundance estimate for the entire North Atlantic was calculated from photo identification data from all feeding areas collected during the YONAH project from 1992 to 1993, using a Chapman 2-sample estimator, where the two samples were feeding areas in 1992 and feeding areas in 1993 (Stevick *et al.* 2003). This estimate included incorporation of an error rate in addition to sample pooling across years to collectively improve the estimates. Abundance was estimated at 11,570 (95% CI 10,290 to 13,390) individuals (Stevick *et al.* 2003). Although this figure is larger and more precise than any previous estimate, it is likely a negatively biased estimate for the entire ocean basin due to heterogeneity in capture probabilities across the North Atlantic (Stevick *et al.* 2003). Although this estimate mostly reflects the abundance of the West Indies population, it also includes the abundance of the Cape Verde Islands/Northwest Africa DPS because of the inclusion of all whales from Iceland and Norway.

Stevick *et al.* (2003) also estimated abundance from YONAH data for just the West Indies breeding population by using a Chapman 2-sample estimator, but where one sample was from the feeding grounds and the other sample was from the West Indies breeding ground. The feeding ground samples were restricted to only data from the Gulf of Maine, Canada, and Greenland; the exclusion of Iceland and Norway data removes whales from the Cape Verde Islands/Northwest Africa DPS from the analysis. In this analysis, the feeding ground samples represent the mark, with their capture probability in the West Indies estimated and applied to the number of whales identified in the West Indies. This should therefore represent an estimate of the West Indies population. This carries the assumption that West Indies whales from the Iceland and Norway feeding areas (which were not included in the mark) have the same capture probability as the other West Indies whales (from GOM, Canada, and Greenland). Should whales from a separate breeding area migrate to the northwestern Atlantic to feed, there would be a positive bias in these estimates, but this is no evidence any whales do this. The most accurate estimate made using this method for the YONAH data was 10,752 (CV = 6.8%; Stevick *et al.* 2003).

Stevick *et al.* (2003, Table 3) also used earlier (pre-YONAH) data from 1979 to 1991 to make additional estimates in the same manner via a feeding-breeding ground comparison. Those estimates ranged from 6,918 to 12,582, with CVs ranging from 18 to 39%.

The YONAH project also included the collection of biopsy samples and genetic identification of individuals. A Chapman 2-sample estimator was also applied to the genetic identification data, again using the feeding grounds (Gulf of Maine, Canada, and Greenland) as the mark, and the West Indies breeding ground as the recapture. This resulted in an estimate of 10,400 (95% CI 8000-13,600;Smith *et al.* 1999). Note that this is nearly identical to the photo-based estimate using an identical estimator (10,752 photo vs. 10,400 genetic).

The West Indies genetic samples were also used to estimate abundance for the West Indies population by using a Chapman 2-sample estimator applied to a breeding-breeding ground comparison for the two YONAH years of 1992 and 1993. The estimate of the population was much lower using this method (7,698 Palsbøll *et al.* 1997), which was attributed to substantial heterogeneity in capture probability on the breeding grounds (heterogeneity in capture probability means that individual whales have different capture probabilities, which violates one assumption of the Chapman estimator). Indeed, when the data were separated into male and female datasets, the estimate for males was 4,894 whereas the estimate for females was 2,804, even though the sex ratio is known to be approximately equal on the feeding grounds. It is thought that this is due to females having a relatively short duration on the breeding ground and perhaps also arriving and leaving outside the period of sampling; in contrast, males have a longer duration that spans most or all of the breeding season. Interestingly, doubling the males-only estimate of 4,894 (assuming a 50:50 sex ratio in the population) leads to a population estimate of 9,788, which was only slightly lower than the feeding-breeding ground estimates.

Although there may also be capture heterogeneity on the feeding ground, it is thought that the capture heterogeneities there are different from those on the breeding ground, and therefore when put together in a feeding-breeding ground mark-recapture, they do not cause a large negative bias. In contrast, in comparing two samples with the same heterogeneity in capture probability, such as the breeding-breeding ground comparison, there can be substantial negative bias. In the North Pacific, Barlow *et al.* (2011) similarly concluded that a feeding-breeding ground comparison was more robust and provided a higher estimate of abundance than breeding-breeding ground comparisons, which had a strong negative bias. The migration between the feeding ground and breeding ground effectively randomizes the sampling in the two areas. This approach also avoids many of the sources of heterogeneity that would result from sampling in only one seasonal habitat (Smith *et al.* 1999). Moreover, Barlow *et al.* (2011) demonstrated this effect through simulation. They found that if individual heterogeneity was the same in the marked sample as in the recaptured sample, this introduced negative bias of 21% in their example (based on the SPLASH project throughout the North Pacific, which was analogous to the YONAH project in its scope). In contrast, they found that using the same range of heterogeneity in capture probability but with different values in different samples (as would be true in a feeding-breeding ground comparison) resulted in a very small bias. Barlow *et al.* (2011) also investigated sex-biased sampling, as apparently occurs on the breeding ground, but again found that bias from this effect is small if one of the two capture occasions is unbiased with respect to sex, as should be the case on the feeding grounds. Therefore, as previously concluded by Stevick *et al.* (2003), the best estimates of the abundance of the West Indies population from the YONAH data are the estimates using the feeding-breeding ground comparisons, which are 10,752 (from photos, Stevick *et al.* 2003) and 10,400 (from genetic IDs; Smith *et al.* 1999).

Additional sampling was conducted in the West Indies in 2004 and 2005 in order to obtain an updated abundance estimate for the West Indies population (More of North Atlantic Humpbacks (MONAH) project; (Clapham 2003; Waring *et al.* 2012) and the BRT reviewed a preliminary analysis of these data. A Chapman 2-sample estimator was applied to the MONAH genetic identification data, using the feeding grounds (Gulf of Maine only) as the mark, and the West Indies breeding ground as the recapture, resulting in an estimate of 12,312 (95% CI 8688-15,954; NMFS unpublished data). This estimate is nearly directly comparable to the genetic estimate of 10,400 for 1992-93 (Smith *et al.* 1999), with the exception that the earlier YONAH estimate used marked animals from Canada and West Greenland in addition to the Gulf of Maine. If it can be assumed that whales from Canada and Greenland have the same capture probability in the West Indies as do whales from the Gulf of Maine, this should not introduce any bias. The MONAH estimate of 12,312 is consistent with the increasing trend for the West Indies shown in Stevick *et al.* (2003), though it suggests the increasing trend in the population has slowed down (see Trends section below).

In contrast, a genetic male-only breeding-breeding ground Chapman 2-sample estimator for the MONAH data from the West Indies leads to a lower estimate of abundance (3,414; NMFS unpublished data) than the comparable estimate for YONAH (4,894 Palsbøll *et al.* 1997). In wide area projects like YONAH and MONAH involving a complex migratory species like the humpback whale, there are details in sampling issues that can be complicated and potentially important to consider. One concern is that there was considerable variability in the arrival and stay duration of the biologists on Silver Bank during the West Indies breeding ground field-seasons among and between the years of YONAH and MONAH. For YONAH, samples were acquired between Day of Year (DOY) 30 and 80 during 1992 and between DOY 18 and 72 for 1993. If one limits a mark-recapture to data collected during the overlapping time frame DOY (30,72) and re-calculates a modified Chapman estimate on those data, one gets a male estimate for YONAH of 3,867 (2605, 5130; NMFS, unpublished data), which is lower than the estimate of 4894 calculated by Palsboll *et al.* (1997) from the same untruncated data. It is still larger than the estimate of 3,414 calculated from MONAH data, but does suggest the nature of the problem. The MONAH field seasons were from DOY 14 to 70 in 2004 and DOY 21 to 67 in 2005. The MONAH field seasons had other issues as well, with substantial bad weather in 2004 and a change in protocol by the ship's captain in 2005 whereby the ship was anchored farther from the reef and thus in a larger swell, reducing the sampling opportunities because of greater difficulties in launching the skiffs. It is also possible to use a Chao estimator on each season of the MONAH West Indies data, breaking each field season into 3 time periods, and incorporating both time-varying capture probability and individual heterogeneity. The Chao estimator resulted in estimates of ~4500 for both field seasons (NMFS, unpublished data), suggesting that the ability to account for individual heterogeneity does increase the estimate substantially, and this can be taken as evidence for substantial heterogeneity in the breeding ground data. Most importantly, as discussed above, a breeding-breeding ground comparison introduces two large sources of bias from sex-biased sampling favoring males and from having the same source of individual heterogeneity in both samples.

It is not clear that there is sufficient information to clarify exactly what is going on with regards to the sampling differences between YONAH and MONAH, and whether this is the cause of the differences in abundance in the breeding-breeding ground estimates. Given all of the above, the BRT concluded that the feeding-breeding ground estimates are more robust, and that therefore the estimate of 12,312 would be considered the best available abundance estimate for the West Indies population from the 2004-05 MONAH data.

Abundance in feeding areas
The abundance of the DPS is considered to be the abundance from the West Indies, but we also summarize abundance estimates from feeding areas here. The most recent estimate for the Gulf of Maine was 902 (CV=0.41) in 1999 (Clapham *et al.* 2003a). An abundance estimate from the TNASS aerial surveys in 2007 in eastern Canada (including the Scotian Shelf, Gulf of St. Lawrence, Newfoundland, and Labrador) was 2,080 humpback whales (95% CI: 1,337-3,172) (Lawson and Gosselin 2009). A Mark-Recapture Distance Sampling estimate of abundance from aerial line-transect surveys conducted off West Greenland for the year 2007 was 3,272 (CV = 0.50) (Heide-Jorgensen *et al.* 2012). The TNASS survey in 2007 in Iceland resulted in an estimate of 11,572 (95% CI 4,502 to 23,807; Pike *et al*. 2010), but preliminary estimates from genetic data suggest roughly half or less of the Iceland whales and relatively few Norwegian whales migrate to the West Indies (e.g., Punt *et al.* 2006). Although these surveys used different methodologies and occurred in different years, note that the total abundance from these areas (Gulf of Maine, eastern Canada, West Greenland, and using half of the Iceland estimate) sums to ~12,000, in the same ballpark as estimates from the West Indies.

D.1.2 Trends

D.1.3 Trends in the West Indies breeding grounds

Stevick *et al.* (2003) estimated the average rate of increase for the West Indies breeding population at 3.1% per year (SE = 0.5%) for the period 1979-1993, slightly below the rate required for a twenty year doubling time. This was based on fitting an exponential trend to 20 abundance estimates calculated from photo-identification data, where a Chapman estimator was applied to two samples pooled across 2 years, where the first was from the feeding ground and the second was from the breeding ground (discussed above in the Abundance section). It was noted that the original analysis in Stevick *et al.* (2003) calculated abundance from each pooled feeding ground sample twice, by matching it to a different sequence of breeding ground years (e.g., 1979-80 feeding ground was matched to both 1979-80 breeding ground and also to 1980-81 breeding ground, producing two abundance estimates). This appears to be a form of using the same data twice, and could potentially lead to an over-estimate of the precision of the trend estimate. Therefore, we re-calculated the trend analysis using only one set of abundance estimates for each time period, calculated in the same manner as the best abundance estimate from YONAH of 10,752 (e.g., using the 1979-80 matched to the 1979-80 data), leaving a total of 11 abundance estimates from 1979-80 to 1992-93. Our revised estimate of the trend for this time period was still 3.1% (SE=1.2%); as expected the precision was lower but the trend was still significantly different from 0.0 (p=0.025). When the MONAH estimate of 12,312 was added to the analysis the increase from 1979-80 to 2004-05 was estimated to be 2.0% (SE=0. 6%) per year, lower than for the earlier time period, but the increase was still significantly different from 0.0 (p=0.008) (Figure 8). Although this is considered the best estimate of trend for the West Indies population, as a sensitivity test we also estimated the trend of the population using the breeding-ground-only estimate from MONAH of 6,828 (NMFS, unpublished data) instead of the feeding-breeding ground estimate of 12,312. In that test, the trend was essentially zero and there was no significant increase or decrease. If the lower abundance estimates is taken at face value, however, it would suggest the population initially increased and then decreased. However, given the concerns raised about the breeding-ground only estimate from MONAH and other indications of generally increasing abundance (see below), the results of this sensitivity test were not given much weight in the BRT's final conclusions.

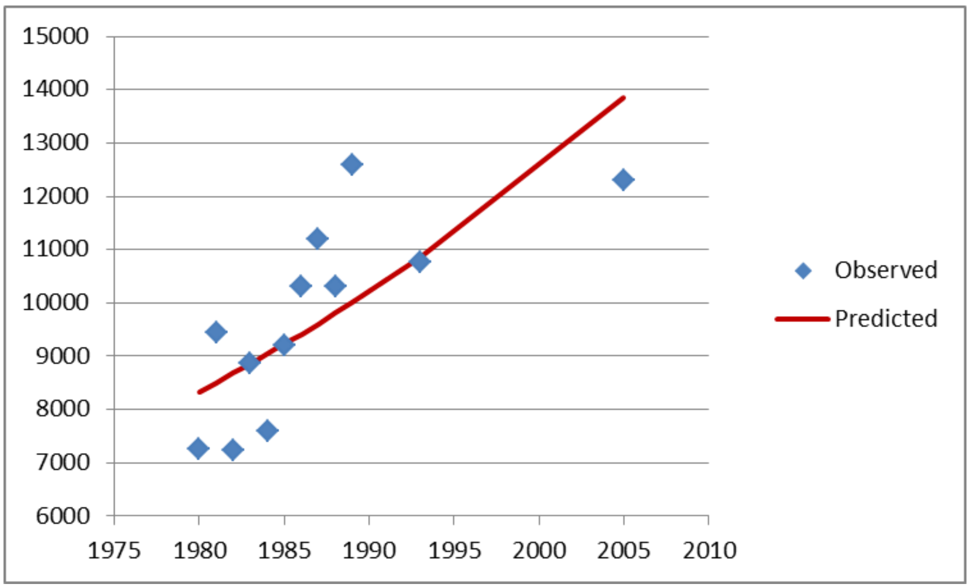

Figure 8. Revised trend analysis for NA humpback West Indies breeding population, based on feeding-breeding ground mark-recapture abundance estimates (Stevick *et al.* 2003; NMFS unpublished data).
Note that only 11 abundance estimates from Table 3 of Stevick *et al.* (2003) were used (see text for explanation).

Given that the population growth rate has appeared to slow, it is reasonable to examine whether the population appears to be leveling off, such as would happen as a population approaches carrying capacity. Using AICc as a measure of model fit, the fit of a logistic model to the same abundance data as in Figure 8 was about the same as the fit of a linear model (Figure 9), meaning the data provide roughly equal support to both models. Therefore, no conclusion can be reached on whether the Silver Bank population is still increasing or is leveling off, as yet. This is unsurprising given that only the one estimate in 2004-05 suggests a leveling off, which is not enough data to support a strong conclusion.

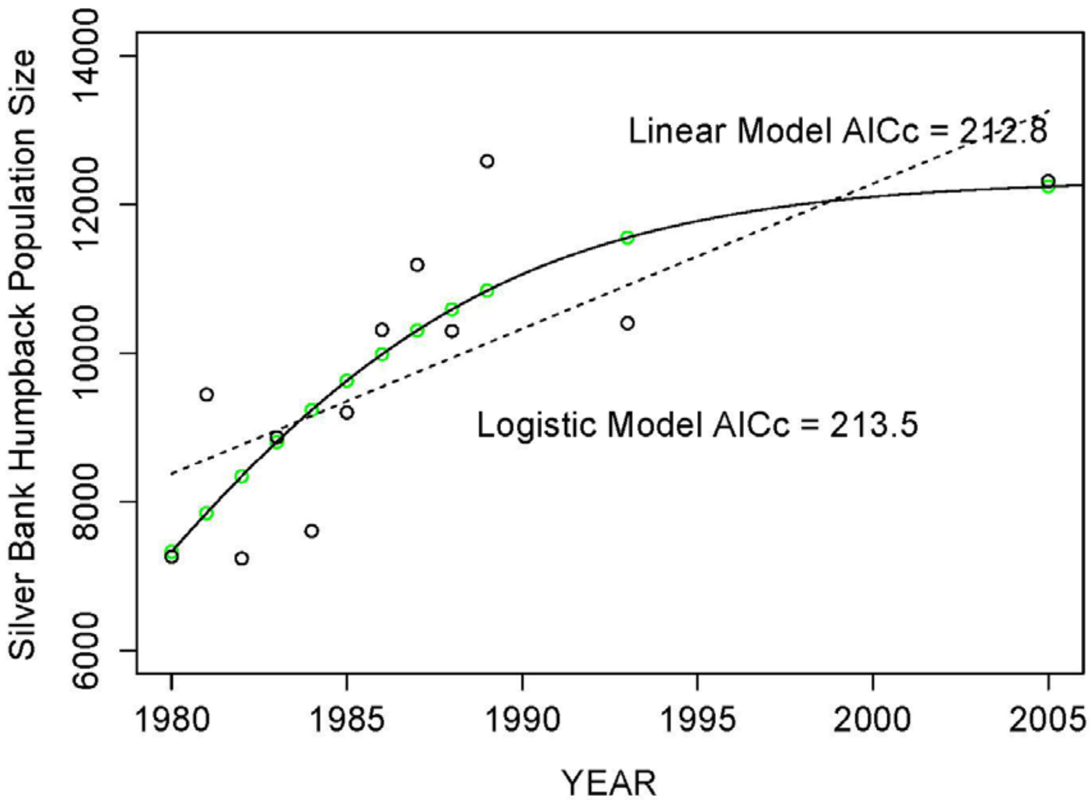

Figure 9. A comparison of the fit of a linear model and a simple logistic model to the abundance data from Figure 8. The AICc for the two models were only different by 0.5, indicating the data support both models equally well.

D.1.3.1 Trends on the feeding grounds

Gulf of Maine

Barlow and Clapham (1997) estimated the Gulf of Maine feeding population (part of the West Indies breeding population) to be increasing at a rate of 6.5% from 1979-1991. However, Clapham *et al.* (2003a) estimated a lower growth rate of 0-4% for the population from 1992 through 2000. Population growth rates were calculated using demographic parameters estimated from photo-identification mark-recapture[6] studies including reproductive rates (birth intervals and maturation ages) and non-calf survival rates. A subsequent study confirmed both low average reproductive rates and calf survival during much of the 1992-2000 period (Robbins 2007). The average estimated calf survival rate for the period 2000-2005 (0.664, 95% CI: 0.517-0.784) fell between the values assumed by Clapham *et al.* (2003a) of 0.51 to 0.875, and did not

[6]Mark returns, "mark-recapture," or "sight-resight," is a method of estimating abundance based on a known number of tagged or identified individuals recaptured in consecutive samplings, which is extrapolated to represent a proportion of the overall population size.

include neonatal mortality prior to arrival on the feeding ground (Robbins 2007). No population growth rate estimates are available for this more recent time period.

Greenland

Aerial line-transect surveys were conducted off West Greenland 8 times between 1984 and 2007 (Heide-Joergensen *et al.* 2012). A Mark-Recapture Distance Sampling estimate of abundance for the year 2007 was 3,272 (CV = 0.50). An annual rate of increase for 1984-2007 estimated from these data was 9.4% (SE = 0.01), which was significantly different from 0.0. There was roughly similar effort across the different years of the surveys, and therefore the estimated increase is apparent from the raw number of sightings per survey, which increased from 5-7 whales in the first 3 surveys to 20-22 whales in the last 3 surveys. This indicates the number of whales in Greenland has increased substantially over this time period. The estimated increase rate is high but just within plausible bounds for humpback whales based on their life history (Zerbini *et al.* 2010; Heide-Joergensen *et al.* 2012). Therefore, it is possible this increase is due solely to internal dynamics and not from the movement of whales into this area from other feeding areas, but there is no movement information for later years to attempt to confirm this.

Iceland

Sigurjónsson and Gunnlaugsson (1990) used an index based on systematic sightings records from whaling vessels kept between 1970 and 1988 to derive an annual rate of increase of 11.6% for humpback whales off western Iceland. From abundance surveys, Pike *et al.* (2005) estimated a trend for humpback whales in Iceland waters from encounter rate data from 1987 through 2001 of ~15% per year, which they note is beyond the boundary of the maximum possible rate of increase for humpback whales (Zerbini *et al.* 2010); it is not clear whether immigration into this feeding area may exist and contribute to this observed increase (Pike *et al.* 2005), whether the survey method employed was biased or unreliable (Smith and Pike 2009), or whether by sampling chance alone the estimate was too high. This latter possibility is supported by the fact that a similar abundance estimate was lower in the TNASS survey in 2007, suggesting the 15% increase was an over-estimate (Pike *et al.* 2010). However, the data do strongly suggest an increasing trend in Iceland over the 1987 to 2007 time period.

D.1.3.2 Conclusions on trend

Overall, the West Indies population was estimated to be increasing slowly over the time period 1980 to 2005, but there is not sufficient evidence to statistically conclude the population has leveled off, such as would occur for a population reaching carrying capacity. In contrast, estimates from feeding areas in the North Atlantic indicate strongly increasing trends in Iceland (1979-88 and 1987-2007), Greenland (1984-2007), and the Gulf of Maine (1979-1991). There is some indication that the increase rate in the Gulf of Maine has slowed in more recent years. It is not clear why the trends appear so different between the feeding and breeding grounds. A possible explanation would be that the Silver Bank breeding ground has reached carrying capacity, and that an increasing number and percentage of whales are using other parts of the West Indies as breeding areas. Observers in the eastern Antilles (the Windward islands) have reported what appear to be increasing numbers of humpback whales in the region of Guadeloupe and Martinique; this might suggest an increasing and/or expanding population, although it is not clear how much such observations are a function of possibly increased observer effort in the area. The only recent dedicated effort in this region was a visual and acoustic survey conducted by Swartz *et al.* (2003), which found a low density of whales from the Virgin Islands to

Venezuela. Although it was not possible to undertake a quantitative comparison with the results of surveys conducted in the 1970's (Levenson and Leapley 1978), Swartz *et al.* (2003) noted that the low density of humpback whales observed in their survey was similar to that observed in the two much earlier studies, and concluded that local abundance in the eastern Antilles remained low.

If local abundance has indeed increased in some areas other than Silver Bank, it would suggest that the West Indies population is larger than estimated by the MONAH study, and that the increase rate of the overall population may be higher than the 2% we estimate.

D.1.4 Threats Analysis

<u>Habitat or Range Curtailment</u>
As elsewhere, human population growth and associated coastal development represent potential threats to this population in certain areas of the West Indies, as well as in regions of high human population density in the high-latitude feeding range. The major breeding habitats of Silver and Navidad Banks are sufficiently remote from land that direct human impact is for the most part unlikely. The largest concentration of humpback whales in a West Indies habitat that is adjacent to the coast occurs in Samaná Bay, Dominican Republic (Mattila *et al.* 1994). There, tourism has spurred an increase in coastal development, which has presumably introduced a rise in runoff and effluent discharge into the waters of the bay. To date, there is no evidence of observable impact on the humpback whales that visit the region, but no studies have been conducted; that the whales do not feed in these tropical waters likely decreases their risk from such point source pollution. Silver Bank, Navidad Bank, and portions of Samaná Bay have been designated by the Dominican Republic as a humpback whale Sanctuary (Hoyt 2013).

As noted above, although whales are found elsewhere in the West Indies, densities outside Dominican waters are relatively low. Much of the additional habitat is in the waters of small islands in the Leeward and Windward groups, where any coastal runoff is likely to be effectively dispersed by highly dynamic water movements driven by frequently strong trade winds.

In some feeding grounds, coastal runoff, vessel traffic and other human activities represent a potential threat to humpback whales from this DPS. This is likely to be most pronounced off the Mid-Atlantic and northeastern United States, and least relevant in remote offshore areas such as Greenland, Labrador and the Barents Sea. A study of contaminants in humpback whales from the Gulf of Maine found elevated levels of polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and chlordanes (Elfes *et al.* 2010), although the authors concluded that these likely did not represent a conservation concern.

Extensive oil and gas development and extraction occurs in the southern portion of the humpback whales' West Indies range, in the Gulf of Paria off Venezuela, but nothing is known of the impacts of this on the whales (Swartz *et al.* 2003). Energy exploration and development in this area are expected to increase. The U.S. assesses the environmental impacts of proposed oil and gas activities, including seismic and other offshore surveys, in the Mid- and South-Atlantic region.

An UME involving humpback whales occurred off Cape Cod in late 1987 that was tied to dinoflagellate poisoning (harmful algal blooms or "red tide") (Geraci *et al.* 1989); such events have been linked to increased coastal runoff. Additional UMEs occurred in the Gulf of Maine in 2003 (12-15 dead humpback whales on Georges Bank) and 2006-7 (minimum of 21 whales), with no cause yet determined but HABs potentially implicated (Waring *et al.* 2009).

Utilization for Commercial, Recreational, Scientific, or Educational Purposes

A native whaling operation targeting humpback whales exists in St Vincent and the Grenadines. Whalers from the St Vincent and the Grenadines island of Bequia have a quota from the IWC; most recently, Bequia was given a "block" quota of up to 24 whales over a six-year period (2013-2018) (IWC 2012). The Scientific Committee of the IWC considers that the allowed quota would have no impact on the growth rate of this population (IWC 2012).

Humpback whales represent a major attraction for tourists in many parts of the world, and in the West Indies their presence supports a large seasonal whale-watching industry in Samaná Bay (Dominican Republic). Although humpback whales can become remarkably habituated to ecotourism-based vessel traffic, whale-watching excursions have the potential to disturb or even injure animals. On feeding grounds such as the Gulf of Maine, where a large whale-watching industry exists, the extreme reaction of habitat displacement has not been observed; this may partly be due to the existence of some guidelines for the operation of whale-watching tours, as well as the fact that the whales are tied to specific areas by a key resource (*i.e.,* food). Since whales do not eat while in sub-tropical waters in winter, they are theoretically far less constrained in their choice of habitat; consequently, if the whales are faced with high enough pressures from noise or other disturbance, they might be able to leave one breeding area and move to another.

It is not clear whether recent anecdotal reports linking a decline in humpback whale abundance in Samaná Bay with increased cruise ship traffic are valid, but the potential exists to drive whales out of a breeding ground. The large number of whale-watching vessels and increasing presence of cruise ships in Samaná Bay suggests that it is very important to assess the effect of this traffic on the behavior and habitat use of the whales there.

Currently, disturbance from whale watching is probably not a major concern for Silver Bank. Although a small number of dive boats operate "swim-with-whales" tours there, their activities are regulated by the Dominican government, and are limited to a very small section of the available habitat. There is currently no commercial or recreational activity on Navidad Bank.

With the exception of the Gulf of Maine, elsewhere in the North Atlantic there is minimal utilization of humpback whales for whale-watching or ecotourism.

This population is exposed to some scientific research activities in waters off the U.S., Canada, and West Indies, but at relatively low levels. Adverse population effects from research activities have not been identified, and overall impact is expected to be low and stable.

Disease or Predation

There are no recent studies of disease in this population, but also no indication that it is a major risk.

A study of apparent killer whale attacks in North Atlantic humpback whales found scarring rates ranging from 8.1% in Norwegian waters to 22.1% off western Greenland; scarring rates among whales observed in the West Indies ranged from 12.3% to 15.3% (Wade *et al.* 2007). It is clear that most killer whale attacks occur on first-year calves prior to arrival in high-latitudes (Wade *et al.* 2007). However, this is not regarded as a serious threat to population growth.

Other Natural or Human-Related Threats

The largest potential threats to the West Indies DPS are entanglement in fishing gear and ship strikes; these occur primarily in the feeding grounds, with some documented in the mid-Atlantic U.S. migratory grounds. There are no reliable estimates of entanglement or ship-strike mortalities for most of the North Atlantic. For the Gulf of Maine feeding population, for the period 2003 through 2007 the minimum annual rate of human-caused mortality and serious injury (from both entanglements and ship collisions) averaged 4.4 animals per year (Waring *et al.* 2009). Off Newfoundland, an average of 50 humpback whale entanglements (range 26-66) was reported annually between 1979 and 1988 (Lien *et al.* 1988); another 84 were reported entangled in either Newfoundland or Labrador from 2000-2006 (Waring *et al.* 2009). Not all entanglements result in mortality (Waring *et al*. 2009). However, all of these figures are likely to be underestimates, as not all entanglements are observed. A study of entanglement-related scarring on the caudal peduncle of 134 individual humpback whales in the Gulf of Maine suggested that between 48% and 65% had experienced entanglements (Robbins and Mattila 2001).

Underwater noise can potentially affect whale behaviour, although impacts are unclear. Concerns about effects of noise include behavioral disruption, interference with communication, displacement from habitats and, in extreme cases, physical damage to hearing (Nowacek *et al.* 2007). Singing humpback whales have been observed to lengthen their songs in response to low-frequency active sonar (Miller *et al.* 2000) and reduce song duration from distant remote sensing (Risch *et al.* 2012). Because of the low level of human activity on Silver and Navidad Banks, noise is currently not a concern in this area. Samaná Bay, however, already has much vessel activity and therefore has the potential for considerable impact on whales from noise. Noise sources include whale-watching vessels, which approach whales closely and thus presumably create a loud acoustic environment in close proximity to the animals, and cruise ships, which may be more distant but whose size guarantees that, at certain frequencies, noise levels in the bay will be very high. There are also additional sources in the form of container ships or other commercial vessels that enter the bay periodically. Underwater noise levels are expected to increase.

Offshore aquaculture was considered a low, but increasing, threat to this population. Competition with fisheries is a low threat to this population.

Overall population level effects from global climate change for this population are not known; nonetheless, any potential impacts resulting from this threat will almost certainly increase. Currently, climate change does not appear to pose a significant threat to the growth of this population.

D.1.5 Extinction Risk

The West Indies DPS has a substantial population size and appears to be experiencing consistent growth (Stevick *et al.* 2003), although the available growth and abundance data are about 10 years old. The North Atlantic humpback whale population was the subject of a Comprehensive

Assessment by the IWC in 2000-2001, but the status of this population relative to its pre-exploitation size remains unclear (IWC 2002a). There has been no commercial or scientific whaling on this population for several decades, and although humpback whales remain the target of a small native hunt in St Vincent and the Grenadines and West Greenland, no significant impact on the population is likely from these catches.

The West Indies DPS was considered by the majority of the BRT to not be at risk of extinction (82% of votes)[7]. The potential for this population to be at moderate or high risk of extinction received 17% and 1% of votes, respectively. The votes for moderate or high risk largely reflects uncertainty stemming from potentially high rates of entanglement and/or ship strikes in some portions of the its range, and the occurrence in the Gulf of Maine of recent multiple UMEs.

D.1.6 Significant portion of its range

As noted above, there are some regional differences in threats for the West Indies DPS. However, the BRT concluded that the effect of any geographically localized threats would be seen in the status of the DPS as a whole. The BRT was unable to identify portions of the DPS that both faced particularly high threats and were so significant to the viability of the DPS as a whole that if lost would result in remainder of the DPS being at high risk of extinction. The BRT therefore concluded that the DPS was not at risk in a significant portion of its range.

D.2 Cape Verde Islands/Northwest Africa

The population abundance and population trend for the Cape Verde Islands/Northwest Africa DPS are unknown. The Cape Verde Islands photo-identification catalog contains only 88 individuals from a 20-year period (1990-2009) (Wenzel *et al.* 2010). Of those 88 individuals, 20 (22.7%) were seen more than once; 15 were seen in two years, 4 were seen in three years and 1 was seen in four years. The relative high re-sighting rate suggests a small population size with high fidelity to this breeding area, although the DPS may also contain other, as yet unknown, breeding areas (Wenzel *et al.* 2010).

D.2.1 Threats Analysis

The BRT evaluated a variety of factors that could pose a risk to this DPS but rated many threats of unknown severity due to the lack of knowledge about the inferred additional breeding area.

<u>Habitat or Range Curtailment</u>
Habitat conditions for this DPS are poorly known. Some members of the population use the waters around the Cape Verde Islands for breeding and calving, but where the remaining hypothesized fraction goes is unknown. The BRT noted that if the remaining portion of the population occurs in the coastal waters of West Africa (a plausible hypothesis, albeit one for which there is currently no evidence), it is likely to be exposed to more threats, which would

[7] The BRT conducted its initial evaluation of extinction risk prior to the availability of the 2004/2005 abundance estimates provided by the MONAH program. After reviewing the preliminary analysis of these data, as described in this section, the BRT concluded by consensus that the original extinction risk evaluation remained valid after considering the new information.

increase with increased coastal development. In considering the Cape Verde Islands population, it was noted that oil spills occur off West Africa, but these levels are thought to be lower than in some other regions and the impact of non-catastrophic spills on humpback whales when they are on the breeding grounds was not considered significant. The threat of energy exploration to the Cape Verde Islands/Northwest Africa population was considered low.

There is little to no information on the impacts of HABs on this DPS.

Utilization for Commercial, Recreational, Scientific, or Educational Purposes

Because the breeding range of this DPS is largely unknown, the importance of anthropogenic disturbance (from activities such as whale-watching, offshore aquaculture, fishing gear entanglements, and scientific research) of this DPS is largely unknown. At present, threats appear low relative to other populations, but again, much of the distribution of the population is unknown. There is no current or planned commercial whaling in this area.

Disease or Predation

There is little to no information on the impacts of disease, predation, or parasites on this DPS.

Other Natural or Human-Related Threats

There is little to no information on the impacts of vessel collisions, climate change, or anthropogenic noise on this DPS, although each is expected to increase. Competition with fisheries and offshore aquaculture were considered low threats to this DPS.

D.2.2 Extinction Risk

The BRT found it very difficult to rate the extinction risk for this DPS because so little is known about that portion of the DPS breeding away from the Cape Verde Islands. Early commercial whaling analyses seem to indicate that the abundance of this DPS was substantial, but offers little in the way of explaining why it has not recovered similarly to most other DPSs. “High risk” received 32% of the votes, “moderate risk” received 43% of the votes, and “not at risk” received 25% of the votes. The BRT noted that only 88 individuals have been catalogued over a 20-year period and there is no information available regarding where else other individuals may be if the population is larger. They emphasized that it is impossible to discern if the whales in the Cape Verde Islands are their own population or part of a larger population, which would translate into two very different risk levels. This uncertainty is reflected in the spread of the voting results.

D.2.3 Significant portion of its range

The BRT concluded that the Cape Verde Islands/North Africa DPS was likely to be at least at moderate risk throughout its entire range. The BRT could not rule out that portions of the range of this DPS are at high risk, but this was largely due to a lack of information on the complete range of the DPS.

D.3 North Pacific DPSs

D.3.1 Abundance

Recent estimates of abundance for the entire North Pacific basin are derived from the comprehensive data collected during the SPLASH project. A preliminary estimate of 18,302 individuals was calculated from the SPLASH data (Calambokidis *et al.* 2008). This estimate was significantly larger than any previous estimates for the basin and is greater than some of the published estimates of pre-whaling abundances (Rice 1978). However, this estimate has been superseded by a re-analysis of the SPLASH data by correcting for some of the known biases, such as those caused by not sampling calves and by births and deaths between sampling periods (Barlow *et al.* 2011) , yielding an updated estimate of 21,808 (CV=0.04) whales in the North Pacific Ocean. This new estimate may still be an underestimate of actual humpback whale abundance due to biases that could not be corrected for using the available data.

Calambokidis *et al.* (2008) approximated the size of the whale populations frequenting each breeding area at: 10,000 individuals in Hawaii; 6,000-7,000 animals in the collective areas in Mexican waters; 1,000 for the Western Pacific areas; and 500 for Central America, for a total of 17,500-18,500. Barlow *et al.* (Barlow *et al.* 2011) did not apportion their estimate of 21,808 to individuals breeding areas, but the proportions are likely to be similar to those estimated by Calambokidis *et al.* (2008) and therefore about 20% larger than the Calambokidis *et al.* (2008) estimates.

D.3.2 Trends

The only mark-recapture study of North Pacific humpback whale abundance on a basin scale other than the SPLASH project was the NPAC study, based on photographic identifications of individual whales from 1990-1993 from three wintering regions (Hawaii, Mexico, Japan) and feeding areas from California to the Aleutian Islands (Calambokidis *et al.* 1997). Calambokidis *et al.* (2008) compared the NPAC best estimate of 6,010 to the SPLASH results and estimated an annual increase of 4.9% over the 13-year time span, considerably higher than the interim recovery goal. Comparing the SPLASH results to the basin-wide estimate made in 1966 by Johnson and Wolman (1984) of approximately 1,200 individuals, Calambokidis *et al.* (2008) estimated a 6.8% annual increase for the 39-year time span. However, this is contingent upon the reliability of the 1966 estimate, which is questionable because of limited spatial coverage.

Growth rates have been calculated on regional scales, including ~8% per year for the U.S. West Coast from 1991-2008 (Calambokidis 2009) and 6.6% per year for the Alaskan Peninsula and Aleutian Islands from 2001-2003 (Zerbini *et al.* 2010). Dahlheim *et al.* (2009) calculated a 10.6% annual increase in population size in Southeast Alaska between 1991 and 2007.

Calambokidis *et al.* (2008) also calculated trends for Hawaii and Asia comparing regional estimates from the NPAC study (1990-1993) and the SPLASH study (2004-2006). The Hawaii population showed an annual growth rate of 5.5-6.0% and the western Pacific population an annual growth rate of 6.7%. The western Pacific estimate is less robust; sampling effort was significantly greater in the SPLASH study, which may upwardly bias the western Pacific trend estimate (Calambokidis *et al.* 2008).

D.4 Hawaii

The size of the population that uses the waters surrounding the Hawaiian Islands for mating and calving was estimated in 2008 to be about 10,000 individuals (Calambokidis *et al.* 2008). The most recent growth rate was estimated between 5.5% and 6.0% for this population (Calambokidis *et al.* 2008).

D.4.1 Threats Analysis

<u>Habitat or Range Curtailment</u>
Other than its Hawaiian Islands breeding area, this population inhabits some of the least populated areas in the United States (Alaska) and Canadian (Northern British Columbia) coastal waters. Coastal development, which may include such things as port expansion or waterfront development, is possible in both the U.S. and Canada; runoff from coastal development in Hawaii and continued human population growth are potential threats. Confidence in information about, and documentation of, these activities and their impacts is moderate. Given continued human population growth in the region and the need to develop alternate energy sources, such as offshore wind farms and wave or tidal generators, the threat can be expected to increase.

This population had the lowest levels of DDTs, PCBs, and PBPEs observed for North Pacific humpback whales sampled on all their known feeding grounds except Russia, between 2004 and 2006; in particular, levels were lower than observed in humpback whales from the U.S. West Coast, as well as the North Atlantic's Gulf of Maine (Elfes *et al.* 2010). The levels observed in all areas are considered moderate and not expected to have a significant effect on population growth (Elfes *et al.* 2010). Confidence in this information is moderate, but the trend is unknown.

There have been proposals to open exploration and drilling in the southeastern Bering Sea, notably in the North Aleutian Basin. While in 2010 this region was removed from consideration for oil and gas lease sales, if such activity were authorized in the future it would represent a potential threat to this population's feeding grounds. There has been a moratorium on offshore oil drilling in the waters of Northern British Columbia since 1972, but there has also been a recent proposal to lift the ban, driven largely by local government (British Columbia Energy Plan 2007). If so, this potential threat could increase in this portion of the habitat as well.

Naturally occurring biotoxins from dinoflagellates and other toxins are known to exist within the range of this population. Although humpback whale mortality as a result of exposure has not been documented in this population, it has been reported from other feeding grounds, so is considered a possibility. The occurrence of HABs is expected to increase with the growth of various types of human- related activities, and with increasing water temperatures. The level of confidence in exposure to HABs and in these assertions is moderate.

<u>Utilization for Commercial, Recreational, Scientific, or Educational Purposes</u>

There are no planned commercial whaling activities in this population's range, however, modest aboriginal hunting has been proposed in British Columbia (Reeves 2002). Certainty in this information is considered relatively high and the magnitude is expected to remain stable.

This population is exposed to whale-watching activities in both its feeding and breeding grounds, but at medium (Hawaii) to low levels (Alaska and British Columbia). Adverse population effects from whale-watching have not been documented, and overall impact of whale-watching is expected to be low and stable.

This population is exposed to some scientific research activities in both U.S. and Canadian waters, but at relatively low levels. Adverse population effects from research activities have not been identified, and overall impact is expected to be low and stable.

Disease or Predation

Evidence of killer whale attacks (15-20%) in the humpback whales found in Hawaiian waters is moderate (Steiger *et al.* 2008) and lower for Alaska and Canada. This is not regarded as a serious threat to population growth. Shark predation likely occurs as well, although evidence suggests the primary targets are the weak and unhealthy. Certainty in this information is considered relatively high and the magnitude is expected to remain stable.

There are no known reports of unusual disease or mass mortality events for this population. Trends may increase slightly in response to other stressors, such as warming oceans and other stressors that may compromise immune systems.

Levels of parasitism in this population are not well known, although approximately 2/3 of humpback whales in Hawaii show some evidence of permanent, raised skin lesions, which may be a reaction to an, as yet unknown, parasite (Mattila and Robbins 2008). However, there is no evidence that these "bumps" impact health or reproduction, or cause mortality. Trends in the severity of this threat are unknown.

Other Natural or Human-Related Threats

There is suspected interaction with the herring fishery in Southeast Alaska, but impacts to humpback whales are considered to be modest; the level of certainty in this information is moderate and currently under study and impacts are considered stable because the herring fishery is regulated. There is a potential for humpback whales to compete with fisheries in British Columbia as well, as they also have a herring fishery, as well as a "krill" fishery.

Currently two modest offshore aquaculture sites are located in Hawaii, and their placement overlaps with humpback habitat. However, there have been no known fatal interactions and indirect impacts from food, waste, or medicines being provided to the cultivated species are likely to be low, as humpback whales do not feed in Hawaii. The level of certainty in this information is high. However, if these and other operations expand to areas of high use by the whales, at a minimum they could physically exclude humpback whales from some of their preferred habitat. Deep water, finfish aquaculture in Alaska is currently prohibited. However, some shellfish and herring "pond" aquaculture does exist close to shore. There are no known fatal encounters with this type of aquaculture in Alaska; however, there are documented cases of humpback whales becoming entangled in herring "pond" and other aquaculture gear in British Columbia (Baird 2003). There have been proposals to allow finfish aquaculture in Alaska, which would increase the threat from this activity in this portion of the population's range. The indirect impacts of aquaculture (*e.g.,* on health and abundance of prey) is not well known. Given decreasing catches of wild fish stocks, and resulting strong incentives to expand aquaculture, this threat is likely to increase.

This population is likely exposed to moderate levels of underwater noise resulting from human activities, which may include, for example, commercial and recreational vessel traffic, and activities in Naval test ranges. Overall population-level effects of exposure to underwater noise are not well established, but exposure is likely chronic. As vessel traffic and other activities are expected to increase, the level of this threat is expected to increase. The level of confidence in this information is moderate.

The range of this population includes some centers of human activities in both Canadian and U.S. waters. Reports of vessel collisions in Hawaii have increased since 2003, when an extensive educational campaign and hotline number were initiated; however the percentage of these that result in fatality is unknown. Collisions have also been reported from Alaska and British Columbia (where shipping traffic has increased 200% in twenty years) (Neilson *et al.* 2012). The level of certainty in this information is high. A reasonable assumption is that the level of the threat will increase in proportion with increases in global commerce. Although 5-10 ship strikes are reported per year in Hawaii and the actual number of ship strikes is estimated to be potentially one order of magnitude greater than this (Lammers *et al.* 2003), the threat level was still considered minimal given the very large population size and the fast rate of growth observed in this population.

Recent studies of characteristic wounds and scarring indicate that this population experiences a high rate of interaction with fishing gear (20-71%), with the highest rates recorded in Southeast Alaska and Northern British Columbia (Neilson *et al.* 2009). However, these rates represent only survivors. Fatal entanglements of humpback whales in fishing gear have been reported in all areas (where such records are kept) but, given the isolated nature of much of their range, observed fatalities are almost certainly under-reported. Recent studies in another humpback whale feeding ground, which has similar levels of scarring, estimate that the actual annual mortality rate may be as high as 3.7% (Angliss and Outlaw 2008). There is a high level of certainty with regard to this information. The threat is considered to be medium.

Overall population level effects from global climate change are not known; nonetheless, any potential impacts resulting from this threat will almost certainly increase. Climate change was not considered to be a major risk to this population currently, however. The level of confidence in the magnitude of this threat is low.

D.4.2 Extinction Risk

The Hawaiian DPS is large and growing and the overall level of threats was considered to be low. This DPS is and will be exposed to some threats from some human activities, the most severe being entanglement in fishing gear; however, these threats are not expected to significantly diminish population growth.

In voting on extinction risk, 98% of votes were for "not at risk" and 2% were for "moderate risk". The votes in the "moderate risk" category reflected uncertainty regarding fishing gear entanglements and the potential for increased vessel collisions.

D.4.3 Significant portion of its range

There are some regional differences in threats for the Hawaii DPS. However, the BRT concluded the effect of any geographically localized threats would be seen in the status of the DPS as a whole. The BRT was unable to identify portions of the DPS that both faced particularly high threats and were so significant to the viability of the DPS as a whole that if lost would result in the remainder of the DPS being at high risk of extinction. The BRT therefore concluded that the DPS was not at risk in a significant portion of its range.

D.5 Central America

Individual humpback whales in the Central America DPS migrate from breeding grounds off Costa Rica, Panama, Guatemala, El Salvador, Honduras, and Nicaragua to feeding grounds off California, Oregon and Washington. A preliminary estimate of abundance of the Central America population is ~500 from the SPLASH project (Calambokidis *et al.* 2008), or ~600 based on the reanalysis by Barlow *et al.* (Barlow *et al.* 2011). There are no estimates of precision associated with these estimates, so there is considerable uncertainty about the actual population size. Therefore, the actual population size could be somewhat larger or smaller than 500-600, but the BRT considered it very unlikely to be as large as 2,000 or more. The size of this population is relatively low compared to most other North Pacific breeding populations (Calambokidis *et al.* 2008). Though no specific growth rate has been estimated for this population, the growth rate for the entire North Pacific population is estimated at 4.9% (Calambokidis *et al.* 2008). The California/Oregon feeding population is comprised of a mixture from this DPS and other whales from the Mexico DPS; this feeding population has been estimated to be growing at a rate of ~8% per year from 1991-2008 (Calambokidis *et al.* 2008). However, given that the Central America population is estimated to be a small proportion of the whales in California/Oregon, this does not necessarily mean that the Central America population is growing. Therefore, the trend of the Central America population was considered unknown.

D.5.1 Threats Analysis

<u>Habitat or Range Curtailment</u>
Human population growth and associated coastal development, including port expansions and the presence of water desalinization plants, are some of the potential threats to this population. The presumed migratory route for this population lies in the coastal waters off Mexico and includes numerous large and growing human population centers from Central America north along the Mexico and U.S. coasts. The California and Oregon feeding grounds are the most "urban" of all the North Pacific humpback whale feeding grounds resulting in relatively constant anthropogenic exposure for the individuals of this population. However, the high degree of coastal development is not preventing the increase of humpback whales in this area and it is considered to be a low level threat.

Associated with this proximity to urban areas is a high level of exposure to man-made contaminants. Elevated levels of DDTs, PCBs, and PBPEs have been observed in "southern California" humpback whales; levels were higher than observed in humpback whales from the North Atlantic's Gulf of Maine feeding ground (Elfes *et al.* 2010). These levels may be linked to historical dumping of DDTs off the Palos Verdes Peninsula, CA (Elfes *et al.* 2010). However, the levels observed are not expected to have a significant effect on population growth (Elfes *et al.* 2010). DDT and PCB levels are likely to decrease in feeding areas because use of these chemicals has been banned in the U.S., but PBDEs may still be increasing.

Energy exploration and development activities are present in this population's habitat range. There are currently numerous active oil and energy leases and offshore oil rigs off the U.S. west coast. Offshore LNG terminals have been proposed for California and Baja California. The feeding grounds for this population are therefore an active area with regard to energy exploration and development. However, there are no plans at present to open the West Coast to further drilling. Alternative energies, such as wind and wave energy, may be developed in the future in this region. Currently, the threat posed to this population by energy exploration and development is low, and is considered stable.

Utilization for Commercial, Recreational, Scientific, or Educational Purposes

Whale-watching tourism and scientific research occur, at relatively low levels, on both the feeding and breeding grounds of this population as well as along the migratory route. Whale-watching is highly regulated in U.S. waters. Many Central American countries also have whale-watching guidelines and regulations in the breeding ground of this population. Whale-watching is therefore not considered a threat to this population. Scientific research activities such as observing, collecting biopsies, photographing, and recording underwater vocalizations of whales occurs throughout this population's range, though no adverse effects from these events have been recorded.

No whaling currently occurs in this population's range.

Disease or Predation

There is little information on the impacts of disease, parasites or algal blooms on this population. Harmful algal blooms (HABs) of dinoflagellates and diatoms exist within the feeding range of this population, but there have been no records of humpback whale deaths as a result of exposure. The occurrence of HABs is expected to increase with the growth of various types of human-related activities but does not pose a threat to this population currently.

Though the occurrence and impacts of predation on humpback whales is not well understood, some evidence of killer whale and shark attacks exists for this DPS. Evidence of killer whale attacks is relatively high in California waters, with 20% of humpback whales showing scars from previous attacks (Steiger *et al.* 2008). Scars from attacks are believed to have originated in the winter when whales are in Mexican and Central American waters. However, this is not regarded as a serious threat to population growth. Shark predation likely occurs as well, though it is not known to what degree but it does not appear to be adversely impacting this population.

Other Natural or Human-Related Threats

There is no evidence to suggest that competition with fisheries poses a threat to this population. Humpback whales in southern and central California feed on small schooling fish including sardine, anchovy and herring all of which are commercially harvested species. In addition, they also feed on krill, which are not harvested off the U.S. west coast. Humpback whales are known to be foraging generalists. Although their piscivorous prey is subject to naturally- and anthropogenically-mediated fluctuations in abundance, there is no indication that fishery-related takes are substantially decreasing their food supply.

This population is likely exposed to relatively high levels of underwater noise resulting from human activities, including commercial and recreational vessel traffic, and activities in U.S. Navy test ranges. Exposure is likely chronic and at relatively high levels. It is not known if exposure to underwater noise affects humpback whale populations, and this threat does not appear to be significantly impacting current population growth.

Vessel collisions and entanglement in fishing gear pose the greatest threat to this population. Especially high levels of large vessel traffic are found in this population's range off Panama, southern California, and San Francisco. Several records exist of ships striking humpback whales (Carretta *et al.* 2008; Douglas *et al.* 2008), although it is likely that not all incidents are reported. Two deaths of humpback whales were attributed to ship strikes along the U.S. West Coast in 2004-2008 (Carretta *et al.* 2010). Ship strikes are probably underreported and the level of associated mortality is also likely higher than the observed mortalities. Vessel collisions were determined to pose a medium risk (level 2) to this population, especially given the small population size. Shipping traffic will probably increase as global commerce increases; thus, a reasonable assumption is that the level of ship strikes will also increase.

Between 2004 and 2008, 18 humpback whale entanglements in commercial fishing gear off California, Oregon, and Washington were reported (Carretta *et al.* 2010), although the actual number of entanglements may be underreported. Effective fisheries monitoring and stranding programs exist in California, but are lacking in Central America and much of Mexico. Levels of mortality from entanglement are unknown and do vary by region, but entanglement scarring rates indicate a significant interaction with fishing gear. Currently there is no aquaculture activity on the feeding grounds of this population, though migrating individuals may encounter some aquaculture operations in very coastal waters off Mexico. Humpback whales in this DPS are not considered to be adversely affected by aquaculture.

Overall population level effects from global climate change are not known; nonetheless, any potential impacts resulting from this threat will almost certainly increase. Humpback whales feeding off southern and central California have a flexible diet that includes both krill and small pelagic fishes. Acidification of the marine environment has been documented to impact the physiology and development of krill and other calcareous marine organisms which may reduce their abundance and subsequent availability to humpback whales in the future (Kurihara 2008). However, the diet flexibility of humpback whales in this region may give this population some resilience to a climate change effect on their prey base compared to Southern Hemisphere humpback whales that have a more narrow krill-based diet. Currently, climate change does not pose a significant threat to the growth of this population.

D.5.2 Extinction Risk

The Central America DPS has a relatively small population size (Calambokidis *et al.* 2008). The estimated number of mature individuals may be less than 250 and there are no data available to determine a population-level growth rate for this DPS, which adds uncertainty to the current status of this DPS. In light of historical records of whaling on the feeding grounds of this population and neighboring feeding grounds, this population likely remains well below pre-exploitation size despite observed positive population trends in other populations over the past decades. The Bay City, WA shore station took 1,331 humpback whales from 1911-1919 (Clapham *et al.* 1997). Shore stations at Moss Landing and Trinidad in California took 1,871 humpback whales between 1919 and 1926 (Clapham *et al.* 1997). When combined with records from factory ships operating off Alaska and the shore station at Bay City, WA, 5,084 humpback whales were taken from 1919-1926 (Clapham *et al.* 1997). From 1956-1965, a further 841 humpback whales were killed by California shore whaling stations, likely depleting this population again while numbers were still low from the earlier 1900s (Clapham *et al.* 1997). Entanglement scarring rates in this population indicate a significant interaction with fishing gear and vessel collisions may be impacting population growth to a small degree. The Central America DPS is therefore considered to be at moderate risk of extinction over the next three generations (a conclusion that was supported by 56% of votes by the BRT). The potential for this DPS to be at high risk of extinction was also considered and received 28% of the votes, largely reflecting uncertainty regarding population size and population trend. The potential for this DPS to not be at risk was given 16% of the votes.

D.5.3 Significant portion of its range

The BRT concluded that the Central America DPS was likely to be at moderate to high risk throughout its entire range. The BRT concluded that the threats identified are likely to impact the DPS in its entirety. The BRT therefore concluded that the DPS was at moderate-to-high risk throughout its range and not at high risk in only a significant portion of its range.

D.6 Mexico

A preliminary estimate of abundance of the Mexico DPS is 6,000-7,000 from the SPLASH project (Calambokidis *et al.* 2008), or higher (Barlow *et al.* 2011). There are no estimates of precision associated with that estimate, so there is considerable uncertainty about the actual population size. However, the BRT was confident that the population is likely to be much greater than 2000 in total size. Estimates of population growth trends do not exist for the Mexican population by itself. Although no specific growth rate has been estimated for this population, the growth rate for the entire North Pacific population is estimated at 4.9% (Calambokidis *et al.* 2008). The California/Oregon feeding population is comprised of a mixture from this DPS and whales from the Central America DPS; this feeding population has been estimated to be growing at a rate of ~8% per year from 1991-2008 (Calambokidis *et al.* 2008). Whales from Mexico comprise the majority of whales in this feeding area, which indicates this population is very likely increasing. Similarly, some whales from Mexico migrate to the Gulf of Alaska, where a growth rate of 6.6% per year was observed from 1987-2003 for the area ranging from the Shumagin Islands through Kodiak Island (Zerbini *et al.* 2006a). Finally, between 1991 and 2007, a 10.6% annual increase in population size was calculated for Southeast Alaska (Dahlheim *et al.* 2009), which is close to the maximum biologically plausible level. Given the evidence of population growth throughout most of the primary feeding areas of the Mexico DPS (California/Oregon, Gulf of Alaska from the Shumagins to Kodiak), it was considered unlikely this DPS was declining, but the BRT noted that a reliable, quantitative estimate of the population growth rate for this DPS is not currently available.

D.6.1 Threats Analysis

Habitat or Range Curtailment

Breeding locations used by this population (and migratory routes to get to aggregation areas) are adjacent to large human population centers. The population may, therefore, be exposed to adverse effects from a number of human activities, including fishing activities (possible competition with fisheries), effluent and runoff from human population centers as coastal development increases, activities associated with oil and gas development, and a great deal of vessel traffic.

Southern California humpback whales were found to have the highest levels of DDT, PCBs, and PBDEs of all North Pacific humpback whales sampled on their feeding grounds (Elfes *et al.* 2010). The DDT levels detected were greater than those found in the typically more contaminated Gulf of Maine humpback whales possibly due to the historical dumping of DDT off Palos Verdes Peninsula (Elfes *et al.* 2010). It is not possible to state unequivocally if population level impacts occur as a result of these contaminant loads, but Elfes *et al.*(2010) suggested the levels found in humpback whales are unlikely to have a significant impact on their persistence as a population.

There are currently numerous active oil and energy leases and offshore oil rigs off the U.S. west coast. Offshore LNG terminals have been proposed for California and Baja California. The feeding grounds for this population are therefore an active area with regard to energy exploration and development. However, there are no plans at present to open the West Coast to further drilling. Alternative energies, such as wind and wave energy, may be developed in the future in this region. Currently, the threat posed to this population by energy exploration and development is low, and is considered stable.

Naturally occurring biotoxins from dinoflagellates and other organisms are known to exist within the range of this population, although there are no records of known humpback whale deaths attributable to biotoxin exposure in the Pacific. The occurrence of HABs is expected to increase with nutrient runoff associated with the growth of various types of human-related activities. The level of certainty in the impacts of exposure to HABs is moderate.

Utilization for Commercial, Recreational, Scientific, or Educational Purposes

No whaling currently occurs in this DPS' range.

The Mexico humpback whale DPS is exposed to some whale watching activities in both U.S. and Mexican waters, but at low levels. Adverse effects from whale watching have not been documented, and overall impact of whale watching is expected to be low and stable.

This population is exposed to some scientific research activities in both U.S. and Mexican waters, but at relatively low levels. Adverse effects from research activities have not been identified, and overall impact is expected to be low and stable.

Under Mexican law, all marine mammals are listed as "species at risk" and are protected under the General Wildlife Law (2000). Amendments to the General Wildlife Law to address impacts to whales by humans include: areas of refuge for aquatic species; critical habitat being extended to aquatic species (including cetaceans), prohibition of the import and export of marine mammals for commercial purposes (enacted in 2005), and protocol for stranded marine mammals (2011). Mexican Standard 131 on whale watching includes avoidance distances and speeds, limits on number of boats, and protection from noise (no echo sounders). Two protection programs for humpback whales (regional programs for protection) have been proposed for the regions of Los Cabos and Banderas Bay (Bahia de Banderas).

Disease or Predation

With regard to natural mortality, and considering all feeding areas assessed, the California population had a higher incidence of rake marks attributed to killer whale attacks (20%) than other populations (Steiger *et al.* 2008). Most of the attacks are thought to occur on calves in breeding/calving areas, and levels observed in the California group likely result from a propensity for killer whale attacks in Mexican breeding areas (Steiger *et al.* 2008). Though a factor in the ensured longevity of this population, it does not appear to be preventing population recovery (Steiger *et al.* 2008).

There is little to no information on the impacts of disease or parasites on this DPS.

Other Natural or Human-Related Threats

This population is likely exposed to relatively high levels of underwater noise resulting from human activities. These may include, for example, commercial and recreational vessel traffic, and activities in U.S. Navy test ranges. The overall population-level effects of exposure to underwater noise are not well-established, but exposure is likely chronic and at relatively high levels. As vessel traffic and other activities are expected to increase, the level of this threat is expected to increase. The level of confidence in this information is moderate.

Of the 17 records of stranded North Pacific humpback whales in the NMFS stranding database, three involved fishery interactions, two were attributed to vessel strikes, and in five cases the cause of death could not be determined (Carretta *et al.* 2010). Specifically, between 2004 and 2008, 14 humpback whales were reported seriously injured in commercial fisheries offshore of California and two were reported dead. What proportion of these represent the Mexican breeding population is unknown. Fishing gear involved included gillnet, pot, and trap gear (Carretta *et al.* 2010). Between 2004 and 2008, there were two humpback whale mortalities resulting from ship strikes reported and eight ship strike attributed injuries for unidentified whales in the California-Oregon-Washington stock as defined by NMFS, and some of these may have been humpback whales (Carretta *et al.* 2010).

Overall population level effects from global climate change are not known; nonetheless, any potential impacts resulting from this threat will almost certainly increase. The BRT concluded that currently climate change is not a risk to the DPS, but the level of confidence in the magnitude of this threat is poor.

D.6.2 Extinction Risk

Overall, the DPS is estimated to contain in the range of 6,000-7,000 individuals and is likely growing at a rate of about 4.9% or more per year (Calambokidis *et al.* 2008). Considering the current estimated size and growth of this DPS, coupled with an assessment of threats that are not expected to severely curtail growth or threaten the existence of the DPS as a whole, the BRT allocated 92% of votes to "not at risk" of extinction, and 8% of votes to "moderate risk" of extinction. The 8% of votes for "moderate risk" reflect the threat of entanglement and the unknown severity of the threats disease and parasites, but given the large (and increasing) population size, these threats are not likely to significantly impact the DPS.

D.6.3 Significant portion of its range

There are some regional differences in threats for the Mexico DPS, and some evidence for minor substructure within the DPS due to multiple breeding locations associated with somewhat distinctive feeding grounds. However, the BRT was unable to identify portions of the DPS that faced particularly high threats compared to other portions of the DPS or that appeared to be at high risk of extirpation. The BRT therefore concluded that the DPS was not at risk of extinction in only a significant portion of its range.

D.7 Okinawa/Philippines DPS and Second West Pacific DPS

The BRT agreed it is likely that the Western North Pacific (WNP) includes two DPSs: one that winters primarily in the Ryukyu Islands (*e.g.*, Okinawa) and the Philippines, and a second that winters, primarily, in an unknown location. Both DPSs are thought to overlap in Ogasawara, similar to the mixing of whales from the Eastern North Pacific in Baja, Mexico.

The abundance of humpback whales in the WNP is estimated to be around 1,000, based on the photo-identification, capture-recapture analyses from the years 2004-2006 by the SPLASH program (Calambokidis *et al.* 2008). This estimate assumed that the two primary sampling regions, Okinawa and Ogasawara, represented a single intermingling population - there are no estimates of abundance for the two proposed DPSs individually. The growth rate of the WNP is estimated to be 6.9% (Calambokidis *et al.* 2008) between 1991-93 and 2004-06, although this could be biased upwards by the comparison of earlier estimates based on photo-identification records from Ogasawara and Okinawa with current estimates based on the more extensive records collected in Ogasawara, Okinawa and the Philippines during the SPLASH program. However, the overall number of whales identified in the Philippines was small relative to both Okinawa and Ogasawara, so any bias may not be large. Given the possible bias in the rate of increase and the fact that it represents a combination of one DPS with at least a portion of a second DPS, it is not possible to make a definite statement about the rate of increase of either DPS. Overall recovery seems to be slower than in the Central and Eastern North Pacific. Humpback whales in the WNP remain rare in some parts of their former range, such as the coastal waters of Korea, and have shown no signs of a recovery in those locations (Gregr 2000; Gregr *et al.* 2000).

D.7.1 Threat Analysis

Habitat or Range Curtailment

Humpback whales in the WNP (both of the DPS described above) are at some risk of habitat loss or curtailment from a range of human activities. Confidence in information about, and documentation of, these activities is relatively good, except on the unknown breeding grounds of the Second West Pacific DPS. Given continued human population growth and economic development in most of the Asian region, these threats can be expected to increase.

Coastal development, including shipping, and habitat degradation are potential threats along most of the coast of Japan, South Korea and China. Organochlorines and mercury are found in relatively high levels in most cetaceans along the Asian coast (Simmonds 2002). Although the threat to the health of these DPS is unknown, the accumulation of these pollutants can be expected to increase over time.

The BRT noted that the Sea of Okhotsk currently has a high level of energy exploration and development and these activities are likely to expand with little regulation or oversight. They determined that the threat posed by energy exploration to the Okinawa/Philippines DPS is medium, but noted that there was low certainty regarding this since specifics of feeding location (on or off the shelf) are unavailable. If feeding activity occurs on the shelf in the Sea of Okhotsk, energy exploration in this area could impact what is likely one of the most depleted subunits of humpback whales.

As above, naturally occurring biotoxins from dinoflagellates and other organisms are known to exist within the range of these DPS, although known humpback whale deaths attributable to biotoxin exposure do not exist in the Pacific. The occurrence of HABs is expected to increase with the growth of various types of human- related activities. The level of confidence in the predicted increase is moderate.

Utilization for Commercial, Recreational, Scientific, or Educational Purposes

There are no proposals for scientific, aboriginal/subsistence or commercial hunting of humpback whales in the North Pacific under consideration by the IWC at this time. Some degree of illegal, unreported or unregulated (IUU) exploitation, including ‘commercial bycatch whaling’, has been documented in both Japan and South Korea through genetic identification of whale meat sold in commercial markets (Baker *et al.* 2000; Baker *et al.* 2006). Some degree of IUU exploitation is also possible in other regions within the range of humpbacks in the WNP humpback, including Taiwan and the Philippines, given past histories of whaling. The full extent of IUU exploitation is unknown. Official reports of whales taken as bycatch entanglement and destined for commercial markets are considered to be incomplete (Lukoschek *et al.* 2009).

There is some whale-watching and non-lethal scientific research in Japanese waters, primarily in Ogasawara and Okinawa, but this is at low levels and not thought to pose a risk to this DPS.

Disease or Predation

The evidence of killer whale attacks is low (6-8%) relative to other North Pacific humpback whales (Steiger *et al.* 2008). Certainty in this information is considered moderate and the magnitude is expected to remain stable. There are no reports of disease in this population and levels of parasitism are unknown. Trends in the severity of disease and parasitism are also unknown.

Other Natural or Human-Related Threats

The WNP DPSs are likely to be exposed to relatively high levels of underwater noise resulting from human activities that may include commercial and recreational vessel traffic, and military activities. Overall population-level effects of exposure to underwater noise are not well established, but exposure is likely chronic and at relatively high levels. As vessel traffic and other activities are expected to increase, the level of this threat is expected to increase. The level of confidence in this information is moderate.

The likely range of the Okinawa/Philippines DPS includes some of the world's largest centers of human activities and shipping. Although reporting of ship strikes is requested in the Annual Progress reports to the IWC, reporting by Japan and Korea is likely to be poor. A reasonable assumption, although not established, is that shipping traffic will increase as global commerce increases; thus, a reasonable assumption is that the level of the threat will increase. The threat of ship strikes was therefore considered to be medium for the Okinawa/Philippines DPS and unknown for the Second West Pacific DPS.

The Fisheries Agency of Japan considers whales to be likely competitors with some fisheries, although direct evidence of these interactions is lacking for humpback whales in the region (other than net entanglement). Whales along the coast of Japan and Korea are at risk of entanglement related mortality in fisheries gear, although overall rates of net and rope scarring are similar to other regions of the North Pacific (Brownell *et al.* 2000). The threat of mortality from any such entanglement is high given the incentive for commercial sale allowed under Japanese and Korean legislation (Lukoschek *et al.* 2009). The reported number of humpback whale entanglements/deaths has increased for Japan since 2001 as a result of improved reporting, although the actual number of entanglements may be underrepresented in both Japan and Korea (Baker *et al.* 2006). The level of confidence in understanding the minimum magnitude of this threat is medium for the Okinawa/Philippines DPS and low for the Second West Pacific DPS, given the unknown wintering grounds and primary migratory corridors.

Overall population level effects from global climate change are not known; nonetheless, any potential impacts resulting from this threat will almost certainly increase. The level of confidence in the magnitude of this threat is poor.

D.7.2 Extinction Risk

Humpback whales in the WNP are exposed to a number of known and suspected direct and indirect threats from human activities. The levels of these threats are higher than in most other regions of the world and are expected to increase, rather than decline. Humpback whales remain rare in parts of their former range and overall recovery seems to be slower than most other populations around the world. An assessment of the WNP humpback whale (as a single population) has been submitted to the IUCN Cetacean Specialist Group with the recommendation that the population be listed as Vulnerable VU (D1) Category and criteria (Brownell Jr. *et al.* 2010).

In voting on extinction risk for the Okinawa/Philippines DPS, 36% of the votes were high risk, 44% were moderate risk and 21% were not at risk (percent of votes in each category is rounded to nearest whole number). In voting on extinction risk for the second WNP DPS, 14% of the votes were high risk, 47% were moderate risk and 39% were not at risk.

D.7.3 Significant portion of its range

The BRT concluded that both Western Pacific DPSs were likely to be at moderate-to-high risk throughout their entire ranges. The BRT concluded that the threats identified are likely to impact the DPSs in their entirety. The BRT therefore concluded neither Western Pacific DPS was at high risk of extinction in only a significant portion of its range.

D.8 West Australia

Abundance of northbound humpback whales in the southeastern Indian Ocean in 2008 was estimated at 21,750 (95% CI = 17,550-43,000) based upon line transect survey data (Hedley *et al.* 2009). The current abundance appears likely close to the historical abundance for the DPS, although there is some uncertainty of the historical abundance due to difficulties in allocating catch to specific breeding populations (IWC 2007a). The current abundance is large relative to any of the general guidelines for viable abundance levels (see earlier discussion). The rate of population growth is estimated to be ~10% annually since 1982, which is at or near the estimated physiological limit of the species (Bannister 1994; Bannister and Hedley 2001) and well above the interim recovery goal.

D.8.1 Threats Analysis

<u>Habitat or Range Curtailment</u>
The threat posed by energy development to the Western Australia population was considered medium because of the substantial number of oil rigs and the amount of energy exploration activity in the region inhabited by the whales (indicator CO-26 in (Beeton *et al.* 2006)). Additionally, there are proposals for many more oil platforms to be built in the near future, which are highly likely to be executed (Department of Industry and Resources 2008).

Coastally populated areas are increasing rapidly, and while the threat associated with coastal development is currently considered low, it is expected to increase. Although contaminant levels in humpback whales in this region are unknown, the threat level was considered low given what is known of contaminant levels in other populations.

There have been no records of humpback whale deaths as a result of exposure to HABs in this DPS, thus the threat is considered low.

<u>Utilization for Commercial, Recreational, Scientific, or Educational Purposes</u>
No whaling occurs in this DPS' range.

Whale-watching tourism and scientific research occur, at relatively low levels, throughout this DPS' range. Therefore, these threats are considered low.

<u>Disease or Predation</u>
There are no recent studies of disease or parasitism in this DPS, but there are no indications that they represent a substantial threat to the DPS.

<u>Other Natural or Human-Related Threats</u>
Competition with fisheries is considered a low threat to humpback whales off the coast of Western Australia due to the lack of spatial and temporal overlap with fisheries and whales. The threat of offshore aquaculture is considered low, but aquaculture activities may be increasing in this region. In the Southern Hemisphere, humpback whales feed almost entirely on krill (*Euphausia superba*). There is a regulated commercial harvest of krill, but harvest levels are currently small and there is no evidence that this threatens the food supply of humpback whales (Everson and Goss 1991; Nicol *et al.* 2008).

Coastally populated areas are increasing rapidly, with associated development of ports bringing increased risks of ship strikes. All ship strikes in Commonwealth waters must be reported by law, and a summary of these has been provided to the IWC annually since 2006. Since this time there has only been one report concerning a possible humpback ship strike in Western Australian waters (IWC 2009b). The threat of ship strikes in Western Australia is considered low, but likely increasing.

There are 25 records of humpback whale entanglement events between 2003 and 2008 in this region, with western rock lobster fishing gear most frequently implicated (Doug Coughran pers comm. IWC 2004a; IWC 2005a; IWC 2006a; IWC 2007c; IWC 2008). A rise in marine fishing debris has also been reported for the region (Environment Western Australia 2007), which suggests that there may be an increasing risk of entanglement.

Climate change may impact the West Australia DPS of humpback whales in multiple ways. Sea level rise, ocean warming and ocean acidification may all negatively impact the reef system providing shallow, protected waters for breeding. Ocean acidification also has a documented impact on krill growth and development (Kurihara 2008), the primary prey item for Southern Hemisphere humpback whales. Krill are tightly associated with sea ice (Brierley *et al.* 1999; Brierley *et al.* 2002), and decreasing sea ice may negatively impact krill abundance and/or distribution. Decreases in krill abundance have been observed around the Antarctic Peninsula (Atkinson *et al.* 2004). Overall population level effects from global climate change and anthropogenic noise are not known and the threat was ranked low; nonetheless, any potential impacts resulting from these threats will almost certainly increase.

D.8.2 Extinction Risk

The BRT did identify some threats to the DPS, particularly extensive oil and gas development near the breeding grounds and migratory areas along the western Australian coast, some risk from entanglement in coastal fisheries, and the potential effects of climate change on the DPS' Southern Ocean prey base. The BRT concluded, however, that large population size and the demonstrated high growth rate of the DPS indicate that these threats are not significantly impacting the DPS now, and would need to become much more severe to create a moderate or high risk of extinction in the future. As a group, the BRT was confident (97% of likelihood points) that the Western Australia DPS is not at risk of extinction (3% of likelihood points were attributed to moderate" risk of extinction).

D.8.3 Significant portion of its range

The BRT concluded that the effect of any geographically localized threats would be seen in the status of the DPS as a whole. The BRT was unable to identify portions of the DPS that both faced particularly high threats and were so significant to the viability of the DPS as a whole that if lost would result in remainder of the DPS being at high risk of extinction. The BRT therefore concluded that the DPS was not at risk in a significant portion of its range.

D.9 East Australia

Abundance of the east Australia DPS was estimated to be 6,300-7,800 (95% CI: 4,040-10,739) in 2005 based on photo-ID data (Paton and Clapham 2006; Paton *et al.* 2008; Paton *et al.* 2009). The annual rate of increase is estimated to be 10.9% for humpback whales in the southwestern Pacific Ocean (Noad *et al.* 2008), well above the interim recovery goal. This estimate of population increase is very close to the biologically plausible upper limit of reproduction for humpbacks (Zerbini *et al.* 2010). The surveys presented by Noad *et al.* (2005; 2008) have remained consistent over time, with a strong correlation ($r > 0.99$) between counts and years.

D.9.1 Threats Analysis

<u>Habitat or Range Curtailment</u>
Whales migrating southward to the feeding grounds as well as a portion of those migrating north, follow the east coast of Australia and many or most are confined to a narrow corridor near the coast (Bryden 1985; Noad *et al.* 2008) passing several large cities. Increasing coastal development is possible in these areas, but they represent a minor portion of the total migratory route. As with coastal development, sources of pollution for the east Australia DPS are concentrated in a few locations along the migratory route. The breeding area for this DPS is primarily within the Great Barrier Reef Marine Park (Chittleborough 1965; Simmons and Marsh 1986), which has a comprehensive set of state and federal protection laws. However, during tropical floods, farmland runoff may bring significant quantities of pollutants (pesticides, fertilizers) down several rivers that empty into the Great Barrier Reef area (Haynes and Michalek-Wagnera 2000). To date there are no known documented impacts of contaminants on humpback whale survival and fecundity. Oil and gas exploration and drilling are prohibited within the Great Barrier Reef Marine Park. However, oil and gas production occurs in Bass Strait (Australian Government 2006), a region used by some whales of this DPS as they migrate to feeding grounds. Overall, these threats were considered to pose a low risk to this DPS.

<u>Utilization for Commercial, Recreational, Scientific, or Educational Purposes</u>
Anthropogenic disturbance of this DPS occurs primarily on the breeding ground. Whale-watching tourism in eastern Australia (Queensland) has seen an annual average growth rate of 8.5% since 1998 (this includes boat and land-based operations and both whale- and dolphin-

watching trips O'Connor *et al.* 2009). In New South Wales, boat-based whale- and dolphin-watching has seen a 2.6% increase between 2003 and 2008. However, Queensland has a substantial whale-watching management program (O'Connor *et al.* 2009), including restricting access to areas deemed essential for humpback conservation, and Australia has national whale-watching guidelines. With these regulations in place, the threat level was considered low.

Scientific research activities on this DPS occur at the feeding grounds, breeding grounds and along the migratory route. Photo-identification studies, biopsy efforts and other field studies do exist. However, adverse effects from research activities have not been documented and threats are considered low. Finally, proposed scientific whaling in the Antarctica feeding grounds would occur in areas where the east Australia DPS is known to feed (Nishiwaki *et al.* 2007). However, at this time no whaling in these feeding grounds is occurring. Should proposed whaling take place, impacts to this DPS should be revisited with information on where the whaling will occur.

Disease or Predation

There is little to no information on the impacts of disease, parasites or predation on this DPS. Evidence for killer whale interaction is documented, and 17% of photo-identified humpback whales in east Australia show scarring on their flukes, most of which is consistent with interactions with killer whales (Naessig and Lanyon 2004). There is no evidence to suggest that this level of predation is outside the norm for the DPS. Given the population size and current growth rate, disease, predation and parasitism seem unlikely to pose a significant threat to this DPS.

Other Natural or Human-Related Threats

There is no published information on negative impacts of offshore aquaculture, competition with fisheries or HABs on this DPS. In the Southern Hemisphere, humpback whales feed almost entirely on krill (*Euphausia superba*). There is a regulated commercial harvest of krill, but harvest levels are currently small and there is no evidence that this threatens the food supply of humpback whales (Everson and Goss 1991; Nicol *et al.* 2008).

Vessel collisions and entanglement in fishing gear pose the greatest anthropogenic risks to the east Australia DPS. Thirteen ship-strike incidents and five deaths have been reported between 2003 and 2008 (summarized in Fleming and Jackson 2011) and an additional ship-strike was recorded in 2009 with the whale being seriously injured (IWC 2010a). Both fishing vessels and commercial vessels have been involved in these incidents. Given the probable increase in fishing, tourism and commercial shipping, the threat is likely to increase. Entanglements are regularly reported along the east coast of Australia and 57 entanglements have been documented between 2003-2008, with 13 confirmed deaths (Fleming and Jackson 2011). In addition, six humpback whales were entangled in shark control nets and released in 2009 (IWC 2010b). These totals are likely underestimates as not all entanglements are reported and some are not identified to species. The majority were recorded in shark nets and occurred along the migratory route (Fleming and Jackson 2011). Although not insignificant, given the population size and estimated growth rate, the threat level posed by these factors is considered low. Anthropogenic noise is also a possible threat to this DPS. There are several commercial shipping routes through the Great Barrier Reef breeding ground and along the coastal migratory route that likely result in some underwater noise exposure. Migration through Bass Strait would also expose whales to energy exploration and production noise. There is no information concerning exposure of whales to underwater military activities.

Climate change may impact the east Australia DPS of humpback whales in multiple ways. Sea level rise, ocean warming and ocean acidification may all negatively impact the reef system providing shallow, protected waters for breeding. Ocean acidification also has a documented impact on krill growth and development (Kurihara 2008), the primary prey item for Southern Hemisphere humpback whales. Krill are tightly associated with sea ice (Brierley *et al.* 1999; Brierley *et al.* 2002), and decreasing sea ice may negatively impact krill abundance and/or distribution. Decreases in krill abundance have been observed around the Antarctic Peninsula (Atkinson *et al.* 2004). Overall population level effects from global climate change and anthropogenic noise are not known and the threat was ranked low; nonetheless, any potential impacts resulting from these threats will almost certainly increase.

D.9.2 Extinction Risk

The east Australia DPS has a relatively high abundance (2005 estimate: 6300-7800; Paton *et al.* 2008). This may be an underestimate as it is thought some demographic groups were likely unequally captured during the mark-recapture period (Paton *et al.* 2008; Paton *et al.* 2009). Population growth rate estimates have been steady at 10.6 – 10.9% since 1978 (Noad *et al.* 2005; Noad *et al.* 2008), a level thought to be near the maximum intrinsic potential of the species (Zerbini *et al.* 2010) and well above the interim recovery goal. The evaluation of population growth rates by Noad *et al.* (2008) appears to be sound with accepted methodologies applied consistently through time. It should be noted, however, that the status of this DPS with respect to pre-whaling conditions has not yet been determined due to difficulties in allocating feeding ground catches among the tropical breeding grounds. The majority of catches (~70%) were concentrated in the years 1958-1961, notably very large illegal takes by the USSR; this led to the complete collapse of the east Australian coastal whaling industry in 1962 (Clapham and Ivashchenko 2009; Clapham *et al.* 2009; Fleming and Jackson 2011).
Because of the relatively high abundance and growth rate, the overall threats to the DPS are deemed low. Furthermore, humpback whales in Australian waters are protected by the Australian Whale Sanctuary, which extends 200nm from Australia's coast. However, ship strikes and entanglements are recorded on a near annual basis and changes in climate could negatively impact their prey resource in the future. There is also a potential for resumption of whaling on their feeding ground (Nishiwaki *et al.* 2007). However, the latter two threats are seen as potential rather than current threats. In voting on extinction risk, 96% of votes were for "not at risk" and 4% were for "moderate risk." The votes in the "moderate risk" category reflected uncertainty regarding entanglement and ship strike rates.

D.9.3 Significant portion of its range

The BRT concluded that the effect of any geographically localized threats would be seen in the status of the DPS as a whole. The BRT was unable to identify portions of the DPS that both faced particularly high threats and were so significant to the viability of the DPS as a whole that if lost would result in remainder of the DPS being at high risk of extinction. The BRT therefore concluded that the DPS was not at risk in a significant portion of its range.

D.10 Oceania

The Oceania humpback whale population is of moderate size (3,827 whales in New Caledonia, Tonga, French Polynesia and Cook Islands combined; CV=0.12) (South Pacific Whale Research Consortium *et al.* 2006); however, no trend information is available for this DPS. The population is quite subdivided and the population estimate applies to an aggregate (although it is known that sub-populations differ in growth rates and other demographic parameters). There are some areas of historical range extent that have not rebounded and other areas without historical whaling information (Fleming and Jackson 2011). There is uncertainty regarding which geographic portion of the Antarctic this population uses for feeding. The complex population structure of humpback whales within the Oceania region creates higher uncertainty regarding demographic parameters and threat levels than for any other DPS.

D.10.1 Threats Analysis

<u>Habitat or Range Curtailment</u>
Surface run-off from nickel strip mines causes habitat degradation and pollution of lagoons in New Caledonia, which is one of the largest producers of nickel globally, yet the effect on the surrounding marine environment has been poorly monitored (e.g. de Forges *et al.* 1998; Labrosse *et al.* 2000; Metian *et al.* 2005). The threat to humpback whales in Oceania from coastal development and contaminants was considered low overall.

The BRT considered the threats of energy exploration and development and offshore aquaculture to the Oceania population to be low but increasing, due to the expected growth of these activities over the next several decades.

The level of threat posed by HABs to humpback whales in Oceania is unknown.

<u>Utilization for Commercial, Recreational, Scientific, or Educational Purposes</u>
Some local whaling of humpback whales was carried out in French Polynesia (Rurutu), the Cook Islands and Tonga during the 20^{th} century (Reeves 2002) but this has ceased since 1960 at Rurutu (Poole 2002), and since 1978 elsewhere (IWC 1981). Whale sanctuaries (local waters where whaling is prohibited) have since been declared in the Exclusive Economic Zones of French Polynesia, Cook Islands, Tonga, Samoa, American Samoa, Niue, Vanuatu, New Caledonia and Fiji (Hoyt 2005), while whales are protected in New Zealand waters under the New Zealand Marine Mammal Protection Act.

Humpback whales are under threat from unregulated scientific whaling in the Antarctic waters directly to the south of Oceania. None have been taken to date, but an annual catch of 50 humpback whales was proposed by Japan in the 2007/2008 season (Nishiwaki *et al.* 2007), as part of its JARPA II research program. This has been held in abeyance while Japan considers that progress is being made by the IWC in its meetings on the "Future of the IWC." It is not known if the proposed take of humpback whales will be reinstated at a future time; however, the effect of this level of annual take on regional population recovery could be substantial.

Whale-watching tourism exists in all four of the principal survey sites in Oceania, with strong growth in the last decade. There is no boat-based, dedicated whale watching industry in American Samoa at present. Whale watching guidelines are in place in Tonga and New

Caledonia, while boat-based whale watching in the Cook Islands, Samoa and Niue is minimal (O'Connor *et al.* 2009). Humpback whales have been at particular risk from excessive boat exposure through whale watching in the Southern Lagoon of New Caledonia, where there are currently 24 working operators. Levels of exposure have been unusually high (peaking during weekend periods), with boats <100m from calves 40% of the time and each whale exposed to an average of 3.4 boats for two hours daily (Schaffar and Garrigue 2008). In 2008, commercial tour operators voluntarily signed a code of conduct and subsequent compliance with this code has significantly reduced the level of daily exposure to boats (South Pacific Whale Research Consortium 2009). Whale watching and other recreational or research-related activities were deemed by the BRT to pose a low level of threat in this region.

<u>Disease or Predation</u>
Mattila and Robbins (2008) reported raised skin lesions along the dorsal flanks of humpback whales in American Samoa. The lesions differ morphologically from the 'depressed' lesions caused by cookie cutter sharks and appear to persist for long periods on the skin, rather than either erupting or healing. There are no reports of these lesions in whaling records, suggesting that this phenomenon is recent. The cause of these lesions is currently unknown (Mattila and Robbins 2008), but they are not considered a threat to the population.

<u>Other Natural or Human-Related Threats</u>
There is little information available from the South Pacific regarding entanglement with fishing gear; two humpback whales have been observed in Tonga entangled in rope in one instance and fishing net in another (Donoghue, pers. comm.). One humpback mother (with calf) was reported entangled in a longline in the Cook Islands in 2007 (South Pacific Whale Research Consortium 2008). Entanglement scars have been seen on humpback whales in American Samoa, but there are not enough data to determine an entanglement rate. Available evidence suggests that entanglement is a potential concern in regions where whales and stationary or drifting gear in the water overlap (Mattila *et al.* 2010). The threat of entanglements was ranked low for the Oceania population.

There is little information available from the South Pacific regarding ship strikes. This threat was ranked low but is expected to increase as vessel activity in the region increases. Similarly, this population is likely exposed to moderate levels of underwater noise resulting from human activities, which may include, for example, commercial and recreational vessel traffic. Overall population-level effects of exposure to underwater noise are not well established, but as vessel traffic and other activities are expected to increase, the level of this threat is expected to increase.

In the Southern Hemisphere, humpback whales feed almost entirely on krill (*Euphausia superba*). There is a regulated commercial harvest of krill, but harvest levels are currently small and there is no evidence that this threatens the food supply of humpback whales (Everson and Goss 1991; Nicol *et al.* 2008). The threat of competition with fisheries was considered low for the Oceania DPS.

Climate change may impact the Oceania DPS of humpback whales in multiple ways. Sea level rise, ocean warming and ocean acidification may all negatively impact the reef system providing shallow, protected waters for breeding. Ocean acidification also has a documented impact on krill growth and development (Kurihara 2008), the primary prey item for Southern Hemisphere humpback whales. Krill are tightly associated with sea ice (Brierley *et al.* 1999; Brierley *et al.*

2002), and decreasing sea ice may negatively impact krill abundance and/or distribution. Decreases in krill abundance have been observed around the Antarctic Peninsula (Atkinson *et al.* 2004). Overall population level effects from global climate change and anthropogenic noise are not known and the threat was ranked low; nonetheless, any potential impacts resulting from these threats will almost certainly increase.

D.10.2 Extinction Risk

The magnitude of each threat facing this population is unknown or fairly low except for entanglement. The voting results showed a spread in point allocation, conveying some uncertainty in the extinction risk of this population. The majority of the votes were for "not at risk" (68% of votes), followed by "moderate risk" (29% of votes) and, then "high risk" (3% of votes). Numerous BRT members noted the lack of trend information, which influenced the distribution of their likelihood points. Two regions where trend information exists (Cook Strait and Fiji) have low or zero growth rates. Some BRT members noted that there are a relatively large number of whales but believed that extinction risk could be greater if the population growth rate is actually negative. Given the lack of data on population growth, the BRT noted their uncertainty in the population's recovery potential pending any significant impact on population abundance. BRT members also noted that IUCN has listed the Oceania population as 'endangered', because of the severe depletion by past commercial and current illegal whaling and the apparently slow rate of recovery.

D.10.3 Significant portion of its range

The Oceania DPS has potentially somewhat greater substructure than most other humpback whale DPS due its extended breeding range, although a lack of strong genetic structure indicates there is likely to be considerable demographic connections among these areas. Some threats, such as whale watching in the Southern Lagoon of New Caledonia, appear to be localized. Nonetheless, the BRT was unable to identify any specific areas where threats were sufficiently severe to be likely to cause local extirpation. The BRT therefore concluded that this DPS is not likely to be at high risk in any significant portion of its range.

D.11 Southeastern Pacific

Individuals of the Southeastern Pacific population migrate from breeding grounds between Costa Rica and northern Peru to feeding grounds in the Magellan Straits and along the Western Antarctic Peninsula. Though no quantitative growth rate information is available for this population, abundance estimates over a 13-year period suggest that the population size is increasing, and abundance was estimated to be 6,504 (95% CI 4270-907) individuals in 2005-2006 (Félix *et al.* 2006a; Félix *et al.* 2011). Total abundance is likely to be larger because only a portion of the DPS was enumerated.

D.11.1 Threats Analysis

<u>Habitat or Range Curtailment</u>
Human population growth and associated coastal development, including port development, disruption and possible partitioning of the marine habitat and increased turbidity in coastal

waters, are potential threats to this population. The presumed migratory route for this population lies in the coastal waters off Costa Rica, Panama, Colombia, Ecuador, Peru, and Argentina and includes some large human population centers in both Central and South America. Currently, the high degree of coastal development in this population's habitat is not substantially affecting the population's size or growth rate and it is considered to be a low-level threat.

Little has been published regarding contaminant levels in this region. However, levels of DDTs, PCBs, and PBPEs are typically lower in Southern Hemisphere feeding areas than off the east or west coasts of the U.S., but little research has been done to confirm lower contaminant levels among Southern Hemisphere whales (Fleming and Jackson 2011). DDT and PCB levels are likely to decrease in feeding areas because use of these chemicals has been banned in many countries, but PBPE use may still be increasing. Man-made contaminants are not considered to be a significant threat to this population.

Energy exploration and development activities are present in this population's habitat range. Oil and gas production is currently increasing in the Gulf of Guayaquil, Ecuador (Félix and Haase 2005). A large number of oil tankers transit through the Straits of Magellan yearly, a notoriously difficult route to navigate. At least one oil spill has resulted from a ship running aground there (Morris 1988). Energy development is likely to expand if oil and gas reserves are discovered in other locations but it does not currently pose a threat to this population.

Harmful algal blooms (HABs) of dinoflagellates and diatoms exist within the feeding range of this population, but there have been no records of humpback whale deaths as a result of exposure in this area. The occurrence of HABs is expected to increase with increased run-off and nutrient input from human- related activities; however, HABs do not pose a threat to this population currently.

<u>Utilization for Commercial, Recreational, Scientific, or Educational Purposes</u>
Whale-watching tourism and scientific research occur, at relatively low levels, throughout this population's range. Whale-watching tourism occurs along all of the South and Central American countries bordering the habitat of this DPS. Whale-watching industry growth has been significant and approximately half of these countries have whale-watching guidelines in place (Hoyt and Iníguez 2008). Though some change in behavior of whales near tourism boats has been noted, whale-watching does not pose a threat to this population currently. Scientific research activities such as observation, biopsying, photographic studies and recording of underwater vocalizations of whales occur in both the breeding and feeding habitats and along this population's migratory route though no adverse effects from these events have been recorded.

No whaling occurs in this population's range.

<u>Disease or Predation</u>
There is little information available on the impacts of disease or parasitism on this population.

Predation does not appear to be a current threat to this population. Killer whale attacks on humpback whales have been observed in this region and scarring from killer whale and potentially false killer whale and shark attacks has been documented from photographic catalogues (Flórez-González *et al.* 1994; Scheidat *et al.* 2000; Félix and Haase 2001). The scarring rate is lower than in some other populations.

Other Natural or Human-Related Threats

In the Southern Hemisphere, humpback whales feed almost entirely on krill (*Euphausia superba*). There is a regulated and growing commercial krill fishery, but harvest levels are currently small and there is no evidence that this threatens the food supply of humpback whales (Everson and Goss 1991; Nicol *et al.* 2008).

Aquaculture activities are high in waters of Argentina and Chile, but the impact of these activities on this population of humpback whales has not been documented and is likely low if few whales use these inland areas. Entanglement was determined to pose a medium threat to this population based on stranding and entanglement observations and spatial and temporal overlap with aquaculture activities.

This population is likely exposed to relatively high levels of underwater noise resulting from human activities, including commercial and recreational vessel traffic, and activities in naval test ranges, and these levels are expected to increase. Especially high levels of large vessel traffic are found off Panama (over 12,000 ship transits annually) and in the Magellan Straits. Naval exercises occur around much of the South American coast annually. It is not known if underwater noise exposure affects humpback whale populations, but this does not currently appear to pose a significant threat to this population.

No ships have reported striking humpback whales in this region but incidents may be under-reported and stranding reports indicate some contribution from vessel collisions (Capella Alzueta *et al.* 2001; Castro *et al.* 2008). Shipping traffic will probably increase as global commerce increases; thus, a reasonable assumption is that the level of vessel collisions will increase. Currently, ship strikes are considered a low level threat to this population.

Entanglement in fishing gear poses the most significant risk to this population. The majority of entanglements involve gillnets and purse seines (Félix *et al.* 1997; Capella Alzueta *et al.* 2001; Alava *et al.* 2005; Castro *et al.* 2008). The artisanal fishing fleet in Ecuador numbers over 15,000 vessels. Scarring rates indicate that close to one third of all observed animals have experienced some level of entanglement (Alava *et al.* 2005). These scarring rates are similar to those observed off the northeast coast of the U.S. Less research effort in the Southeast Pacific region compared to the northeast coast of the U.S. suggests that this reported scarification rate may even be an underestimate of the actual level of entanglement occurring in the Southeast Pacific. The number of dead and entangled whales off Colombia has increased over the last two decades (Capella Alzueta *et al.* 2001). Calves comprise over half of all observed entanglement events, a disproportionate value in light of the calf to adult ratio in the population (Engel *et al.* 2006; Neto *et al.* 2008).

Overall population level effects from global climate change and anthropogenic noise are not known and the threat was ranked low; nonetheless, any potential impacts resulting from these threats will almost certainly increase. Humpback whales in the Southern Hemisphere feed almost entirely on krill (*Euphausia superba*) and acidification of the marine environment has been documented to impact the physiology and development of krill and other calcareous marine organisms, potentially reducing their abundance and subsequent availability to humpback whales in the future. The life cycle of *Euphausia superba* is tied to sea ice, making this prey species vulnerable to warming effects from climate change. Decreases in krill abundance have been observed around the Antarctic Peninsula (Atkinson *et al.* 2004).

D.11.2 Extinction Risk

The Southeastern Pacific DPS has a relatively high abundance (2005-2006 estimate: 6,500 individuals). The growth rate has not been quantitatively estimated, but the qualitative trend in abundance estimates indicates the population is likely to be growing. In light of historical whaling records from the feeding and breeding grounds, recovery from exploitation is estimated to be between 30% and 70% (IWC 2007b) but the data are considered relatively unreliable given the absence of trend estimates for this specific population. Entanglement scarring rates in this population indicate a significant interaction with fishing gear (Capella *et al.* 2008) and pose the greatest threat to this population. Krill stocks may become more variable or may decrease in upcoming decades due to climate change. Given the large population size and apparent positive population growth, this population is considered to be not at risk of extinction over the next three generations (93% of votes). The potential for this population to be at moderate risk of extinction was also considered and received 7% of the votes, largely reflecting uncertainty regarding population trend.

D.11.3 Significant portion of its range

The BRT concluded that the effect of any geographically localized threats would be seen in the status of the DPS as a whole. The BRT was unable to identify portions of the DPS that both faced particularly high threats and were so significant to the viability of the DPS as a whole that if lost would result in remainder of the DPS being at high risk of extinction. The BRT therefore concluded that the DPS was not at risk in a significant portion of its range.

D.12 Brazil

The most recent abundance estimate for this population comes from aerial surveys conducted off the coast of Brazil in 2002-2005 (Andriolo *et al.* 2010). These surveys covered the continental shelf between 6º and 24º30'S and provided a best estimate of 6,400 whales (95% CI = 5,000-8,000) in 2005. This estimate corresponds to nearly 24% of this population's pre-exploitation abundance (Zerbini *et al.* 2006d). Nearly 80% of the whales are found in the Abrolhos Bank, the eastern tip of the Brazilian continental shelf located between 16 and 18ºS (Andriolo *et al.* 2010). The best estimate of population growth rate is 7.4%/year (95% CI = 0.5-14.7%) for the period 1995-1998 (Ward *et al.* 2011).

D.12.1 Threats Analysis

<u>Habitat or Range Curtailment</u>
Human population growth and associated coastal development represent potential threats to coastal populations of humpback whales. These can take many forms, including chemical pollution, increase in ship traffic and underwater noise levels. The coast of Brazil has

experienced various levels of human development within the range of humpback whales. These are of greater intensity along the northeastern coast of the country (between 5º and 12º S), where large human settlements are found (the three main cities – Salvador, Recife and Natal - have 1-3 million inhabitants and have observed population increases of 3% per year since the early 1970s) (Instituto Brasileiro de Geografia e Estatistica 2010). Such population growth has resulted in a substantial rise in effluent discharge in coastal areas used by humpback whales during the breeding season. The stretch of the coast where the largest concentration of humpback whales is found (Abrolhos Bank, 16º-18ºS) has not had the same level of human growth and is relatively pristine compared to areas farther to the north.

There is no evidence that human population growth has had any major direct impact on western South Atlantic humpback whales. In fact, this population has shown strong signs of recovery in the same period in which human growth occurred adjacent to the breeding grounds. Shifts in habitat use and abundance may have occurred on a local basis, but no studies have been conducted to assess these changes. Effects of chemical pollution are largely minimized because these whales don't feed in the tropical wintering grounds. The feeding grounds for western South Atlantic humpback whales are located in relatively remote offshore areas in the Southern Ocean where human activities have been minimal. While potential impacts are unknown, they are probably small in these areas. The current threat of coastal development to this population was ranked as low, but is considered to be increasing.

The construction of new ports along the coast of Brazil has been stimulated by the country's recent economic growth as well as the rapid development of the oil and gas industry. Therefore, a resultant increase in ship traffic will likely increase the probability of ship strikes and possibly result in greater humpback whale mortality off Brazil. The threat posed by energy exploration and development was ranked low but increasing.

The effects of contaminants on this population are unknown. The occurrence of HABs is expected to increase with increased run-off and nutrient input from human-related activities; however, HABs do not pose a threat to this population currently.

<u>Utilization for Commercial, Recreational, Scientific, or Educational Purposes</u>

A seasonal humpback whale-watching industry exists in some parts of the wintering grounds off Brazil. In the Abrolhos Bank, the area of greatest humpback whale concentration, whale-watching is usually associated with other tourist activities. The Bank contains large coral reef formations and the associated biological diversity makes this region an important diving/snorkelling center. Diving with whales is prohibited by federal law in Brazil, but opportunistic whale-watching occurs during diving trips (Morete *et al.* 2003). Most whale-watching operations are concentrated within the Abrolhos National Park and therefore are highly controlled. The maximum number of boats allowed within the park is 15 (Hoyt 2000). Despite great potential, expansion of whale-watching in this region is difficult because of poor tourism infrastructure and because whales are far away from the coast relative to other areas (Cipolotti *et al.* 2005).

A more established whale-watching industry operates farther to the north, near Praia do Forte and Salvador. Most whale watching tours in Bahia State depart from Praia do Forte (Hoyt and Iníguez 2008). In other parts of the humpback wintering grounds (*e.g.* Ilhéus, Itacaré, Porto Seguro) whale-watching can occur in an opportunistic fashion. Often, fishermen are hired to take groups of tourists to see whales, but these are unregulated and occasional. Because of the relatively small scale, whale-watching activities possibly cause limited, if any, impact on humpback whale populations in Brazil. This threat is considered low.

There is currently no commercial whaling in this region.

This humpback whale population is exposed to scientific research activities, but adverse effects from research activities have not been identified, and overall impact is expected to be low and stable.

<u>Disease or Predation</u>
There are studies of disease in the western South Atlantic humpback whale population, but no indication that it represents an issue. Stranded whales have shown different types of bone pathologies (Groch *et al.* 2005), but the incidence of these pathologies are not well known.

A recent increase in humpback whale mortality has occurred along the coast of Brazil. The number of carcasses seen floating at sea or found ashore in 2010 (96 individuals) was nearly 3 fold greater than the average for the period 2002-2009 (29.5 individuals). The causes for this increased mortality are not well understood and are under investigation (Humpback Whale Institute, unpublished data).

Killer whales appear to be the one of the main predators of humpback whales, especially of calves and immature individuals (Clapham 2000). While predation can represent an important source of neonatal/juvenile mortality (Steiger *et al.* 2008), no studies have been conducted to assess its effects on this population.

<u>Other Natural or Human-Related Threats</u>
The threats posed by offshore aquaculture and competition with fisheries were considered low for the Brazil population of humpback whales.

Entanglements in various types of fishing nets have been increasing in the wintering areas (Zerbini and Kotas 1998) but there is no current estimate of mortality. Reports from fishermen indicate that a large proportion of entanglements are comprised of calves (Zerbini and Kotas 1998). In the past 20 years, the number of entanglement cases observed or reported has increased substantially as is the proportion of whales seen in wintering grounds with evidence (*e.g.,* scars) of entanglement in fishing gear (Siciliano 1997; Groch *et al.* 2008)). Interactions of humpback whales with fisheries have been observed throughout the wintering ground and they seem to be increasing as the population grows and re-occupies new or historical habitats. However, there is currently no assessment on the proportion of entanglements resulting in mortality and no estimates of fishery-related mortality for this population. The threat of entanglements was considered low but increasing.

Ship collisions are a well-known cause of mortality in humpback whales (Laist *et al.* 2001), but their incidence among humpback whales in the western South Atlantic is not well known. Reports of collisions with whales have been provided by fishermen and recreational boaters. In addition, photographic/physical evidence of ship strikes has been recorded throughout the wintering grounds off Brazil (*e.g.* Marcondes and Engel 2009). These events have been increasing and seem to be correlated with population recovery, but their conservation implications require further studies. In areas of high whale density (*e.g.,* the Abrolhos Bank), collisions between whales and fishing boats have resulted in permanent damage to the boats. The fate of whales involved in these accidents is not known (Andriolo, unpublished data). Ship strikes were considered a low, but increasing, threat to this population of humpback whales.

The increase in coastal development and ship traffic, the construction of new ports and the expansion of the offshore oil and gas extraction have resulted in a rise of underwater noise levels along the breeding range of humpback whales. Concerns about effects of noise include disruption of behavior, interference with communication, displacement from habitats and, in extreme cases, physical damage to hearing (Nowacek *et al.* 2007). Few studies have been carried out to assess whether and how an increase in noise levels has impacted the western South Atlantic population. Research conducted in Abrolhos Bank (Sousa-Lima and Clark 2008; Sousa-Lima and Clark 2009) showed that the number of singing whales diminished in the presence of low-frequency boat noise and that singing whales stopped calling and changed direction of movement if the sound source was within 7.5km on average. Anthropogenic noise was considered a low, but increasing, threat to the Brazil population of humpback whales.

Climate change may impact the Brazil DPS of humpback whales in multiple ways. Sea level rise, ocean warming and ocean acidification may all negatively impact the reef system providing shallow, protected waters for breeding. Ocean acidification also has a documented impact on krill growth and development (Kurihara 2008), and krill is the primary prey item for Southern Hemisphere humpback whales. Krill are tightly associated with sea ice (Brierley *et al.* 1999; Brierley *et al.* 2002), and decreasing sea ice may negatively impact krill abundance and/or distribution. Decreases in krill abundance have been observed around the Antarctic Peninsula (Atkinson *et al.* 2004). Overall population level effects from global climate change and anthropogenic noise are not known and the threat was ranked low; nonetheless, any potential impacts resulting from these threats will almost certainly increase.

D.12.2 Extinction Risk

Western South Atlantic humpback whales were heavily exploited by commercial whaling. This was the first Southern Hemisphere population to be hunted in the Southern Oceans in the early 1900s (Tønnessen and Johnsen 1982). It is estimated that nearly 30,000 whales were killed by whalers between 1904 and 1963, with nearly 27,000 catches coming from coastal waters of South Georgia (Allison 2006). Currently, the population is relatively large and appears to be growing steadily (Ward *et al.* 2011). A recent Comprehensive Assessment conducted by the IWC (IWC 2007a) estimated that the stock was reduced to nearly 3-5% of the 1900 population size and that is had recovered to 24-32% of its pre-exploitation size in 2006 (Zerbini *et al.* 2006d; IWC 2007a).

Given the large population size and apparent positive population growth, this population is considered to be not at risk of extinction over the next three generations (96% of votes). The potential for this population to be at moderate risk of extinction was also considered and received 4% of the votes.

D.12.3 Significant portion of its range

The BRT concluded that the effect of any geographically localized threats would be seen in the status of the DPS as a whole. The BRT was unable to identify portions of the DPS that both faced particularly high threats and were so significant to the viability of the DPS as a whole that if lost would result in remainder of the DPS being at high risk of extinction. The BRT therefore concluded that the DPS was not at risk in a significant portion of its range.

D.13 Gabon/Southwest Africa

The lower and upper bounds of the abundance estimate for Iguela, Gabon are 6,560 (CV=0.15) for 2001-2004 and 8,064 (CV=0.12) for 2001-2005. These were generated using mark-recapture genetic data, and numerous other (generally similar) estimates are available depending on model assumptions (Collins *et al.* 2008). There are no trends available for this population, and it is not entirely clear how the estimates relate to potential subdivision within the DPS (Collins *et al.* 2008). Using a Bayesian estimation methodology, Johnston and Butterworth (2008) estimate the Gabon population to be in the range of 65-90% of its pre-exploitation size.

D.13.1 Threats Analysis

<u>Habitat or Range Curtailment</u>
For humpback whales utilizing the waters of central western Africa, expanding offshore hydrocarbon extraction activity now poses an increasing threat (Findlay *et al.* 2006). The degree to which humpback whales are affected by offshore hydrocarbon extraction activity is not known but it is believed that long term exposure to low levels of pollutants and noise, as well as the drastic consequences of potential oil spills, could have conservation implications.

The Gulf of Guinea region suffers from pollution and habitat degradation, both from major coastal cities (Lagos, Accra, Libreville, Porto-Nevo) which dispense raw sewage and untreated toxic waste into the marine environment (United Nations Environment Programme 1999), and from unregulated foreign trawling and oil and gas developments (Chidi Ibe 1996). The practice of mining construction materials from the near-shore coastal zone (*e.g.* sand and gravel) is also common in this region, which contributes to habitat degradation (Chidi Ibe 1996). The threat of coastal development is considered low, but increasing.

Certain naturally occurring biotoxins from dinoflagellates and other organisms may exist within the range of this population, although humpback whale deaths as a result of exposure have not been documented in this population. The occurrence of HABs is expected to increase with the growth of various types of human-related activities. The level of confidence in the predicted increase is moderate.

<u>Utilization for Commercial, Recreational, Scientific, or Educational Purposes</u>
Whale-watching in the Gulf of Guinea region is small in scale, with small humpback whale-watching industries documented in Benin, Gabon, São Tomé and Príncipe (O'Connor *et al.* 2009). Whale-watching in South Africa is mainly focused on right whales, with humpback whales watched opportunistically. Boat-based whale-watching has grown 14% in the last

decade, and is concentrated in the western Cape region; South Africa now numbers among the top ten destinations for whale-watching worldwide (O'Connor *et al.* 2009). There are regulations in place for all whale-watching activity in South Africa (Carlson 2007). Whale-watching in Namibia is primarily focused on dolphins, and has seen 20% growth since 2008. The threat posed to this population by whale-watching is considered low.

This humpback whale population is exposed to scientific research activities, but adverse effects from research activities have not been identified, and overall impact is expected to be low and stable.

No commercial whaling occurs in this population's range. If there is an aboriginal hunt at Pagalu it is estimated to be 3 or less individuals per year.

<u>Disease or Predation</u>
There are no reports of disease in this population and levels of parasitism are unknown. Predation likely occurs, though it is not known to what degree but it does not appear to be adversely impacting this population.

<u>Other Natural or Human-Related Threats</u>
There is no known/reported competition with fisheries; this threat is therefore considered low and stable. The threat of offshore aquaculture is considered low.

Certain potential and real effects on cetaceans and other fauna are expected to increase due to the growth of industry activities, including noise disturbance from seismic surveys (Richardson *et al.* 1995). Changes in their behavioral patterns or displacement from migratory, mating, and especially important calving and nursing habitats could impact reproductive success and calf survival during critical stages of development.

Rapid increases in shipping and port construction throughout the Gulf of Guinea (Van Waerebeek *et al.* 2007) are likely to increase the risks of ship strikes for humpback whales. Whales are reported as stranding in Benin, with wounds suspected as originating from ship strikes (Van Waerebeek *et al.* 2007). There are no dedicated stranding networks in the region and ship strikes with oil tankers and other vessels have not been documented. Collisions with vessels are not likely to be a major threat considering the size of the population.

There are entanglement risks for humpback whales in these regions, including a growing commercial shrimp industry off Gabon (Walsh *et al.* 2000), and an expansion in unregulated fishing by foreign fleets in Gulf of Guinea waters (Collins pers. comm., Chidi Ibe 1996; Brashares *et al.* 2004). Entanglement in fishing gear occurs but it is not likely to be a major threat considering the size of the population.

Climate change may impact the Gabon/SW Africa of humpback whales in multiple ways. Sea level rise, ocean warming and ocean acidification may all negatively impact the reef system providing shallow, protected waters for breeding. Ocean acidification also has a documented impact on krill growth and development (Kurihara 2008), and krill is the primary prey item for Southern Hemisphere humpback whales. Krill are tightly associated with sea ice (Brierley *et al.* 1999; Brierley *et al.* 2002), and decreasing sea ice may negatively impact krill abundance and/or distribution. Decreases in krill abundance have been observed around the Antarctic Peninsula

(Atkinson *et al.* 2004). Overall population level effects from global climate change and anthropogenic noise are not known and the threat was ranked low; nonetheless, any potential impacts resulting from these threats will almost certainly increase.

D.13.2 Extinction Risk

The population has an abundance estimate of >8000 animals (Collins *et al.* 2008) but trend information is unavailable. The Gabon/Southwest Africa region appears to serve a variety of purposes with some individual whales remaining in the area through the year while some utilize the area for feeding and others for mating. Boom-bust cycles in whaling records indicate some degree of substructure within this population historically. It is unclear how many oil rigs are in the region but there is heavy vessel traffic along the coast of southwest Africa. There is also seismic activity in the area as energy exploration is expanded. There are very few records of entanglement (1 record in 1996). Whale-watching has increased by 14% in the last decade in the region though the focus of the industry is on right whales.

This population is considered to be not at risk of extinction over the next three generations (93% of votes). The potential for this population to be at moderate risk of extinction was also considered and received 7% of the votes, largely reflecting uncertainty regarding population trend.

D.13.3 Significant portion of its range

The BRT concluded that there was some evidence for population substructure within the DPS, based on an extensive breeding range with some significant genetic differentiation among breeding locations (Rosenbaum *et al.* 2009). However, the BRT was unable to identify any portions of the DPS that both faced particularly high threats and were so significant to the viability of the DPS as a whole that if lost would result in the remainder of the DPS being at high risk of extinction. The BRT therefore concluded that the DPS was not at risk in a significant portion of its range.

D.14 Southeast Africa/ Madagascar

The most recent abundance estimates for the Madagascar population were from surveys of Antongil Bay, 2000-2006 (Cerchio *et al.* 2009). Estimates using data from 2004-2006 and involving "closed" models of photo-identification of individuals and genotype data were 7,406 (CV = 0.37, CI: 2106-12706) and 6,951 (CV = 0.33, CI: 2509-11394), respectively. Additional estimates were made using various data sets (*e.g.*, photo-identification and genotype) and models, estimating 4,936 (CV = 0.44, CI: 2137-11692), and 8,169 individuals (CV = 0.44, CI 3476-19497, Cerchio *et al.* 2009). The mark-recapture data were derived from surveys over several years and thus may represent the abundance of whales breeding off Madagascar, in addition to possibly whales breeding in Mayotte and the Comoros (Ersts *et al.* 2006), and to a smaller degree from the East African Mainland (Razafindrakoto *et al.* 2008).

Earlier estimates exist, including one of 2,532 (CV = 0.27) individuals (Best *et al.* 1996) based on surveys of the continental shelf region across the south and southeast coasts of Madagascar in 1994. However, these surveys likely did not cover the full distribution of humpback whales in the area. Data from a 1991 survey yielded an estimate of 1,954 whales (CV = 0.38) (Findlay *et al.* 1994). A subsequent line transect survey in 2003 included a larger region of the coast (Findlay *et al.* 2011). From these, two estimates were generated in 2003: 6,664 whales (CV = 0.16); and 5,965 (CV = 0.17) when data were stratified by coastal regions.

Two trends in relative abundance have been calculated from land-based observations of the migratory stream passing Cape Vidal, east South Africa in July 1998-2002, and July 1990-2000. The first was an estimate of 12.3% per year (Findlay and Best 2006) (however, this estimate is likely outside biological plausibility for this species (Bannister and Hedley 2001; Noad *et al.* 2008); Zerbini *et al.* 2010); and the second is 9.0% (an estimate that is within the range calculated for other Southern Hemisphere breeding grounds (e.g. Ward *et al.* 2006; Noad *et al.* 2008; Hedley *et al.* 2009). Both rates are considered with caution because the surveys were short in duration. It is not certain that these estimates represent the growth rate of the entire DPS. Given this uncertainty, and the uncertainty from the short duration of the surveys, it is likely the DPS is increasing, but it is not possible to provide a quantitative estimate of the rate of increase for the entire DPS.

D.14.1 Threats Analysis

Habitat or Range Curtailment
Human populations are growing rapidly in coastal areas in Madagascar and East Africa, which may contribute, generally, to humpback whale habitat degradation and related negative influences.

Until recently, oil and gas reserves in east Africa were largely unexplored. However, recently, a number of offshore seismic oil and gas surveys have been conducted in Mozambique, Tanzania, Madagascar and the Seychelles. As a result, drilling is now either underway or planned in all of these regions (Frynas 2004; Findlay *et al.* 2006). As noted elsewhere, such activity brings threats of increased underwater noise from the exploration and development phases themselves, and increased vessel activity; the possibility of an oil spill; possible habitat degradation from such things as drill spoils and dredging; and vessel collisions. In Madagascar, offshore development has been concentrated on the northwest coast; in Mozambique it is concentrated in the Mozambique Basin, Zambezi delta region, while development in Tanzania has been most focused on coastal Zanzibar. Humpback whales occur seasonally in all of these regions. Apparently, there are no local, national, or regional measures in place or contemplated to reduce the impact of these threats.

Levels of exposure of humpback whales in this region to various pollutants are not known, nor is the occurrence of HABs**.** Trends in the extent of this threat likewise are not known.

Utilization for Commercial, Recreational, Scientific, or Educational Purposes
Whale-watching activities are growing rapidly in waters off Mozambique; yet, these are poorly regulated (O'Connor *et al.* 2009). Most of these activities are locally based and involve motorized boats, recreational fishing boats, and dive boats. There is a voluntary code of conduct for operators, but at present this is poorly upheld and no formal regulations or enforcement are currently in place (O'Connor *et al.* 2009). Whale-watching in South Africa is mainly focused on right whales, although the industry at St Lucia in KwaZulu Natal province is focused on

southwestern Indian Ocean humpback whales. Recent political instability in Madagascar has limited the growth rate of whale-watching activities in this region, although growth between 1998-2008 was still estimated at about 15%, with the main industry focused on humpback whales frequenting the Ile Ste Marie/Antongil Bay region, and over 14,000 tourists participating in whale watch tours by 10-15 operators in 2008 (O'Connor *et al.* 2009). This industry has recently developed some guidelines for the protection of humpback whales, which was passed as legislation in 2000 with local regulations for Ile Sainte Marie (Fleming and Jackson 2011) and Antongil Bay (Journal Officiel de la Republique de Madagascar 2000). Whale watch tourism in Mayotte is small-scale, but has expanded rapidly, from no industry in 1998 to 10,000 annual whale watchers in 2008 (O'Connor *et al.* 2009), with a focus on a range of cetacean species. In the Mascarene Islands, the expanding whale-watching industry in La Réunion (3,000 tourists estimated in 2008) is currently unregulated, while in Mauritius large cetacean watching is a minimal component of the whale watch industry and is therefore unlikely to have much impact (O'Connor *et al.* 2009). An industry for watching humpback whales in Mauritius commenced in 2008 (Fleming and Jackson 2011).

No commercial whaling occurs in this population's range. This humpback whale population is exposed to scientific research activities, but at low levels. Adverse effects from research activities have not been identified, and overall impact is expected to be low and stable.

Disease or Predation

There is little to no information on the impacts of disease, parasites, or predation on this DPS.

Other natural or human-related threats

There is little known/reported interaction with fisheries, nor are there any current or planned offshore aquaculture sites in the region. These threats are therefore considered low and stable.

Information regarding fisheries and other activities is limited. Kiszka *et al.* (2009) and Razafindrakoto *et al.* (2008) provided summaries of humpback whale entanglement and strandings based on interviews with artisanal fishing communities. Substantial gillnet fisheries have been reported in the near-shore waters of the coasts of mainland Africa and Madagascar; and to a lesser extent in the Comoros Archipelago, Mayotte and Mascarene Islands, where such practices are hindered by coral reefs and a steep continental slope bathymetry (Kiszka *et al.* 2009). Stranding reports and observations from Tanzania and Mozambique have mostly implicated gillnets, with most Madagascan entanglements associated with long-line shark fishing (Razafindrakoto *et al.* 2008). In Mayotte, humpback whales have been observed with gillnet remains attached to them (Kiszka *et al.* 2009), although no fatalities have yet been documented. Industrial fishing operations, including longlines and drift longlines on fish aggregation devices, purse seine and midwater trawling occur in waters off Mauritius. The extent of bycatch and entanglement in these waters is unknown (Kiszka *et al.* 2009). Strandings and by-catch data from 2001-2005 from South Africa indicated an estimated 15 humpback whales entangled in shark nets (large-mesh gillnets) in KwaZulu Natal province (only one death) while a total of nine stranded whales were reported from the south and east coasts (IWC 2002b; IWC 2003; IWC 2004b; IWC 2005b; IWC 2006b). Fishing activities are prohibited in localized marine protected areas in Mayotte, Moheli (in the Comoros Archipelago), Madagascar (northeast coast), Aldabra (under protection as a UNESCO World Heritage Site) and the coastal region between Southern Mozambique and South Africa.

The range of this population includes some growing centers of human activities. Although there are no known records of ship struck humpback whales in this region, the amount of vessel traffic suggests this is probably a low-level threat. However, a reasonable assumption is that the amount of vessel traffic, and the level of the threat, is likely to increase as commercial shipping, recreational boating, and whale-watching, oil and gas exploration and development, and fishing activities increase.

This population is likely exposed to relatively high levels of underwater noise resulting from human activities, including, for example, commercial and recreational vessel traffic, and activities related to oil and gas exploration and development. Overall population-level effects of exposure to underwater noise are not well established, but exposure is likely chronic and at moderate levels. As vessel traffic and other activities are expected to increase, the level of this threat is expected to increase. The level of confidence in this information is moderate.

Climate change may impact the Southeast Africa/Madagascar DPS of humpback whales in multiple ways. Sea level rise, ocean warming and ocean acidification may all negatively impact the reef system providing shallow, protected waters for breeding. Ocean acidification also has a documented impact on krill growth and development (Kurihara 2008), and krill is the primary prey item for Southern Hemisphere humpback whales. Krill are tightly associated with sea ice (Brierley *et al.* 1999; Brierley *et al.* 2002), and decreasing sea ice may negatively impact krill abundance and/or distribution. Decreases in krill abundance have been observed around the Antarctic Peninsula (Atkinson *et al.* 2004). Overall population level effects from global climate change and anthropogenic noise are not known and the threat was ranked low; nonetheless, any potential impacts resulting from these threats will almost certainly increase.

D.14.2 Extinction Risk

Overall, the population is estimated to contain in the range of 6,000-8,000 individuals and is likely growing. The principal threat to humpback whales in this population is entanglement in fishing gear (ranked a moderate threat). Given the size and growth of this population and threats that are not expected to severely curtail growth or threaten the existence of the population as a whole, this group is considered not at risk of extinction (96% of votes; 4% of votes for "moderate" risk of extinction).

D.14.3 Significant portion of its range

The BRT concluded that the effect of any geographically localized threats would be seen in the status of the DPS as a whole. The BRT was unable to identify portions of the DPS that both faced particularly high threats and were so significant to the viability of the DPS as a whole that if lost would result in remainder of the DPS being at high risk of extinction. The BRT therefore concluded that the DPS was not at risk in a significant portion of its range.

D.15 Arabian Sea

Mark-recapture studies using tail fluke photographs collected in Oman from 2000-2004 yielded a population estimate of 82 individuals (95% CI: 60-111). However, sample sizes were small, and there are various sources of possible negative bias including insufficient spatial and temporal coverage of the population's suspected range (Minton *et al.* 2010b).

Reproductive rates in this population are not well understood. Cow-calf pairs were very rarely observed in surveys off the coast of Oman, composing only 7% of encounters in Dhofar, and not encountered at all since 2001. Soviet whaling catches off Oman, Pakistan and northwestern India also included low numbers of lactating females (3.5% of mature females) relative to pregnant females (46% of mature females) (Mikhalev 1997).

No trend data are available for this population. A low proportion of immature whales (12.4% of all females) was also found, even though catches were indiscriminate with respect to sex and condition (Mikhalev 1997), suggesting that either calf mortality in this population is high, immature animals occupy areas that have not been surveyed, or that the whales have reproductive 'boom and bust' cycles which respond to high annual variation in productivity. The BRT noted that the entire region has not been surveyed; however, in areas where the whales are likely to be, not many whales have been observed. The BRT noted that this is a very small population but felt that there was some uncertainty in abundance estimates.

<u>Habitat or Range Curtailment</u>

The BRT determined that the threat posed by energy exploration to the Arabian Sea population should be classified as high given the small population size and the present levels of energy activity. A catastrophic event similar to that of the Deepwater Horizon Oil Spill in the Gulf of Mexico could be devastating to this population, especially in light of the year-round presence of humpback whales in this area.

The effect of pollutants on cetaceans is a concern in the region, as the Arabian Sea is a center of intense human activity with poor sea circulation, so pollutants can persist for long periods (Minton 2004). Since the 1970s, the coastal and marine infrastructure in Oman has developed at a rapid rate, with over 80% of the population now living within 13 miles from the coast, and expanding development of oil and gas resources and fishing fleets (Minton 2004). The threats from coastal development and contaminants are ranked low but increasing.

<u>Utilization for Commercial, Recreational, Scientific, or Educational Purposes</u>

This humpback whale population is exposed to minimal scientific research and whale-watching activities. The adverse effects from these activities have not been identified, and overall impact is expected to be low and stable.

No commercial whaling occurs in this population's range, although 238 humpback whales were illegally killed in the Arabian Sea by the USSR in 1966 (Mikhalev 1997).

<u>Disease or Predation</u>

Liver damage was detected in 68.5% of necropsied humpback whales in this area during Soviet whaling in 1966, with degeneration of peripheral liver sections, cone-shaped growths up to 20cm in diameter and blocked bile ducts (Mikhalev 1997). While this pathology was consistent with infection by trematode parasites, none were identified during necropsy, and the causes of this liver damage remain unknown.

Poisonous algal blooms and biotoxins have been implicated in some mass fish, turtle, and possibly cetacean, mortality events on the Oman coast, although no events have yet been known to include humpback whales. Coastal run-off from industrial activities is likely to be increasing rapidly, while regular oil spills in shipping lanes from tankers also contribute to pollution along the coast (*e.g.* Shriadah 1999). Tattoo skin lesions were observed in 26% of photo-identified whales from Oman (Baldwin *et al.* 2010). While not thought to be a common cause of adult mortality, it has been suggested that tattoo skin disease may differentially kill neonates and calves that have not yet gained immunity (Van Bressem *et al.* 2009). The authors also suggested that this disease may be more prevalent in marine mammal populations that experience chronic stress and/or are exposed to pollutants that suppress the immune system.

<u>Other Natural or Human-Related Threats</u>

The primary prey of humpback whales in Oman (*Sardinella sp.*) is also consumed by tuna and other commercial pelagic fish targeted by gillnet fisheries, but the severity of the threat of competition with fisheries is unknown.

The BRT did not have information about offshore aquaculture activities in the Arabian Sea.

Humpback whales in the Arabian Sea are exposed to a high level of vessel traffic (Baldwin 2000; Minton 2004; Kaluza *et al.* 2010) so the threat of ship strikes was considered medium for this small population.

This population is likely exposed to relatively high levels of underwater noise resulting from human activities, including, for example, commercial and recreational vessel traffic, and activities related to oil and gas exploration and development. Overall population-level effects of exposure to underwater noise are not well-established, but exposure is likely chronic and at moderate levels. As vessel traffic and other activities are expected to increase, the level of this threat is expected to increase.

There is high fishing pressure in areas off Oman where humpback whales are sighted. Eight live humpback whale entanglement incidents were documented between 1990-2000, involving bottom set gillnets often with weights still attached and anchoring the whales to the ocean floor (Minton 2004). Minton *et al.* (2010b) examined peduncle photographs of humpback whales in the Arabian Sea and concluded that at least 33% had been entangled in fishing gear at some stage. The threat of fishing gear entanglements in the Arabian Sea is considered high and increasing.

The threat posed by climate change on the Arabian Sea humpback whales was determined to be slightly higher than on the other DPSs and was assigned medium threat level. This higher threat level is based on the more limited movement of this population that both breeds and feeds in the Arabian Sea. Changing climatic conditions may change the monsoon-driven upwelling that creates seasonal productivity in the region. While Northern Hemisphere individuals may be able to adapt to climatic changes by moving farther north, Arabian Sea individuals have less flexibility for expanding their range to cooler regions.

Evidence that this population has undergone a recent genetic bottleneck and is currently at low abundance (Minton *et al.* 2010b) suggests that there may be an additional risk of impacts from increased inbreeding (which may reduce genetic fitness and increase susceptibility to disease).

At low densities, populations are more likely to suffer from the ‘Allee’ effect, where inbreeding and the heightened difficulty of finding mates reduces the population growth rate in proportion with reducing density.

D.15.1 Extinction Risk

This population is genetically and demographically isolated from other humpback whale populations in the southern Hemisphere. The small population size, restricted range, and high rates of entanglements and other anthropogenic impacts put this population at considerable risk. The Arabian Sea DPS was considered by the majority of the BRT to be at high risk of extinction (87% of votes). The potential for this population to be at moderate risk of extinction received 13% of votes, reflecting some uncertainty in the designation of “high risk” for this DPS.

D.15.2 Significant portion of its range

The BRT concluded that the Arabian Sea DPS is likely to be at high risk of extinction throughout its range, so it was not necessary to conduct an analysis of extinction risk in a significant portion of the DPS’s range.

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IV. Summary of risk assessment

A. Evaluation of Abundance and Trends

The BRT's assessment of what is known about the abundance and trends of each DPS is summarized in Table 7 and Table 8 below. In the North Atlantic Ocean, the abundance of the West Indies DPS is much greater than 2,000 individuals and is increasing moderately. However, little is known about the total size of the Cape Verde Islands DPS, and its trend is unknown.

In the Pacific Ocean, the abundances of the Mexico and Hawaiian DPSs are known to be much greater than 2,000 individuals and are thought to be increasing moderately. The abundance of the Central American DPS is thought to be about 500 individuals with unknown trend, and that of the Okinawa/Philippines DPS is thought to be about 1,000 individuals with unknown trend. Little is known about the abundance of the Second West Pacific DPS, but it is likely to number at least 100 or more, with unknown trend.

In the Southern Hemisphere, all seven DPSs are thought to be greater than 2,000 individuals in population size. The two Australian DPSs are both large and increasing rapidly. The Brazil DPS is increasing either rapidly or moderately. The Southeastern Pacific and Southeast Africa/ Madagascar DPSs are thought to either be increasing or stable. The trends of the Oceania and Gabon/Southwest Africa DPSs are unknown.

The estimated abundance of the Arabian Sea DPS is less than 100, but its entire range was not surveyed, so it could be somewhat larger. Its trend is unknown.

Table 7. Summary of abundance for each DPS.

Population level	**>1000 mature individuals (>2000 total)**	**< 1000 mature individuals (<2000 total)**	**<250 mature individuals (<500 total)**	**<50 mature individuals (<100 total)**
Atlantic Ocean				
West Indies	■			
Cape Verde Islands plus Northwest Africa	■	■	■	■
Pacific Ocean				
Hawaii	■			
Central America		■	■	
Mexico	■			
Okinawa/ Philippines		■	■	
Second West Pacific	■	■	■	
Southern Hemisphere				
West Australia	■			
East Australia	■			
Oceania	■			
Southeastern Pacific	■			
Brazil	■			
Gabon/Southwest Africa	■			
Southeast Africa/ Madagascar	■			
Arabian Sea				
Arabian Sea			■	■

NOTE: Details on abundance are in the Threat and extinction risk analysis by DPS section. The level of abundance the DPS is estimated to be at is shaded. If there is uncertainty in the abundance level of the DPS, all categories that could apply are shaded. The number of mature individuals was taken to be approximately one-half of the total population size. The columns represent relative risk of extinction, increasing from left to right (see section B.1 for further detail).

Table 8. Summary of what is known about the trends in abundance for each DPS.

Population trend	Increasing Strongly	Increasing moderately	Stable/little trend	Declining	Unknown
Atlantic Ocean					
West Indies		■			
Cape Verde Islands plus Northwest Africa					■
Pacific Ocean					
Hawaii		■			
Central America					■
Mexico	■	■	■		
Okinawa/ Philippines					■
Second West Pacific					■
Southern Hemisphere					
West Australia	■				
East Australia	■				
Oceania					■
Southeastern Pacific	■	■	■		
Brazil	■	■			
Gabon/Southwest Africa					■
Southeast Africa/ Madagascar	■	■	■		
Arabian Sea					
Arabian Sea					■

NOTE: Details are provided in the Threat and extinction risk analysis by DPS section. The category of trend that the DPS is thought to be undergoing is shaded. If there is substantial uncertainty in the trend, all categories that may apply are shaded. If no reliable information on trend for the DPS is available, the last column ("unknown") is shaded.

B. Evaluation of Threats

The BRT's assessment of the current and imminent threats to each DPS is summarized in (Table 9). In the North Atlantic Ocean, the threats of HABs, vessel collisions, and fishing gear entanglements are likely to moderately reduce the population size and/or the growth rate of the West Indies DPS. All other threats, with the exception of climate change (unknown severity), are considered likely to have no or minor impact on population size or the growth rate of this DPS. For the Cape Verde Islands plus Northwest Africa DPS, the threats of HABs, disease, parasites, vessel collisions, fishing gear entanglements and climate change are unknown. All other threats to this DPS are considered likely to have no or minor impact on the population size and/or growth rate.

In the Pacific Ocean, all threats are considered likely to have no or minor impact on population size and/or the growth rate or are unknown, with the following exceptions: Energy development, whaling, and competition with fisheries are considered likely to moderately reduce the population size or the growth rate of the Okinawa/Philippines DPS. Vessel collisions are considered likely to moderately reduce the population size or the growth rate of the Central America and Okinawa/Philippines DPSs. Fishing gear entanglements are considered likely to moderately reduce the population size or the growth rate of the Hawaii, Central America, and Mexico DPSs and likely to seriously reduce the population size or the growth rate of the Okinawa/Philippines DPS. In general, there is great uncertainty about the threats facing the Second West Pacific DPS.

In the Southern Hemisphere, all threats are considered likely to have no or minor impact on population size and/or the growth rate or are unknown, with the exception of energy exploration posing a moderate threat throughout Western Australia and the west coast of Africa, and fishing gear entanglements posing a moderate threat to the Colombia, and Southeast Africa/Madagascar, DPSs.

The Arabian Sea DPS faces unique threats given that the whales do not migrate, but instead feed and breed in the same, relatively constrained geographic location. Energy exploration and fishing gear entanglements are considered likely to seriously reduce the population's size and/or growth rate, and disease, vessel collisions and climate change are likely to moderately reduce the population's size or growth rate.

Table 9. Severity of current or imminent threats to humpback whales, by DPS.

	coastal development	Contaminants	Energy exploration & development	HABs	Whaling	Whale-watching	Scientific research activities	Killer whale and shark predation	Disease	Parasites	competition with fisheries	offshore aquaculture	Anthropogenic Noise	Vessel collisions	Fishing gear entanglements	Climate Change
West Indies	1*	1	1*	2*	1	1	1	1	1	1	1	1*	1*	2*	2	unkn*
CVI + NW Africa	1*	1	1	unkn*	1	1	1	1	unkn	unkn	1	1	1*	unkn*	unkn	unkn*
Hawaii	1*	1	1*	1*	1	1	1	1	1	1	1	1*	1*	1*	2	unkn*
Central America	1*	1	1	1*	1	1	1	1	1	1	1	1	1*	2*	2	unkn*
Mexico	1*	1	1	1*	1	1	1	1	unkn	unkn	1	1	1*	1*	2*	unkn*
Okinawa/ Philippines	1*	1*	2*	unkn	2*	1	1	1	unkn	unkn	1	unkn	1*	2*	3	unkn*
2nd West Pacific	1	unkn	unkn	unkn	unkn	1	1	unkn	unkn	unkn	unkn	unkn	1*	unkn	unkn	unkn*
West Australia	1*	1	2*	1	1	1	1	1	1	1	1	1*	1*	1*	1*	1*
East Australia	1*	1	1	1	1	1*	1	1	1	1	1	1	1*	1*	1*	1*
Colombia	1*	1	1*	1*	1	1	1	1	1	1	1	1	1*	1*	2	1*
Brazil	1*	unkn	1*	1*	1	1*	1	1	unkn	unkn	1	1	1*	1*	1*	1*
Gabon/SW Southwest	1*	1	1*	1*	1	1	1	1	1	1	1	1*	1*	1	1	1*
Mozamb/E SA/Mad	1*	unkn	1*	unkn	1	1*	1	unkn	unkn	unkn	1	1	1*	1*	2	1*
Oceania	1	1	1*	unkn	1	1*	1*	1	1	1	1	1*	1*	1*	1	1*
Arabian Sea	1*	1*	3*	unkn	1	1	1	unkn	2	unkn	unkn	unkn	1*	2*	3*	2*

Severity of Threat

1 = Low or none, threat is likely to have no or minor impact on population size or the growth rate

2 = Medium, threat is likely to moderately reduce the population size or the growth rate of the population

3 = High, threat is likely to seriously reduce the population size or the growth rate of the population

4 = Very High, threat is likely to eliminate the DPS

unkn = Severity of threat is unknown

* = trend of threat is increasing

C. Summary of Extinction Risk Conclusions

The BRT conducted its analysis using the best available science and experts' opinions and concluded (summarized in Table 10):

- There are at least 15 discrete and significant population segments for humpback whales globally, according to the criteria outlined the joint NMFS/FWS DPS policy;
- Nine DPSs are *not at risk of extinction* with high certainty (>80% of votes): the West Indies, Hawaii, Mexico, west Australia, east Australia, Colombia, Brazil, Gabon/Southwest Africa, and Southeast Africa/Madagascar;
- The Oceania DPS is *not at risk of extinction* with moderate certainty (68% of votes) with some support for *moderate risk of extinction* (29% of votes);
- Both the Okinawa/Philippines and Central America DPSs were between *moderate* and *high* risk of extinction (≤20% of votes for *not at risk of extinction* for each DPS), but the distribution of votes among the risk categories indicates uncertainty;
- The Arabian Sea DPS is *at high risk of extinction* (87% of votes); and
- There was considerable uncertainty regarding the risks of extinction of two of the DPSs due to a general lack of data: the Cape Verde Islands plus Northwest Africa and the Second West Pacific.

Table 10. Summary of extinction risk assessments.

Distinct Population Segment	High Risk	Moderate Risk	Not at Risk
West Indies	1%	17%	82%
Cape Verde Islands plus Northwest Africa	32%	43%	25%
Hawaii	0%	2%	98%
Central America	28%	56%	16%
Mexico	0%	8%	92%
Okinawa/Philippines	36%	44%	21%
Second West Pacific	14%	47%	39%
West Australia	0%	3%	97%
East Australia	0%	4%	96%
Oceania	3%	29%	68%
Southeastern Pacific	0%	7%	93%
Brazil	0%	4%	96%
Gabon/Southwest Africa	0%	7%	93%
Mozambique/East South Africa and Comoros Archipelago/Madagascar	0%	4%	96%
Arabian Sea	87%	13%	0%

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Appendix A: Question posed to the ad-hoc committee on taxonomy within the Society for Marine Mammalogy

The humpback whale Biological Review Team requested help from the Ad-hoc Taxonomy Committee of the Society for Marine Mammalolgy in determining whether subspecies are likely to exist within the global species (*Megaptera novaeangliae*). The BRT sent a questionnaire and related background information (below) to William Perrin, the chair of the Ad-hoc Taxonomy Committee, who then distributed it to the membership of that committee (C. Scott Baker, Annalisa Berta, Daryl J. Boness, Robert L. Brownell, Jr., Daryl P. Domning, Ewan Fordyce, Rebecca M. Hamner, Thomas A. Jefferson, James G. Mead, Larissa Rosa de Oliveira, Dale W. Rice, Patricia E. Rosel, John Y. Wang, and Tadasu Yamada, which includes two members of the BRT). Their conclusions, summarized by Perrin, are presented in Section II. B.

Questionnaire

Are humpback whales (*Megaptera novaeangliae*) that feed in the North Atlantic, North Pacific, Southern Oceans and Arabian Sea likely to belong to different sub-species? Based on your expert opinion, please rate the likelihood that humpback whales in the following adjacent regions belong to different subspecies (rate likelihood as high, medium, or low). Please fill out this table, but feel free to provide additional commentary.

Region 1	Region 2	Likelihood (high, medium, low)
North Pacific	North Atlantic	
North Pacific	Southern Oceans	
North Atlantic	Southern Oceans	
Arabian Sea	Southern Oceans	

Background

A biological review team (BRT) has been convened to assess the status of humpback whales under the U.S. Endangered Species Act (ESA). The BRT can recommend the designation of distinct population segments (DPS) which are treated as “species” under the provisions of the ESA. One of the criteria used to designate a population as a DPS is whether loss of that population would result in a significant gap in the range of the taxon. The taxon would be the entire species or (if present) subspecies. Taxonomy is therefore an important component in managing species under the ESA. Subspecies taxonomy in cetaceans has lagged behind that of other taxa (Reeves *et al.* 2004). However, the BRT is obligated to make their designations based on “best available science”. If subspecies are likely to exist but have not yet been recognized or nomenclature has not yet been resolved, the BRT can take this into consideration in their designation of distinct population segments for humpback whales.

Rice (1998) reviewed previous sub-species designations for humpback whales. Tomilin (1946) named a Southern Hemisphere sub-species (*M. n. lalandii*) based on body length, but this length difference was not substantiated in subsequent studies. The populations around Australia and New Zealand were described as another subspecies (*M. n. novazelandiae*) based on color patterns and length (Ivashin 1958). Rice (1998) noted that the percent separability between putative sub-species is "not quite as high as is customarily required for division into subspecies" and that genetic analyses using restriction-fragment length polymorphisms is not congruent with the proposed regional division. Rice (1998) recommended that *Megaptera novaeangliae* be considered monotypic.

The 2004 cetacean taxonomy workshop (Reeves 2004) proposed the following guidelines for determining cetacean subspecies:

> In addition to the use of morphology to define subspecies, the subspecies concept should be understood to embrace groups of organisms that appear to have been on independent evolutionary trajectories (with minor continuing gene flow), as demonstrated by morphological evidence or at least one line of appropriate genetic evidence. Geographical or behavioral differences can complement morphological and genetic evidence for establishing subspecies. As such, subspecies could be geographical forms or incipient species.

Evidence

<u>Reproductive Seasonality</u>: Humpback whales breed and calf in July-November in the Southern Hemisphere and in Jan-May in the Northern Hemisphere (including the Arabian Sea). It is not known if reproductive seasonality in baleen whales is determined genetically or whether it results from a learned behavior (migration to a particular feeding destination) combined with a physiological response to day length.

<u>Behavior</u>: The most obvious behavioral difference is that migrations to and from high latitudes are in opposite times of the calendar year for Southern Hemisphere and most Northern Hemisphere populations, following the difference in reproductive seasonality. A Northern Hemisphere exception to this migration pattern is found in the Arabian Sea where a non-migratory population is found. Although these behavioral differences could be learned, they could also be innate, genetically determined traits. Obviously, singing and other mating behaviors also follow the differences in reproductive seasonality.

<u>Color patterns</u>: Humpback whales in the Southern Hemisphere tend to have a much more white pigmentation on their bodies which is especially noticeable laterally (Matthews 1937; Chittleborough 1965). This has been noted in eastern and western Australia, the Coral Sea, and Oceania, but might not be characteristic of all Southern Hemisphere populations. Rosenbaum *et al.* (1995) ranked ventral fluke coloration patterns from one (nearly all white) to five (nearly all black) and compared whales from several breeding areas. He found that over 80% of humpback whales in eastern and western Australia were in Category 1, and that less than 10% of whales in three breeding areas in the North Pacific were ranked in that category. Only 36% of Southern Hemisphere whales in Colombia were classified in Category 1, but Colombian whales were still, on average, whiter than North Pacific whales. A higher frequency of flippers with white dorsal pigmentations is found in the North Atlantic compared to the North Pacific (Clapham 2009).

Genetics: Baker and Medrano-Gonzalez (2002) review the worldwide distribution of mtDNA haplotypes. They find three major clades with significant differences among major ocean basins (Figure 1), but they did not find reciprocal monophyly. The North Pacific only included the AE and CD clades, the North Atlantic only included the CD and IJ clades, and the Southern Oceans included all three. In a more recent comparison, Baker (pers. comm.) found no shared haplotypes between the North Pacific and North Atlantic. Based on mtDNA, Rosenbaum *et al.* (2009) estimated an average migration rate of less than one per generation between the Arabian Sea and neighboring populations in the southern Indian Ocean. Migration rates among neighboring populations within the Southern Hemisphere were generally much larger. In a review of mtDNA and nuclear DNA (nDNA) variation among ocean basins and among regions within basins, Jackson *et al.* (2014) found that gene flow between among regional populations within the Southern Hemisphere oceans is 20-60 times higher than gene flow between the Southern Hemisphere and the two Northern Hemisphere ocean basins.

Summary

An often-cited criterion for separation of subspecies is the ability to differentiate 75% of individuals found in different geographic regions. Based on this criterion, differences in the calendar timing of mating and reproduction could be used to distinguish close to 100% of Northern Hemisphere from Southern Hemisphere individuals, but it is not known if this genetically determined. Based on mtDNA haplotypes that have been identified to date, haplotype could be used to distinguish 100% of North Pacific from North Atlantic individuals, but some haplotypes from both ocean basins are shared with the Southern Ocean. Genetic exchange across hemispheres is 1-2 orders of magnitude less than genetic exchange among populations within an ocean basin. Ventral fluke color patterns can be used to correctly differentiate >80% of whales in eastern and western Australia from the whales in the North Pacific (Rosenbaum *et al.* 1995).

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Figure 1. From Baker & Medrano 2002.

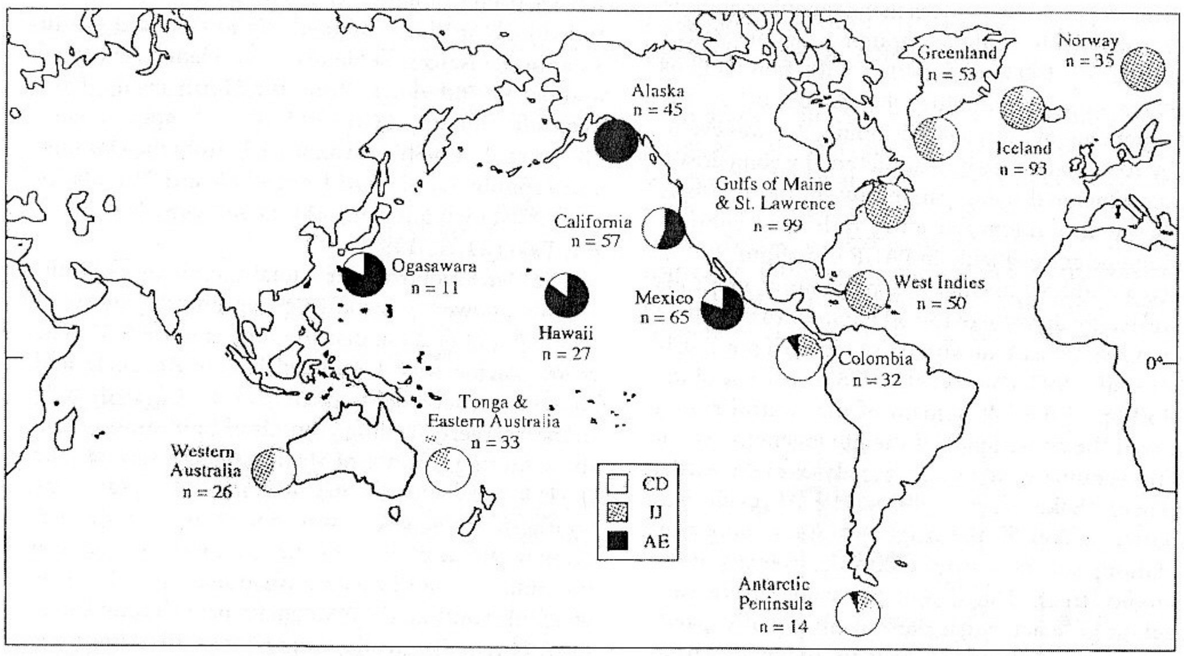

Figure 8.5. Regional frequencies of the three primary clades of humpback whale mtDNA lineages inferred from control region sequenes and RFLP analyses of the partial and complete mitochondrial genome (Baker et al., 1990, 1993, 1994, 1998a and b; Medrano-González et al., 1995; Palsbøll et al., 1995; Larsen et al., 1996).

Appendix B: List of national laws related to conservation of marine mammals. Source: http://faolex.fao.org/faolex/.

Country	Title	Web site
AMS	Chapter 9 of Title 24 - Fishing.	www.asbar.org
ARG	Resolución Nº 907/2012 - Medidas de Conservación aprobadas por la Comisión para la Conservación de los Recursos Vivos Marinos Antárticos.	www.infoleg.gov.ar
ARG	Ley Nº 4.567 - Declara al Delfín Franciscana (Pontoporia blainvillei) especie protegida en la Provincia de Río Negro.	www.legisrn.gov.ar
ARG	Resolución Nº 539/2010 - Apruébanse las condiciones sanitarias para autorizar la importación de mamíferos marinos a la República Argentina con destino a oceanarios.	www.infoleg.gov.ar
ARG	Resolución Ministerial Nº 86/2010 - Crea el Programa Red de Rescate, Rehabilitación y Reintroducción de Fauna Marina de la Provincia de Buenos Aires.	
ARG	Ley Nº 5.714 - Prohíbese la actividad de acercamiento o persecución de la Ballena Franca Austral.	www.infoleg.gov.ar
ARG	Ley Nº 4.115 - Prohíbe la captura de todo mamífero marino en aguas y costas de jurisdicción provincial.	www.legisrn.gov.ar
ARG	Decreto Nº 598/03 - Reglamenta la Ley Nº 25.052, que prohíbe la caza o captura de ejemplares de orca	

	(Orcinus orca).	
ARG	Ley Nº 25.577 - Prohíbe la caza o captura de cetáceos en todo el territorio nacional.	
ARG	Ley Nº 25.052 - Prohíbe la caza o captura de ejemplares de orca (Orcinus orca).	
ARG	Resolución Nº 351/95 - Reglamento de oceanarios.	www.medioambiente.gov.ar
ARG	Ley Nº 176 - Prohíbe el acercamiento a cualquier especie de mamífero marino y zonas de nidificación de aves en las costas y mar de jurisdicción provincial.	
ARG	Ley Nº 23.094 - Declara monumento natural a la ballena franca austral dentro de las aguas jurisdiccionales argentinas y sujeto a las normas establecidas por la Ley Nº 22.351.	
AUS	Exhibited Animals Protection Act 1986.	www.austlii.edu.au
AUS	National Parks and Wildlife Act 1974.	www.austlii.edu.au
AUS	Wildlife Act 1975.	www.legislation.vic.gov.au
AUS	Whales Protection Act, 1988.	www.thelaw.tas.gov.au
AUS	Nature Conservation (Whales and Dolphins) Conservation Plan 1997.	www.legislation.qld.gov.au
AUS	Nature Conservation (Dugong) Conservation Plan 1999.	www.legislation.qld.gov.au

AUS	Environment Protection and Biodiversity Conservation Act 1999.	www.austlii.edu.au
AUS	Environmental Reform (Consequential Provisions) Act 1999 (Act No. 92 of 1999).	www.austlii.edu.au
AUS	Environment Protection and Biodiversity Conservation Regulations 2000.	www.austlii.edu.au
AUS	Adelaide Dolphin Sanctuary Act 2005.	www.legislation.sa.gov.au
AUS	National Parks and Wildlife (Protected Animals - Marine Mammals) Regulations 2010.	www.legislation.sa.gov.au
AUS	Exhibited Animals Protection Regulation, 2010.	www.austlii.edu.au
AUS	Wildlife (Marine Mammals) Regulations, 2009.	www.legislation.vic.gov.au
AUS	Antarctic Seals Conservation Repeal Regulations 2007 (SLI No. 143 of 2007).	www.austlii.edu.au
AUS	Adelaide Dolphin Sanctuary Regulations, 2005.	www.austlii.edu.au
BER	Fisheries (Protected Species) Order 1978.	www.bermudalaws.bm
BHA	Seal Fisheries (Crown Colonies and Protectorates) Orders in Council, 1913 (Cap. 242).	laws.bahamas.gov.bs
BHA	Whaling Industry (Regulation) Act (Newfoundland, Colonies, Protectorates and Mandated Territories) Order, 1936 (Cap. 242).	laws.bahamas.gov.bs
BHA	Fisheries Resources (Jurisdiction and Conservation)	laws.bahamas.gov.bs

	Regulations, 1986 (Cap. 244).	
BLZ	Wildlife Protection Regulations 1982.	www.belizelaw.org
BRA	Decree No. 3.939 on the Inter-ministerial Commission on Marine Resources (CIRM).	www.senado.gov.br
BRA	Order No. 5 regulating maritime traffic in order to protect dolphins in the archipelago of Fernando de Noronha Island.	
BRA	Order No. 40-N creating the National Centre for the Management and Protection of Sirenia - 'Peixe-Boi'.	
BRA	Order No. 2.306 prohibiting intentional disturb of all species of cetaceans into the brazilan territorial sea.	
BRA	Act No. 7.643 prohibiting the catching of Cetaceans.	www.bdtextual.senado.gov.br
BRA	Order No. N-11 prohibiting the capture of marine mammals (little cetaceans, sea lions, marine seals and manaties into brazilian territorial sea).	
BRA	Decree-Law No. 221 promoting and protecting fishing activity.	www.bdtextual.senado.gov.br
CAM	Sub-Decree No. 15 (RGC) on creation of a commission to conserve and develop tourism zone for freshwater dolphins in the Mekong River.	
CAN	Marine Mammal Regulations (SOR/93-56).	www.gc.ca

CAN	Marine Activities in the Saguenay-St. Lawrence Marine Park Regulations (SOR/2002-76).	www.gc.ca
CAY	Seal Fishery Ordinance (No. 8 of 1921).	
CHI	Decreto Nº 38 - Reglamento general de observación de mamíferos, reptiles y aves hidrobiológicas y del registro de avistamiento de cetáceos.	
CHI	Decreto Nº 1.892 - Establece veda extractiva para el recurso lobo marino común en área y período que indica.	
CHI	Decreto Nº 1.612 - Fija valor de sanción de especies hidrobiológicas que indica, período 2009-2010.	
CHI	Decreto Nº 230 - Declara monumento natural a las especies de cetáceos que indica.	
CHI	Decreto Nº 179 - Establece prohibición de captura de especies de cetáceos que se indican en aguas de jurisdicción nacional.	
CHI	Decreto Nº 1.571 - Suspende temporalmente la veda extractiva del recurso Lobo marino común en la XII Región y establece cuota anual de captura para años 2008 y 2009.	
CHI	Decreto Nº 1.471 - Fija valor de sanción de especies hidrobiológicas que indica, período 2007-2008.	
CHI	Decreto Nº 243 - Establece cuota anual de captura del	

	recurso lobo marino para el año 2006.	
CHI	Decreto Nº 276 - Fija los valores de sanción de especies hidrobiológicas.	
CHI	Decreto Nº 366 - Veda extractiva para el recurso Lobo marino común.	
CHI	Decreto Nº 287 - Medidas de conservación adoptadas por la Comisión para la Conservación de los Recursos Vivos Marinos Antárticos en su XVI reunión de 1997.	
CHI	Resolución Nº 896 - Fija tamaño mínimo y regula implementos para la extracción del recurso lobo marino común en la I y II Región.	
CHN	Whaling Industry (Regulation) Ordinance (Chapter 496).	www.hklii.org
COK	Marine Resources Act 2005 (No. 7 of 2005).	www.paclii.org
COK	Cook Islands Declaration on the establishment of a whale sanctuary.	
COL	Resolución Nº 1.499 - Asigna el límite de mortalidad de delfines para el año 2014.	www.imprenta.gov.co
COL	Resolución Nº 375 - Prohíbe el aleteo de tiburón y reglamenta los procedimientos para su manejo y control.	www.imprenta.gov.co
COL	Resolución Nº 1.035 - Asigna el límite de mortalidad de	www.imprenta.gov.co

	delfines para el año 2013.	
COL	Resolución Nº 446 - Reasigna y ajusta el límite de mortalidad de delfines para el año 2012.	www.imprenta.gov.co
COL	Resolución Nº 1.596 - Medidas de conservación sobre poblaciones de atunes aleta amarilla, barrilete, patudo y especies afines que se aprovechan en el Océano Pacífico Oriental (OPO), para el año 2011.	www.imprenta.gov.co
COL	Resolución Nº 3.651 - Distribuye el límite de mortalidad de delfines para el año 2011.	www.imprenta.gov.co
COL	Resolución Nº 4.159 - Distribuye el límite de mortalidad de delfines para el año 2009.	www.imprenta.gov.co
COL	Resolución Nº 523 - Reglamenta la pesca de atún en el Océano Pacífico Oriental.	www.imprenta.gov.co
COL	Resolución Nº 2 - Reglamenta la pesca del atún para embarcaciones cerqueras mayores de 400 toneladas de capacidad de acarreo en el Océano Pacífico oriental.	
COL	Decreto Nº 1.608 - Reglamenta el Código Nacional de los Recursos Naturales Renovables y de Protección al Medio Ambiente, en materia de fauna silvestre.	
COS	Decreto Nº 34.327/MINAE/MAG - —Declara las aguas interiores, del mar territorial y de la Zona Económica Exclusiva como santuario para las ballenas y delfines.	www.imprenal.go.cr

COS	Acuerdo Nº 415/AJDIP - Reglamento para la protección, aprovechamiento y comercialización del tiburón y de la aleta del tiburón.	www.gaceta.go.cr
COS	Resolución Nº 430/AJDIP - Manual de procedimientos para el control de la trazabilidad y certificación del atún denominado dolphin safe"."	
COS	Sistema de seguimiento y verificación del atún capturado con y sin mortalidad de delfines.	
CRO	Regulation on the protection of fish and other marine organisms.	www.nn.hr
CUB	Decreto Nº 63 - Prohibe la pesca del manatí en aguas jurisdiccionales.	
CZE	Decree implementing certain provisions of the Act on trade in endangered species.	www.zakonyprolidi.cz
DEN	Order No. 288 on the use of acoustic deterrent devices (pingers) in certain fisheries.	www.retsinformation.dk
DEN	Order No. 259 on Wildlife Damages.	www.retsinformation.dk
DEN	Order No. 203 on the use of acoustic deterrents (pingers) in certain fisheries.	www.retsinformation.dk
DJI	Décret nº 85-103/PR/AG portant sur la protection de la faune et des fonds sous-marins et modifiant le décret nº 80-62.	

DJI	Décret nº 80-62/PR/MCTT du 25 mai 1980 portant sur la protection de la faune et des fonds sous-marins.	
DOM	Resolución Nº 1/08 - Reglamento sobre la tenencia, manejo y exhibición de especies de mamíferos marinos.	
DOM	Decreto Nº 319/86 - Crea un santuario para mamíferos marinos llamado Santuario de Ballenas Jorobadas del Banco de la Plata.	
ECU	Acuerdo Nº 18 - Establece sistema de seguimiento y verificación del atún capturado en el Océano Pacífico Oriental (OPO).	
ELS	Acuerdo Nº 96 - Crea el Sistema de seguimiento y verificación del atún capturado por buques en aguas territoriales de El Salvador.	
EUR	Commission Regulation (EU) No. 737/2010 laying down detailed rules for the implementation of Regulation (EC) No. 1007/2009 of the European Parliament and of the Council on trade in seal products.	europa.eu.int
EUR	Regulation (EC) No. 1007/2009 of the European Parliament and of the Council on trade in seal products.	europa.eu
EUR	Council Regulation (EC) No. 520/2007 laying down technical measures for the conservation of certain stocks of highly migratory species and repealing Regulation (EC) No. 973/2001.	europa.eu

EUR	Council Regulation (EC) No. 1967/2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, amending Regulation (EEC) No. 2847/93 and repealing Regulation (EC) No. 1626/94.	europa.eu	
EUR	Council Regulation (EC) No. 812/2004 laying down measures concerning incidental catches of cetaceans in fisheries and amending Regulation (EC) No. 88/98.	europa.eu	
EUR	Council Regulation (EC) No. 882/2003 establishing a tuna tracking and verification system.	europa.eu	
EUR	Council Regulation (EC) No. 1936/2001 laying down control measures applicable to fishing for certain stocks of highly migratory fish.	europa.eu	
EUR	Council Decision 1999/337/EC on the signature by the European Community of the Agreement on the International Dolphin Conservation Programme.	europa.eu	
EUR	Council Directive 83/129/EEC concerning the importation into Member States of skins of certain seal pups and products derived therefrom	europa.eu	
EUR	Council Regulation (EEC) No. 348/81 on common rules for imports of whales or other cetacean products.	europa.eu	
FAL	Whale Fishery Ordinance (No. 9 of 1936).		
FAL	Whaling Regulations.		

FIN	Decree of the Ministry of Interior relative to fishing and the catch of seals in certain convention areas within the territorial waters of the Russian Federation in he Gulf of Finland (No. 917 of 1993).	
FRA	Arrêté portant interdiction de capturer et de détruire les dauphins.	
FRA; MAY	Arrêté du 1er juillet 2011 fixant la liste des mammifères marins protégés sur le territoire national et les modalités de leur protection.	
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FRA; MAY	Arrêté du 1er juillet 2011 fixant la liste des mammifères marins protégés sur le territoire national et les modalités de leur protection.	
FRA; MAY	Arrêté fixant la liste des mammifères marins protégés sur le territoire national.	
FRA; NCA	Délibération de l'assemblée de la province Sud n° 03-2004/APS du 31 mars 2004 relative à la protection des mammifères marins.	www.juridoc.gouv.nc
FRA; NCA	Délibération du congrès n° 397 du 13 août 2003 relative à la création d'un sanctuaire baleinier.	www.juridoc.gouv.nc
FRA; NCA	Délibération n° 98 du 25 juillet 1990 relative à l'institution d'une commission des ressources marines.	www.juridoc.gouv.nc

GBR	Behring Sea Award Act 1894.	www.opsi.gov.uk
GBR	Whaling Industry (Regulation) Act 1934.	www.opsi.gov.uk
GBR	Marine (Scotland) Act 2010 (Consequential Provisions) Order 2010 (S.I. No. 2870 of 2010).	www.opsi.gov.uk
GBR	Seal Products Regulations 2010 (S.I. No. 2068 of 2010).	www.opsi.gov.uk
GBR	Marine (Scotland) Act 2010 (2010 asp 5).	www.opsi.gov.uk
GBR	Conservation of Seals (England) Order 1999 (No. 3052 of 1999).	www.opsi.gov.uk
GBR	Fisheries Act 1981 (Chapter 29).	www.opsi.gov.uk
GBR	Seal Fisheries (North Pacific) Act 1912.	www.opsi.gov.uk
GBR	Seal Fisheries Act 1875 (Official Revised Edition 31 October 1978).	www.opsi.gov.uk
GBR	Conservation of Seals Act, 1970 (Chapter 30).	www.opsi.gov.uk
GRE	Ministerial Decision No. AP 0546/?.5471/?S58 notifying the withdrawal of Greece from the International Convention for the Regulation of Whaling and from the relevant Protocol.	www.et.gr
GRE	Ministerial Joint Decree No. 30781/1521 establishing measures for the protection of the MONACHUS-MONACHUS" Mediterranean seal and its habitat."	
GRL	Statutes on narwhal hunting with nets in the management areas Ammassalik and Ittoqqortoormiit in	www.lovgivning.gl

	East Greenland.	
GRL	Order No. 4 on the protection and hunting of large whales.	www.lovgivning.gl
GRL	Order No. 17 on leisure-hunting license.	www.lovgivning.gl
GRL	Order No. 18 on commercial hunting license.	www.lovgivning.gl
GRL	Order No. 7 on conservation and hunting of beluga and narwhal.	www.lovgivning.gl
GRL	Order No. 16 on the protection and hunting of seals.	www.lovgivning.gl
GRL	Order No. 12 on the reporting of catch and wounding of large whales.	www.lovgivning.gl
GRL	Order No. 20 on walrus protection and hunting.	www.lovgivning.gl
GRL	Order No. 3 on recreational hunting evidence.	www.lovgivning.gl
GRL	Order No. 30 on whale hunting restrictions.	www.lovgivning.gl
GRL	Order No. 13 relaon whale hunting restriction.	www.lovgivning.gl
GUA	Acuerdo que prohíbe la pesca con fines comerciales y de sustento del delfín.	
ICE	Act on Fishing Outside of Icelandic Jurisdiction.	
ICE	Act on Fishing in Iceland's Exclusive Fishing Zone.	
IRE	Sea-Fisheries (Incidental Catches of Cetaceans in	www.agriculture.gov.ie

	Fisheries) Regulations 2007 (S.I. No. 274 of 2007).		
IRE	Whale Fisheries Act, 1937 (Extension to Mammals of the order Cetacea) Order, 1982.	www.bailii.org	
IRE	Whale Fisheries Act, 1937 (Extension to Sperm Whales) Order, 1937.	www.bailii.org	
IRE	Whale Measurement Regulations (No. 2), 1937.	www.bailii.org	
IRE	Whale Fisheries Act 1937.	www.bailii.org	
ISR	Fisheries Rules.		
ISR	Fisheries Ordinance.		
ITA	Ministerial Decree No. 469 laying down provisions in matter of keeping of live dolphins belonging to Tursipos Truncatus species, in accordance with article 17, paragraph 6 of Act No. 93 of 23 March 2001.	www.comune.jesi.an.it	
ITA	Decree of 3 May 1989 regulating the fishing for cetaceans, turtles and sturgeon.		
JAP	Regulations for Whaling of Small Type (as amended by Ordinance No. 54 of July 8, 1952).		
JAP	Regulations for factory-ship type fisheries (Ministry of Agriculture and Forestry Ordinance No. 30).		

KAZ	Ministerial Decree No. 1140 regarding validation of charges for the compensation of damage caused by infringement of legislation on protection, reproduction and management of wildlife species.	
KEN	Fisheries (General) Regulations (Cap. 378).	www.kenyalaw.org
KEN	Fisheries Act (Cap. 378).	www.kenyalaw.org
KOR	Conservation and Management of Marine Ecosystems Act.	www.moleg.go.kr
LEB	Resolution No. 125/1 of 1999 prohibiting to fish whales, seals and marine turtles.	
MAS	Marine Mammal Protection Act 1990 (Public Law 1990-84).	www.paclii.org
MAT	Tourism Authority (Dolphin and Whale Watching) Regulations 2012 (GN No. 154 of 2012).	www.gov.mu
MAT	Fisheries and Marine Resources Act 2007 (Act No. 27 of 2007).	
MAU	Décret nº 86-620 portant création de la réserve satellite du Cap blanc.	
MAY; JUA; GLO; BDI	Arrêté préfectoral nº 32/DG/01-TAAF portant interdiction de la chasse aux cétacés dans les zones économiques exclusives française des îles éparses et de Mayotte, pour une période de dix ans.	

MEX	Aviso mediante el cual se da a conocer al público en general la temporada 2013-2014 para llevar a cabo actividades de observación de ballenas.
MEX	Aviso mediante el cual se da a conocer al público en general la temporada 2012-2013 para llevar a cabo actividades de observación de ballenas.
MEX	Norma Oficial Mexicana NOM-131-SEMARNAT-2010: Establece lineamientos y especificaciones para el desarrollo de actividades de observación de ballenas, relativas a su protección y la conservación de su hábitat.
MEX	Aviso mediante el cual se da a conocer al público en general la temporada 2009-2010 para llevar a cabo actividades de observación de ballenas.
MEX	Decreto que modifica la Ley general de vida silvestre.
MEX	NOM-135-SEMARNAT-2003: Regulación de la captura, transporte, manejo y manutención de mamíferos marinos en cautiverio.
MEX	NOMEM-136-ECOL-2002: Establece las especificaciones para garantizar el bienestar de los mamíferos marinos en cautiverio.
MEX	NOM-131-ECOL-1998: Especificaciones para el desarrollo de actividades de observación de ballenas, relativas a su protección y la conservación de su hábitat.

MEX	Tasa máxima de captura incidental de delfines durante las operaciones de pesca de túnidos con redes de cerco en el Océano Pacífico Oriental.	
MEX	Tasa máxima de captura incidental de delfines durante las operaciones de pesca de túnidos con redes de cerco en el Océano Pacífico Oriental.	
MEX	NOMEM-074-ECOL-1996: Lineamientos y especificaciones para la regulación de actividades de avistamiento en torno a la ballena gris y su hábitat, así como las relativas a su protección y conservación.	
MEX	Tasa máxima de captura incidental de delfines durante las operaciones de pesca de tunidos con redes de cerco en el Océano Pacífico Oriental.	
MEX	Zona de refugio para ballenas y ballenatos.	
MIC	Chapter 1 of Title 29 of the Pohnpei State Code - Pohnpei State Fisheries Protection Act of 1995.	www.vanuatu.usp.ac.fj
MLT	Marine Mammals Protection Regulations, 2003 (L.N. 203 of 2003).	www.doi.gov.mt
MOR	Arrêté du Ministre des pêches maritimes et de la marine marchande nº 2134-93 relatif à l'interdiction temporaire de pêcher des phoques-moines et autres mammifères marins ainsi que de certaines autres espèces marines.	
NAM	Marine Resources Act, 2000 (Act 27 of 2000).	

NAM	Regulations relating to the exploitation of marine resources (No. 241 of 2001).	
NIC	Resolución Nº 23/02 - Conservación y utilización sostenible de las especies de la familia delfínidos.	www.asamblea.gob.ni
NIU	Whale Sanctuary Regulations 2003.	www.paclii.org
NOR	Act relative to the catching of polar bears.	www.lovdata.no
NOR	Decree No. 1 of 1969 to prohibit the hunting of seals without a permit.	www.lovdata.no
NOR	Decree No. 5 of 1969 relative to the hunting for seals.	www.lovdata.no
NOR	Decree on prohibition to import animals and infectious substances.	www.lovdata.no
NOR	Decree No. 195 of 1998 to regulate fishing by Norwegian vessels in the Antarctic (CCALMR-area).	www.lovdata.no
NOR	Act No. 15 of 1999 relative to the right to participate in fishery and hunting of marine animals (Participation Act).	www.lovdata.no
NOR	Decree to regulate hunting for minke whales (No. 312 of 2000).	www.lovdata.no
NOR	Decree No. 799 of 2001 to regulate the exportation of minke whales.	www.lovdata.no
NOR	Decree No. 57 of 2003 relative to a notification duty relative to landing and sale of fish.	www.lovdata.no

NOR	Decree No. 151 of 2003 to provide rules for the hunting of seals in the West Arctic Sea and the East Arctic Sea.	www.lovdata.no
NOR	Act No. 37 of 2008 relating to the management and conservation of living marine resources (Marine Living Resources Act).	www.lovdata.no
NOR	Decree No. 106 of 2011 relative regulate the hunting of seals in the West Arctic Sea and the East Arctic Sea in 2011 and relative to participation in such hunting.	www.lovdata.no
NOR	Regulation No. 1124 on cessation of minke whales hunting in 2013.	www.lovdata.no
NOR	Regulation No. 340 on access and regulation of minke whale hunting in 2013.	www.lovdata.no
NOR	Regulation No. 183 on participation and hunting of seals in the West- and East- Ice in 2013.	www.lovdata.no
NOR	Regulation No. 267 on capture of minke whales in 2012.	www.lovdata.no
NOR	Regulation No. 240 on participation in hunting minke whales in 2012.	www.lovdata.no
NOR	Regulation No. 108 on the right to participate in seal hunting in the West Ice and East Ice in 2012.	www.lovdata.no
NOR	Regulation No. 1272 on quotas in coastal hunting for seals in 2012.	www.lovdata.no

NOR	Decree No. 681 of 2010 relative to a register for the storage of electronic information on catch and activities of fishing and hunting vessels.	www.lovdata.no
NOR	Decree No. 1745 of 2009 to provide for the management and conservation of seals on the Norwegian coast.	www.lovdata.no
NOR	Decree No. 263 of 2009 to regulate the hunting of seals in the West Arctic Sea and the East Arctic Sea in 2009.	www.lovdata.no
NOR	Decree No. 88 of 2009 on participation in the hunting of seals in the West Arctic Sea and the East Arctic Sea in 2009.	www.lovdata.no
NOR	Directive No. 1276 of 2008 to provide hunting quotas for coast seals in 2009.	www.lovdata.no
NOR	Decree No. 370 of 2006 relative to maximum quotas in the catching of minke whales in 2006.	www.lovdata.no
NOR	Directive No. 451 of 2003 relative to maximum quotas in hunting for minke whales in 2003.	www.lovdata.no
NOR	Delegation of authority pursuant to the Act regulating importation and exportation of goods (No. 618 of 1998).	www.lovdata.no
NOR	Decree relative to meat control, hygiene and related matters in relation with the preparation and marketing of whale meat (No. 298 of 1997).	www.lovdata.no
NOR	Decree relative to export licences and the exportation of fish and fish products and marine mammals and	www.lovdata.no

	products of marine mammals (No. 598 of 1993).	
NOR	Decree to prohibit hunting for Ross-seals (No. 1 of 1968).	www.lovdata.no
NOR	Royal Decree relative to the entry into force of Acts concerning Norwegian fisheries limits for Jan Mayen (No. 3471).	www.lovdata.no
NOR	Decree No. 3 of 1953 to regulate catching of fur seals and elephant seal on Bouvet Island and Peter I. Island.	www.lovdata.no
NOR; JMN; SVA	Decree No. 336 of 2011 to regulate hunting for minke whales in 2011.	www.lovdata.no
NOR; JMN; SVA	Decree No. 268 of 2009 to regulate hunting for minke whales in 2009.	www.lovdata.no
NOR; JMN; SVA	Decree No. 249 of 2005 to regulate hunting for minke whales in 2005.	www.lovdata.no
NOR; SVA	Decree No. 1743 of 2009 relative to position reporting and electronic reporting of Norwegian fishing and hunting vessels.	www.lovdata.no
NOR; SVA; JMN	Decree No. 291 of 2011 relative to access to participation in the catching of minke whales in 2011.	www.lovdata.no
NOR; SVA; JMN	Decree No. 265 of 2009 relative to access to participation in the catching of minke whales in 2009.	www.lovdata.no

NZE	Marine Mammals Protection Act, 1978 (Act No. 80 of 1978).	www.legislation.govt.nz
NZE	Marine Mammals Protection (Banks Peninsula Sanctuary) Notice, 1988.	www.legislation.govt.nz
NZE	Marine Mammals Protection Regulations, 1992.	www.legislation.govt.nz
NZE	Marine Mammals Protection (Auckland Islands Sanctuary) Notice, 1993.	www.legislation.govt.nz
NZE	Biosecurity Act, 1993 (Act No. 95 of 1993).	www.legislation.govt.nz
NZE	Marine mammals protection (Clifford and Cloudy Bay Sanctuary) Notice, 2008.	www.legislation.govt.nz
NZE	Marine mammals protection (West Coast North Island Sanctuary) Notice, 2008.	www.legislation.govt.nz
NZE	Marine mammals protection (Te Waewae Bay Sanctuary) Notice, 2008.	www.legislation.govt.nz
NZE	Marine mammals protection (Catlins Coast Sanctuary) Notice, 2008.	www.legislation.govt.nz
PAN	Resolución Nº 22 - Requisitos para la expedición de certificados de exportación de aletas de tiburón.	www.gacetaoficial.gob.pa
PAN	Decreto Nº 9 - Protege al tiburón ballena.	www.gacetaoficial.gob.pa
PAN	Resolución Nº 1 - Norma el avistamiento de cetáceos en aguas jurisdiccionales.	www.asamblea.gob.pa

PAN	Resolución Nº 2 - Norma la recolección de mamíferos marinos para cautiverio.	www.asamblea.gob.pa
PAN	Ley Nº 13 - Establece el corredor marino de Panamá.	
PAU	Marine Protection Act of 1994.	
PER	Decreto Supremo Nº 026/01/PE - Prohíbe la caza de diversas especies de ballenas y la captura de todas las especies de tortugas marinas.	
PER	Decreto Supremo Nº 003/02/PE - Sistema de seguimiento y verificación del atún capturado por buques atuneros de cerco.	
PER	Resolución Nº 588/96/PE - Condiciones ambientales y de cuidado para el adecuado mantenimiento y bienestar de los cetáceos menores en cautiverio.	
PER	Decreto Supremo Nº 002/96/PE - Reglamento para la protección y conservación de los cetáceos menores.	
PHI	Fisheries Administrative Order No. 185 banning the taking or catching, selling, purchasing and possessing, transporting and exporting of Dolphins.	www.tanggol.org
PIT	Local Government Regulations.	www.government.pn
PNG	Whaling Act.	www.paclii.org
PNG	Fauna (Protection and Control) Maza Wildlife Management Area Rules 1979.	www.paclii.org

PNG	Fauna (Protection and Control) Act 1966.	www.paclii.org
POR	Regional Legislative Decree No. 15/2013/M approving the Regulation for Observation of Marine Vertebrates within the Autonomous Region of Madeira.	www.dr.pt
POR	Decree No. 19/2004 approving the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area, (ACCOBAMS).	
POR	Regional Legislative Decree No. 9/99 regulating whale watching within Azorian waters.	
POR	Regional Decree No. 11/97/M creating the Natural Reserve of 'Sítio da Rocha do Navio'.	
POR	Regional Decree No. 14/90/M creating the Special Protected Area of 'Ilhas Desertas'.	
POR	Decree-Law No. 263/81 approving the Regulation on marine mammals protection.	
RUS	Order No.86 of 1994 of the Federal Fisheries Committee regarding validation of the Provisional Regulation on the modalities and terms of issuing fishing authorization to foreign legal and natural persons, Russian enterprises with the foreign participation for catch of aquatic biodiversity in EEZ and continental shelf of the Russian Federation.	

RUS	Order No.82 of 2004 of the Federal Fisheries Committee regarding issuing fishing licences for catch (harvest) of aquatic biodiversity for coastal fisheries to the users of the Sakhalin Region in the Far Eastern basin for the period of 2004.	
RUS	Order No. 313 of the Federal Fisheries Agency validating the list of aquatic biological resources authorized for fisheries.	www.fishcom.ru
RUS	Joint Order No. 23 of the Ministry of Agriculture and of the Federal Fisheries Agency regarding the elaboration and validation of total allowable catch.	www.lawrussia.ru
RUS	Order No. 85 of the Ministry of Agriculture validating the list of aquatic biological resources industrial fisheries, artisanal and sport fishing of which, and also protection thereof by the regional authorities shall not be carried out.	http://base.consultant.ru
RUS	Order No. 85 of the Ministry of Agriculture validating the list of biological resources, the industrial fisheries, artisanal and sport fishing of which and the protection thereof shall not be regulated by the regional executive bodies.	sevrv.ru
RUS	Order No.330 of 2004 of the Ministry of Agriculture regarding setting quotas for catch of aquatic biodiversity for proper needs (personal consumption) of scanty indigenous population and ethnic communities of Koryak Autonomous Area for the period	

	of 2004.
RUS	Order No.297 of 2004 of the Ministry of Agriculture regarding issuing fishing licences (permits) for catch (harvest) of aquatic biodiversity for industrial purposes for coastal fisheries to the applicants of the Koryak Autonomous Area in the Far Eastern basin for the period of 2004.
RUS	Order No.227 of 2004 of the Ministry of Agriculture regarding issuing fishing licences (permits) for catch (harvest) of aquatic biodiversity for industrial purposes for coastal fisheries to the applicants of the Kamchatka Region in the Far Eastern basin for the period of 2004.
RUS	Governmental Ordinance No.1948-r of 2003 regarding validation for the period of 2004 of total allowable catch (harvest) of aquatic biodiversity for proper consumption (personal consumption) of indigenous scanty population and ethnic communities of the North, Siberia and the Far East of the Russian Federation.
RUS	Governmental Ordinance No.1644-r of 2003 regarding validation of total allowable catch for the period of 2004 in freshwater inland water basins, inland sea, territorial sea, continental shelf, EEZ of the Russian Federation, in the Azov sea, Caspian sea and the lower reaches of the

	rivers flowing into them, as well as in the Amour river.	
RUS	Order No. 32 of the Federal Fisheries Committee regarding validation of the Regulation on the structure and the functioning of the ichthyologic branches of the basin fishing inspections attached to the Committee.	www.dalryba.vladivostok.ru
RUS	Governmental Ordinance No.1603-r of 2002 regarding validation of total available catch for the period of 2003 of aquatic biodiversity in the internal sea, territorial sea and Exclusive Economic Zone of the Russian Federation.	
RUS	Governmental Ordinance No.1551-r of 2001 regarding validation for the period of 2002 of total allowable catch of aquatic biodiversity in internal sea, territorial sea, continental shelf and Exclusive Economic Zone of the Russian Federation.	
RUS	Ministerial Decree No. 1582-p granting hunting authorization for two Groenlandian whales for the needs of small indigenous populations living on the territory of Tchukotka Autonomous Region of the Russian Federation.	www.law.optima.ru
RUS	Ministerial Decree No. 967 of 1992 regarding participation of the Russian Federation in the	

	International Convention for the Regulation of Whaling.	
RUS	Fisheries Regulation No. 141 on artisanal and sport fishing in the water bodies of the Sea of Azov, Manych water reservoirs, water bodies of Kalmykia and Stavropol region subordinated to the fisheries basin institution of the Sea of Azov.	www.ohota.novochek.ru
RUS	Order No. 349 of the Fisheries Ministry validating the Regulation on conservation and catch of marine mammals.	www.dalryba.vladivostok.ru
RUS	Statute of Fishing Inspection (1970).	
SAF	Sea Birds and Seals Protection Act.	
SAF	Sealing Regulations.	www.enviroleg.co.za
SAF	Regulations to amend the Regulations for the management of boat based whale watching and protection of turtles (No. R. 819 of 2009).	www.info.gov.za
SAF	Regulations for the management of boat based whale watching and protection of turtles (No. R. 725 of 2008).	www.info.gov.za
SAF	Marine Living Resources Act (No. 18 of 1998).	www.enviroleg.co.za
SAF	Notice on Assignment of certain provisions of the Sea Birds and Seals Protection Act. to the administrators of the provinces of Cape of Good Hope and Natal (Proc. No. 8 of 1993).	www.enviroleg.co.za

SAF	Sea Birds and Seals Protection Regulations (GN. R. 1168 of 1982).	www.enviroleg.co.za
SIE	Fisheries (Management and Development) Decree, 1994.	
SLO	Act on protection of wild animals and wild plants.	www.b4b.sk
SPA	Real Decreto Nº 1.727/2007 - Medidas de protección de los cetáceos.	www.boe.es
SPA	Real Decreto Nº 942/2001 - Programa de seguimiento y verificación del atún capturado en el área del Acuerdo relativo al Programa Internacional para la Conservación de los Delfines (APICD).	
SRL	Fauna and Flora Protection Ordinance.	
SRL	Fishing Operations Regulations of 1996.	
STH	Spear Guns Control Ordinance (Cap. 91).	www.sainthelena.gov.sh
STH	Endangered Species Protection Order.	www.sainthelena.gov.sh
STH	Spear Guns Control Order, 2006 (Cap. 91).	www.sainthelena.gov.sh
TCI	Fishery Protection Ordinance 2003 (Cap. 104).	www.environment.tc
TCI	Fisheries Protection Regulations 1989 (Cap. 104).	www.environment.tc
TON	Whaling Industry Act.	www.paclii.org
TON	Fisheries (Conservation and Management) Regulations	

	1994.	
TON	Fisheries Regulations 1992.	www.tonga-law.to
TUK	Law No. 230-I on protection and rational management of wildlife.	
TUR	Circular No. 33/1 on commercial fishing activity into marine and inland waters (1999-2000).	
UKR	Order No. 129 of the Ministry of Agrarian Policy validating Fisheries Regulations for the period of 2005.	
UKR	Ministerial Decree No. 1126 validating the Regulation on the modalities of carrying out artisanal and sport fishing.	
URU	Ley Nº 19.128 - Decláranse al mar territorial y a la zona económica exclusiva de la República "Santuario de Ballenas y Delfines".	
URU	Resolución S/n - Apruébanse las modificaciones a los Apéndices de la Convención sobre el Comercio Internacional de Especies Amenazadas de Fauna y Flora Silvestre (CITES).	
URU	Decreto Nº 261/002 - Regula las actividades relacionadas con la observación y el acercamiento a los ejemplares de diferentes especies de ballenas por particulares.	www.presidencia.gub.uy
URU	Decreto Nº 238/998 - Medidas para reducir la mortalidad incidental y caza ilegal de pinnipedios y de	

	cetáceos.	
URU	Decreto Nº 149/997 - Actualiza la reglamentación referente a la explotación y dominio sobre riquezas del mar.	
VAN	Maritime (Conventions) Act [CAP 155].	www.paclii.org
VAN	Maritime (Protection of Mammals) Regulations (Cap 131).	www.paclii.org
VAN	Fisheries Act (Cap. 315).	www.paclii.org
VIE	Decision No. 131/2004/QD-TTg approving the Aquatic Resource Protection and Development Program till 2010.	
VIE	Regulation on Management and Conservation of Marine Resources.	

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Appendix C: Response to Peer Review Comments

The BRT enlisted the help of the Marine Mammal Commission (MMC) to coordinate scientific peer review of the June 2012, version of the status review report. The MMC received comments from five reviewers and these reviews were provided, without attribution, to the BRT. The reviews and a summary of how the BRT responded to them are provided below.

Reviewer 1

Attached are various editorial suggestions and comments on the draft humpback whale status review. I read parts of the global review by Flemming and Jackson but did not comment on it as it's already a final NOAA Tech report. I am glad to see this effort and overall thought the BRT did a yeoman's job sorting through and summarizing a huge amount of information and factors. I also thought the bottom line results on stock delineation and the degree to which each of the stocks is endangered was reasonable and well supported by the available scientific information. That said, there are a number of serious and not so serious flaws in the analyses. I tried to summarize the points noted in the attached below. Some may be relatively easy to correct, but others probably could be corrected without reconvening the BRT. Among those flaws are the following:

1. One of the most troubling flaws was the scoring system the used to evaluate expert opinion. I agree that expert opinion is a reasonable and appropriate way to evaluate stock status relative to ESA listing criteria, but the system the BRT used seems flawed. It includes three categories: high risks, moderate risk, and not at risk. There is no low risk category even though the risk analyses frequently categorizes various threats as being low risk. Indeed they conclude that some species are between moderate and "not at risk," which falls into a category they did not consider. If they had a low risk category, I suspect at least some stocks – principally those considered to be a greater risk – would have received much lower "not at risk" scores.

Response: We agree that there are some benefits to having more, and therefore finer, risk categories. However, ultimately the species (or DPS) needs to be categorized into one of the three ESA risk categories (endangered, threatened, not listed), so the use of three categories in the status review makes sense in that context. The description of threats and the narrative description of status also allows for discussion of more nuanced risk status than is provided in just the three categories. Finally, distributing 'votes' among multiple categories also allows for a finer gradation of risk status than would be the case otherwise.

2. The scoring table in Appendix D showing the vote results decisions on the degree of endangerment seems so central to the findings (and short enough) it should be included in the main body of the text – and perhaps even in the executive summary. I would move it up into both the conclusions and the executive summary.

Response: We agree, and have moved this table into the main text.

3. The report notes that the BRT considered the possibility of there being three or four unrecognized subspecies of humpback whales. After seeking the opinion of the SMM Committee on Taxonomy, a majority of the BRT agreed there were likely three subspecies (North Atlantic, North Pacific, and Southern Hemisphere) and then based that opinion, proceeded to analyze DPSs. I do not feel this is either appropriate or necessary. It seems inappropriate to assume three subspecies until such a decision has been published and vetted in the scientific literature and it becomes accepted by the scientific community. Notwithstanding the respected opinion of the SMM Committee, it is not the place of the BRT or listing process to decide whether new subspecies should be recognized. That is a role for the scientific literature based on a thorough analysis relevant data beyond the scope of the BRT. By assuming 3 subspecies, any listing decision based on the BRT's advice would presumably have to be reflected in listing DPSs according to their assumed three subspecies model which is not currently supported in the scientific literature. Moreover, the need to consider subspecies seems irrelevant in this case. That is, it seems to me all of the identified DPS could be supported assuming the species is monophyletic with now subspecies. In almost every case, the principle supporting rational for the DPS is that the absence of a stock would leave a significant gap in the range. This is no less true for a single global species than it is assuming three subspecies. Thus the debate and analysis about subspecies seems superfluous and distracting. I would suggest either deleting that discussion entirely, or at least leaving it as a question needing further research and not basing the DPS analysis on an assumption of subspecies. The discussion of DPSs could still be lumped under the three ocean basins as a matter for presentation convenience without considering each basin a separate subspecies and arrive at the same conclusions. The referenced precedence for considering possible subspecies set by the Southern Resident Killer whale was in my view more a political decision than a scientifically based argument. I would hate to see that situation become a precedent for future analyses.

Response: We agree that the sub-species question is a difficult one. However, because the ESA specifically mentions sub-species and because marine mammal sub-species may be somewhat under described due to the difficulty of access to specimens (Reeves et al. 2004a), the BRT concluded that some discussion of potential humpback whale sub-species would be useful. In response to this and similar comments, however, we made substantial revisions to the discussion of sub-species in the report. In particular, the revised report focuses on describing the major differences among humpback whales inhabiting different ocean basins, and simply notes that these differences may be *consistent with sub-species. Because of the major differences among ocean basins, the report focuses primarily on assessing the question of whether there are DPS within ocean basins, but also discusses whether any DPS so identified are also discrete and significant with respect to the global taxon. With some possible exceptions (noted in the report), the BRT agrees with the reviewer that the DPS identified in the report meet the DPS criteria regardless of whether the larger taxon in question relates to an ocean basin or the global species. Finally, the report cites a recently published study that proposes three sub-species of humpback.*

4. In some cases where there were different possible alternatives regarding regional stock structure (e.g. North Atlantic) , the BRT used the same process of allocating 100 points to different options that they used to evaluate DPS risks and reported the results in a table. In other cases, such as the division between the Central American and southeast Pacific stocks (p 33-34) it notes a "majority" or "consensus" view but does not provide the scores. The report should be consistent in providing scores wherever there were a range of possible options considered.

Response: The BRT made some decisions by consensus, as noted in the report. The structured decision making process, particularly for population structure issues, was only employed when the BRT concluded that there was substantial uncertainty.

5. The discussion of the Okinawa/Philippines stock (with which they lump in Ogasawara) and the unknown second western population seemed confusing and not particularly convincing. The suggestion that Ogasawara is part of the migratory corridor for Okinawa/Philippines stock does not seem convincing. Ogasawara is nearly 1000 miles due east of Okinawa and would not appear to be along the same route whales would take to the Philippines. The background document mentions that there have been a few photo ID matches between the Okinawa and Ogasawara, but that the Ogasawara whales had a distinct genetic signature. It is not clear to why the Ogasawara whales are not part of the "second western" stock whose calving grounds have yet to be identified (but may in part include Ogasawara) and instead should be considered part of the migratory corridor to the Philippines while Okinawa is considered part of the calving range for that population. This is a confusing situation but I think a better job could be done laying out the basis for the supposed second western population, why it is apparently different from the Ogasawara whales, and why Ogasawara is considered only part of the migratory corridor while Okinawa is considered part of the calving range.

Response: We have edited the report to try to clarify our reasoning.

6. The DPS analysis seems to assume all mating occurs on the winter calving grounds. Some added discussion of the potential for mating either on the northern feeding grounds or along the migratory corridor seem important. If whales do mate on feeding grounds where different stock intermingle, it could significantly undermine

support for the DPS analysis. As a related point, I seriously doubt whales in the Southern Hemisphere stick to the narrow Antarctic wedges Identified as their summer feeding areas. Rather I imagine there is more overlap and intermingling then suggested in their model (which was based on an IWC model. Thus, it seems important to state why whales are not thought breed in shared feeding or migratory corridors.

Response: We agree with the reviewer regarding the likely overlap of feeding areas in the southern hemisphere, and have revised the report to clarify this point. Regarding breeding locations, it is widely believed that, while occasional mating may occur on feeding grounds or on migration, the great majority of mating and conceptions take place in winter breeding areas and the report references studies supporting these observations. In addition, any breeding activity that occurs at what are generally considered to be feeding locations would be reflected in the patterns of genetic diversity considered by the BRT, and low levels of breeding at these areas do not therefore reduce support for the DPS analysis.

7. According to page 3, the BRT was asked not to review the ESA listing criterion on "adequacy of existing regulatory mechanisms." Yet the threats analyses for several different stocks mentions and seem to reflect consideration of various national laws, guidelines and other such management measures. For example, for the Oceania stock, they dismiss future whaling as a threat given various whale sanctuaries and national laws prohibiting whaling. Similarly for the east Australia stock as part of the rationale for concluding the stock was at low risk of extinction is a statement that Australian waters are protected by the Australian Whale Sanctuary.

Response: We agree that there was an inconsistency within the report on this point. In fact the BRT did consider the effects of existing regulatory mechanisms on the current status. The revised report clarifies that the BRT considered these effects, and includes additional explicit discussion of adequacy of existing regulatory mechanisms.

8. The report is generally very well written, but there are parts, particularly the general description of threats in Section A.2 that need some further editing. I have included some suggestions. There also are incorrect references and inaccurate and incomplete information in the "vessel collision" in section A.2.4. See corrections on attached.

Response: The report has been edited for clarity and accuracy per the reviewer's comments.

9. I would simplify stock names for convenience and rely on the text to say what parts of the range are included in that stock. For example the reference to the

“Mozambique/East South Africa/Comoros Archipelago/Madagascar” stock could be simplified to the Southeast Africa/Madagascar stock or simply the Southeast Africa stock. Similarly, the “Cape Verde plus Northwest Africa” stock could be simplified to the Cape Verde stock or Norwest Africa stock. Also, at times the report goes to considerable length to note that the Arabian stock is not in the Southern Hemisphere, but at others is seems to forget that distinction and lump them in even though it is north of the equator. The report should be consistent in noting this is not a Southern Hemisphere stock.

Response: We agree, and have edited the report for consistency and simplicity of names.

10. The discussion of research threats should include invasive tagging. I do not believe it is a significant risk, but it is probably one of the greatest risks that research poses for individual whales and as such should not be omitted from the assessment of research effects.

Response: The report has been edited to include discussion of tagging.

Reviewer 2

No general comments – all comments were as comments in file (see Table C1 for responses).

Reviewer 3

In general, from my perspective, I think they have done a pretty good job on this task. They have certainly taken it seriously and attacked it in a thorough, sensible manner, investing lots of intellectual firepower. Allie Fleming and Jen Jackson did a yeoman job of pulling things together in the first place, as acknowledged, and the BRT seems to have thought things through carefully. So I think overall, what the MMC can and should offer is commendation for a job well done, plus added comments on how things can be improved in a final document. Basically though, I think the judgments on how to define, and assess, the DPSs are reasonable and well justified.

No response necessary.

Reviewer 4

Please see attached for BRTs document with comments inserted and a stand-alone document with three primary comments and supporting material in an appendix

A couple of other points and question:

1. I have added my graduate student to this, as she was helpful in the process especially for combing through past IWC reports. I hope that was OK.

2. I provided a broader review but also had some specific comments and questions for DPSs. These are areas where we have greatest familiarity. But I hope this doesn't come across as 'our monkey isn't on the list. That isn't the case as to why I raised the issues. Actually, we have spent the better part of the last 8 (and even 12 years) reviewing humpback whales at IWC--including North Atlantic, and several SH assessments. The issues we point out are the populations that actually have more complex population sub-divisions that others --and now some of the assessments completed in the earlier days are going back and re-evaluating evidence for population structure. I believe these points are well-substantiated, and just don't want to have an appearance of self-interest.

3. So what are the next steps in the process and how can we stay engaged?

I hope all of this is helpful and what you were expecting from my review.

Response: See response to specific comments in Table C1.

Reviewer 5

Given the constraints of the DPS focus I think the BRT did an outstanding job of synthesizing a lot of information. The presentation and writing was clear and well organized.

I will address each of the recommended review topics as listed in your email. However, I am not as familiar with the non-North Pacific populations; hence I won't be able to give those adequate review.

• Is the information presented accurate and current? (If they are aware of additional or more current relevant information, we would appreciate it if they would provide copies of all additionally suggested references.)

The information was for the most part current. Suggested additions or changes are:

1. There was one reference that cited the SAR instead of the publication. I suggest that be changed (page 6 Angliss and Outlaw to Gabriele *et al.*1996).

Response: The reference was corrected.

2. In the overview there was no mention of the age of humpbacks and the discrepancy in the whaling literature (see Gabriele et al 2010). Longevity seems critical to assessing risk of extinction and I am curious why the omission?

Response: As noted in the introduction, the BRT report provides only a brief summary of the biology and ecology of humpback whales, deferring a more detailed discussion to the companion report of Fleming and Jackson (2011). That report does discuss maximum ages.

3. A paper on trend (rate of increase), survival and abundance in Southeast Alaska was recently accepted for a final revision and will be published soon (see Hendrix *et al.* in Press). These results should be used as the most up to date and best data available for this population.

Response: This paper was not available to the BRT during the course of their deliberations and was therefore not included in the report. It does not appear that the information in the paper would change the basic conclusions of the report, however.

4. There are a number of references to strong migratory link with Mexico and Southeast Alaska. This simply is not true. SEAK has very few MX whales. I can find sources if needed but Jorge Urban's paper on MX migratory destinations should be a good start. The genetics papers from MX including SPLASH reports should be used as well.

Response: We agree and corrected this mistake.

5. Genetic diversity for the Gulf of Alaska is described in Witteveen *et al.* 2011. This could be added to the genetic diversity background or in the specific region.

Response: This paper was not available to the BRT during the course of their deliberations and was therefore not included in the report. It does not appear that the information in the paper would change the basic conclusions of the report, however.

6. Interactions (not specifically competition) with fisheries are described in Rice et al 2011 and these papers have been accepted for publication in Fisheries Oceanography. I can provide full citations if necessary.

Response: This paper was not available to the BRT during the course of their deliberations and was therefore not included in the report. It does not appear that the information in the paper would change the basic conclusions of the report, however.

7. Update on vessel collisions in AK has been published. Neilson *et al.* 2012. This paper should replace the IWC 2007 version and is updated and more thorough.

Response: The reference was updated.

• Does the information presented sufficiently make the case for the designation of potential DPSs based on the agency policy described in the document?

Yes I believe the BRT did a good review and assessment. Although I don't have evidence to say this with any certainty, I am not 100% convinced Ogasawara is not a standalone breeding area or used as both a pass through and a breeding area.

• Are the extinction risk assessment approaches appropriate and sufficient?

Yes the approach for assessing risk was sufficient with the exception of a discussion as to how long humpbacks can live.

• Does the threats assessment accurately and sufficiently summarize the threats facing the identified DPSs?

For the most part, yes, the BRT assessed threats. However, the aquaculture issue was mis- represented for Alaska. Alaska prohibits fish farming for finfish but does have an aquaculture program (ocean ranching) for salmon. Humpbacks feed at the release sites upon salmon smolts and fry which complicates returns to the commercial fisheries (see Straley et al 2010). The sections on aquaculture in Alaska need to be accurate. The issue of predation on releases needs to be added both as a competition factor and threat (eating fish who were fed fish meal while held in net pens). There is low risk of entanglement from net pens.

Response: If we understand the comment correctly, the reviewer is referring to releases of hatchery salmon, which are very common throughout the entire Pacific Rim. We did not consider such releases to be "aquaculture" per se, and the BRT did not directly evaluate risks from whales preying on hatchery salmon. Although this issue may be worth further investigation, it does not appear to be a significant risk at this time.

• Are the conclusions in the report clear and well justified?

The BRT and the writer of the document clearly presented the conclusions.

Suggested references in order from review answers 1 to 7:

Gabriele, C.M., J.M. Straley, L.M. Herman, and R.J. Coleman. (1996) Fastest documented migration of a North Pacific humpback whale. Marine Mammal Science, 12(3):457-464.

Gabriele, C.M., *et al.* (2010) Sighting history of a naturally marked humpback whale (Megaptera novaeangliae) suggests ear plug growth layer groups are deposited annually. Marine Mammal Science, 26(2):443–450.

Straley, J. *et al.* (2010) Preliminary investigations of humpback whale predation at salmon enhancement facilities on eastern Baranof Island, southeastern Alaska, April to June 2010. University of Alaska Southeast, 1332 Seward Ave, Sitka, AK 99835 19pp.

Hendrix, N., J. Straley, C. Gabriele and S. Gende (In Press) Bayesian estimation of humpback whale (Megaptera novaeangliae) population abundance and movement patterns in southeast Alaska. Canadian Journal of Fisheries and Aquatic Sciences

Witteveen, B. *et al.* (2011) Using movements, genetics and trophic ecology to differentiate inshore from offshore aggregations of humpback whales in the Gulf of Alaska Vol. 14: 217–225,

Neilson, Janet L., Christine M. Gabriele, Aleria S. Jensen, Kaili Jackson, and Janice M. Straley (2012) Summary of Reported Whale-Vessel Collisions in Alaskan Waters

Volume 2012 Article ID 106282

Response: We thank the reviewer for the information, and have added most of these references as appropriate.

Comment #	p. #	Comment	Response
1	v	This is strange to say before a review of genetics and to even include such speculation. Who is on that committee?	The executive summary is necessarily brief, but the main body of the report provides much more information on this topic. Based on numerous comments related to the sub-species question, we have also modified the text in both body of report and the executive summary to better qualify the uncertainty surrounding possible sub-species. We provided a list of committee members as a footnote.
2	v	This sounds premature to me. Would it not be better to say something like "… on the assumption that at least three subspecies will eventually be described, named, and recognized."	We agree, and have revised draft provides a more nuanced view of the sub-species question.
3	v	Sub-species debates have been going on for quite some time. Most recently the NOAA-SWFSC has taken favor with sub-species definitions following on a 'journal club' and a pre-meeting workshop at the 2009 SMM meeting in Quebec City. One of the major problems with sub-species approaches is the arbitrary nature of such evaluations. This statement seems to be guided on a combination of biogeography, long-term movements and identity, and genetics. However the genetic differentiation of the Arabian Sea population from all other populations around the world (See Pomilla et al 2005; Pomilla et al-IWC report) is more significant than many other ocean basin comparisons and yet it is being grouped with the Southern Hemisphere humpbacks. Furthermore, it was at the 2002 IWC and in a taxonomic review by Brownell and Perrin that of all the humpback whale populations worldwide, the Arabian Sea population merited sub-specific status. The problem is how this information is uniformly and consistently applied, particularly as it relates to management decisions. I agree that there are divisions below the species level for humpbacks but whether those are DPS or sub-species.	The sub-species section was revised considerably to reflect this and other comments. In the revised draft, we focus more on the degree of divergence among whales from difference ocean basin and the possibility (only) that this divergence may be consistent with sub-species. The updated report also cites more recent literature on this topic.

4	vi	For this analysis this is too vague a term and should be changed to mating areas. How well known are mating areas. While we know they mate in the tropics, is that the only part of their range this occurs?	We do not agree with this comment. Among other things, the unit to manage is a “population” not an “area”. The fact that specific mating areas are not all identified does not matter at this level. The existing text has been retained; however, a footnote has been inserted after the first mention of “breeding areas” to define the term as used in this document.
5	vi	This is a double-may phrase – makes no sense. Potentially means could and could means potentially so why use both?	We have corrected the text.
6	vi	Why not just Southeast Africa/Madagascar DPS to simplify?	We agree, and made this change.
7	vi	It would be good to clarify here if these are all ages or just mature.	We agree, and have edited to clarify.
8	vii	It would be good to clarify here if these are all ages or just mature.	We agree, and have edited to clarify.
9	vii	This whole statement is correct if at first DPS are defined correctly in a two-step process. First, define the unit to conserve and then 2nd evaluate status, trend and probability to extinction (similar to IWC, no loss of distinct demographic unit). But what about other possible DPSs not fully considered. For example the B2 sub-population, genetically distinct (albeit low levels of genetic differentiation) and possibly containing only a few hundred animals.	The BRT's approach was to identify the best supported DPS configurations and evaluate extinction risk of each DPS identified. With only a few exceptions (e.g., West Pacific 2, Cape Verde Islands), the BRT was sufficiently confident in the DPS configurations that evaluation of additional, less supported configurations would not be considered useful.
10	vii	What about noise/ interference with communications? That might be added to climate change	Noise was considered and ranked as low but increasing threat.
11	vii	Why include this one reference in Ex. Sum. Delete?	We agree, and deleted the reference.
12	vii	This paragraph is about the NORTH Pacific subspecies, no? If so, should say so here.	Text was clarified.

13	vii	Should be more specific From noise? Oil spills? Ship traffic? or all of the above?	This is further explained in the body of the document.
14	vii	Whaling. Isn't this the same as "directed takes"? And where in the region are humpback whales whaled?	This is further explained in the body of the document.
15	vii	Moderately (or minor) reduce pop growth through combined effects or each individually? Need to define moderate in terms of effect on population growth… or perhaps PBR	Modified with "each" to clarify individually.
16	vii	The west coast of Africa has extensive oil and gas leases currently proposed and in operation. This is not highlighted at all and was discussed in the IUCN review of SH humpbacks and during the IWC reviews. I have to take complete exception with the fact that the review can find a concern off Western Australia from energy exploration for a population that was reviewed to be several times larger than the populations off west Africa. This is simply incorrect and erroneous. NB. This information was provided to the BRT via Jackson and Flemming report. See supporting Materials #1	We agree that oil and gas extraction is a potential threat and added text that acknowledges this.
17	vii	This seems irrelevant. Issue is whether there are threats where ever they are	We disagree; in this case the population faces increased risks due to its location in a relatively constrained geographic location.
18	vii	How about prey availability, given it is the only species that feeds in the subtropics which are generally less productive and subject to extensive fishing.	Prey availability was unknown, and this is stated later in the report.
19	vii	This is the Western Gray Whale of humpback whales and yet it isn't getting appropriate attention. We are in the process of trying to get a Conservation Management plan set in motion at IWC, but requires government interest and effort and support.	No change necessary.

20	vii	Unclear. Does this mean the BRT worked "collectively" (which would be implicit and therefore unnecessary to say)? Or the BRT evaluated the collective array of threats facing each DPS? Or?	Removed "collectively".
21	viii	Past, present, or future?	Text was clarified.
22	viii	Needs more explanation. Just who and how many on the BTR and what are the boundaries of bins in terms of points?	This is further explained in the body of the document.
23	viii	Although I don't' believe the subspecies question is as important as this report makes it out to be, I note that the decision to consider a three subspecies structure is not noted here.	We agree with the comment that the sub-species question is not likely to influence the DPS designations to any great degree, and have added a section on this in the body of the report.
24	viii	Does this mean then that there are some insignificant DPSs as well?	Removed significant.
25	viii	Variously referred to as Southeastern Pacific, Columbia/Ecuador, and other names throughout. Need to be consistent.	We agree, and have edited the document for consistency.
26	viii	If it's not "not at risk" or moderate risk, then it must be at high risks	We edited to report the percentage support for each of the three categories.
27	viii	This is not a score	This is correct, but no revision is necessary.
28	1	Was that comprehensive evaluation this document? If so, should be "began a" and should make the connection more explicit. If not, is there a citation for the 2010 review?	Text was clarified per reviewer's suggestion.

29	2	The evaluations of humpbacks in other fora such as IWC also strive to determine DPS and are documenting them within these basins. Whether these can be assessed in a rigorous way is another story. But they appear to exist and would potentially double the number of DPS identified by this Review.	As discussed in the report, a DPS has a specific interpretation under the ESA, as described in the joint USFWS-NMFS DPS Policy. Units identified by the IWC do not necessarily conform to this definition, which states that a population must be both 'discrete' and 'significant' in order to be considered a DPS. This issue is discussed at length in the report.
30	2	By whom?	We deemed it unnecessary to include these details here.
31	2	Also subspecies?	As noted in the report, the BRT concluded that it would be useful to evaluate the sub-species question.
32	2	Aren't BRTs supposed to make recommendations to the agency re listing?	The BRT was tasked with evaluating biological status and threats, not making a listing recommendation.
33	3	Understand that this is limited by ESA, but for some of the DPSs, the extent of current and emerging threats to limit recovery may need to be considered. Thus the risk of extinction may just be too high a bar.	We evaluated status with respect to the risk categories described in the report. We agree that understanding factors limiting recovery is also important information to consider, however, and edited the text to make this point.
34	3	For me, this is a missed opportunity. It would have been more work for the BRT, but this would have been an interesting and valuable exercise. It would have at least provided something to discuss or challenge below the 'risk of extinction' level. Do we know why the BRT was not asked?	The report has been edited to clearly state the charge to the BRT and the purpose of the report.
35	5	Why not assume no information on three subspecies and just review re DPS and leave subspecies question to later research. Does it make a difference if a DPS is a DPS of a species or subspecies?	We now describe the differentiation among ocean basins more clearly and discuss whether or not these differences might be consistent with sub-specific divergence. We added a section discussing whether the 'taxon' of reference (possible sub-species based on ocean basins versus the global species) makes any difference to identified DPS.

36	5	This seems more ad hoc than should fly for this review. What about the considerable debate about whether sub-species exist and whether one can reliably, consistently, and rigorously delimit subspecies? **See supporting materials #2	We do not think this report is the appropriate venue to present a detailed discussion regarding the nature or validity of sub-species. The BRT accepted the opinion of experts who have specifically reviewed this question and proceeded on that basis. However, we also edited the report to make it clear that we are primarily describing differentiation among ocean basins that may be consistent with potential sub-species.
37	6	It would be helpful if this figure included dots with labels for breeding grounds.	This figure has been deleted, as a subsequent figure shows the breeding grounds.
38	8	To be useful for identifying DPSs given policy guidance, this section should discuss what is known about where the whales mate. It is noted elsewhere that they mate on calving grounds, but it is not clear whether there is any information to suggest they may mate on feeding grounds or elsewhere. A definitive statement about such possibilities (i.e., there is no evidence they mate on feeding grounds or this is unknown) would be helpful.	We have edited this section for clarity per the reviewer's suggestions.
39	9	Sounds like a pretty safe upper limit but not very realistic.	No change necessary.
40	9	This is a strange section heading given previous headings	We modified heading.
41	9	I think this overstates the singularity of the DR concentration (Silver and Navidad Banks) to the neglect of numerous other smaller concentrations in the Greater and Lesser Antilles and along the coast of Venezuela.	We revised the text to discuss the other areas.

42	10	Some mention of Roman and Palumbi seems warranted, even if the results/conclusions are disputed.	Roman and Palumbi’s paper is important but does not deal directly with current trends, which is the section here; rather the debate surrounding this paper centers on the size of the North Atlantic humpback whale population prior (perhaps greatly prior) to whaling. We have added a reference to the issue, however, in the context of a new section related status to the recovery plan.
43	10	There is information on survival probability in Rosenbaum *et al.* 2002 Journal of Heredity on this matter as well. **See supporting materials #3	While Rosenbaum *et al.* (2002) has survival information, it is more of a model that we do not feel would add significantly to this section.
44	10	If so, why is only one of these provided in the paragraph?	Text has been clarified.
45	10	To be useful for the purpose of determining DPSs given the policy guidance, these genetic sections should discuss the extent to which there is a detectable genetic difference between the various populations. Where this has not yet been analyzed it should be so noted.	We agree, and have added this here and elsewhere in relevant sections of the document.
46	10	Has a “Gulf of Maine” population been introduced in this report yet?	Yes.
47	11	This sounds really strange to me. What are ‘inland’ waters, and might it not be significant that ‘inland and coastal’ waters are the areas most easily and often observed where feeding behavior can be documented?	Removed "inland "
48	11	Not sure what is meant here by ‘territorial’ waters. Within 12nmi of shore? Also, saying that ‘more than half feed’ is hard to interpret – more than half spend some time, from a little to a lot, feeding in US territorial waters, or more than half of their aggregate annual nutrition is obtained in same, or??	Text was clarified.

49	11	I remain reluctant to be so strong about this point. There is lots of turnover, I'm told, in the animals on the DR banks through the winter, and lots of other areas where the whales sing, nurse etc. in the wider Caribbean region.	Text was clarified.
50	11	"Broad" in what sense? As in widely spaced from each other? Or large? Another general point is that using the term "breeding" loosely with migratory cetaceans is problematic. Conflating mating, calving, and nursing leads to confusion and muddle. Important these terms be clearly defined and used consistently.	Text was clarified.
51	11	Why this level of detail for SPLASH but not YONAH? Probably less for SPLASH is better?	We disagree, and believe the level of detail provided (a brief summary) for the SPLASH and YONAH projects is appropriate. Citations to both studies are provided for readers desiring a greater level of detail.
52	11	Measure of uncertainty	The 18,302 estimate was an average between feeding and breeding ground estimates, no measure of uncertainty was given in the original document.
53	12	Earlier "best" estimates were reported, so seems unnecessary to report the preliminary estimate, particularly given the lack of uncertainty.	The text simply attempts to summarize the current literature.
54	12	Perhaps worth saying something here re validity of the ratios even if the absolute numbers don't quite line up with Barlow *et al.*?	We agree, and have edited the text accordingly.
55	12	Is the Johnson and Wolman estimate credible?	Text was clarified.
56	12	Logic here not clear. Why the "however"?	Removed "however".

57	13	While the Arabian Sea population likely has SH origin, it should not be lumped in with SH populations. It shows the greatest differentiation of any of the DPSs compared to one another. By this very nature, it actually 'throws a wrench' into why it would be considered the same sub-species in the Southern Hemisphere when it is extremely differentiated from all populations, even more than the other sub-species are to one another or at the same level. So by the logic applied, if you we are to go that route, it should be its own sub-species.	Text has been clarified.
58	13	Including the Arabian Sea in the introduction to Section I is confusing as the reader then expects the population to be discussed as part of this section rather than Section J.	Text has been clarified.
59	13	Lower level of detail regarding trends, in terms of time frame, citations etc, than for N. Pacific?	We do not feel that the somewhat greater detail for the North Pacific is unjustified given the scope and greater precision of the SPLASH estimate and the delisting petition focused specifically on these populations.
60	13	So the east Africa DPS was assessed at IWC as having one trend at this rate. Compare to humpback whales off the east coast of Madagascar (C3 breeding sub-stock, DPS) that potentially had a much reduced rate of recovery. See IWC 2009 or 2010. **See supporting materials #4	These general overview statements of the southern hemisphere populations have been deleted from this section, which now focuses only on population structure issues. Information available for the abundance and trends of each DPS is now discussed in the extinction risk section. The difference between a flat trend and an inability to measure a trend is now clarified.

61	13	Not obvious what this means. Does it mean the Gabon and SE Pacific populations could be increasing, decreasing, stable – any of those? No evidence exists one way or the other? Whereas for Oceania there is sufficient evidence to say something and it indicates stability? I.e. I think it would be important to clarify the difference between non-availability of data and inability to discern.	These general overview statements of the southern hemisphere populations have been deleted from this section, which now focuses only on population structure issues. Information available for the abundance and trends of each DPS is now discussed in the extinction risk section. The difference between a flat trend and an inability to measure a trend is now clarified.
62	13	Overall, there is now increasing evidence that greater complexity in population structure exists within each of the SH oceanic populations. What implications does this have for DPS? This information is starting to come out and much of thes points in the review were completed before 2011 (around 2010).	The information we are aware of is discussed in the DPS section. Per earlier comments, we have modified the text to more clearly describe information on available patterns of genetic differentiation, and compare these patterns in different parts of the species' range.
63	14	Overall, these sections do not take into account Rosenbaum et al 2009, PloS ONE which provides the most comprehensive and largest SH humpback whale genetic assessment and provides key evidence for DPSs within the oceanic regions. I know this is taken up later but the key results are not given adequate or correct assessment based on what the BRT has proposed as DPSs compared to what we have published, evaluated at IWC, etc...	We now cite and discuss the results of Rosenbaum *et al.* 2009.
64	14	Check reference. Possibly not published as this data has recently been submitted to Conservation Biology: Rosenbaum, HC., Maxwell, S., Kershaw, F. & Mate, B. "Quantifying broad scale movements and range-wide cumulative potential impacts for humpback whales in the South Atlantic Ocean." For the purpose of the BRT and the NOAA technical report, this is the updated reference to Rosenbaum and Mate 2006	As far as we are aware, this paper has not yet been published.

65	14	Not sure about the wording here as all migrations would at some point have to occur in" Antarctic offshore waters". Rather, there may be a migratory route that follows the coastline of Africa and one or more that occur in offshore African waters, for example, as whales move offshore to follow the Walvis Ridge as ~18*S. There is direct satellite telemetry evidence of this in the Rosenbaum *et al.* paper described in Comment I4. As such, this section should be expanded to reflect the length of the SWIO section on migration below. **See supporting materials #5	The offending clause was deleted in the final version.
66	14	This section for example insufficiently characterizes distribution and population structure that exists within the southeast Atlantic. The IWC SC has reviewed this information for approximately the last 5-7 years and has concluded that there is strong evidence for 2 breeding sub-stocks, and thus 2 DPSs in this region. To say that this "This section is organized by breeding ground stocks and is generally consistent with IWC management units for the Southern Hemisphere," is misleading and doesn't take into account the degree to which information exists and has been reviewed and verified. **See supporting materials #5--BUT IN PARTICULAR, The complexity that exists in the North Pacific Ocean and is becoming better understood may be similar in some ways to what we are seeing along the west coast of Africa. Certainly similar in some of the geographic extent and possible latitudinal separation of breeding stocks with associated feeding grounds. The available evidence we have points that way.	The BRT reviewed the available evidence for population structure in this area, including the latest information from the IWC. We disagree that "sub-stocks" would all necessarily meet the criteria described in the joint NMFS-FWS DPS policy.

67	15	This paragraph and migratory pathways are given too much weight based on a single publication where singing was detected. It does not take into account some of the more recent evidence for these populations that show connectivity and movements between migratory streams. Importantly, the concern is that for some areas, there was a reliance on older information that may be more familiar and not as strong a focus on assimilating new information.	Text was clarified.
68	15	Also, see Van Waerebeek, K. *et al.* "A newly discovered wintering ground of humpback whale on the Northwest African continental shelf exhibits a South Atlantic seasonality signature." Paper SC/64/SH4 presented to the IWC scientific committee, Panama, 2012.	This information was not available to BRT to review and include in the report.
69	15	From this year's IWC, evidence emerging that greater complexity for population structure than previously and traditionally thought. **See supporting materials #6	The BRT reviewed the available evidence for population structure.
70	15	Footnote to mark—recapture first time used several pages earlier instead?	Text has been clarified.
71	16	But what is meant here by the SW Atlantic? Is this estimate from photo-id data obtained mainly or entirely on the Brazil wintering grounds? Should make this clear.	Text has been clarified.
72	16	Would it not be just as likely that Brazil whales go to other parts of the Antarctic rather than staying N of 60?	Given the coverage of the surveys reported by Branch, we consider dispersal to other parts of the Antarctic to be unlikely.
73	16	See IWC 2012 (for report of SH 2011) for which abundance estimates were chosen and why. **See supporting materials #7	Comment is unclear; the section in question does not discuss abundance estimates.

74	16	This is hard to comprehend. The numbers given apply to a 'portion' of a very large area. Would it not be helpful to readers if something were explained here about implications? For example, is it reasonable to conclude that 6000-8000 is about it for the entire region, or could there be twice, three times etc. that many? Or what?	This has been moved to the extinction risk section. The text has been modified to reflect that the population to which the estimates apply is somewhat uncertain due to some degree of substructure within the DPS.
75	16	Again, the reader is left to his own devices here. Should he see these numbers from the two different areas as corroborative, additive, or what? Also, whereas the method is given for the Cerchio estimates, none is indicated for the Findlay one.	Added Findley method. This whole topic has been moved to the extinction risk section, where the various estimates are now described in greater detail.
76	16	In my opinion and that of the IWC, these abundances represent two separate DPSs one along east Africa and one off Madagascar.	There is now some discussion of the differences among these areas. Based on the information available to the BRT, we do not believe these two sub-areas meet both criteria (discrete and significant) to be considered separate DPS.
77	16	See my point above about concern for Western Australia and energy development, especially when it is far more extensive off Western Africa.	The West Africa section was modified per the reviewer's comment; the BRT saw no need to modify the Western Australia section.
78	17	Similar clarity is needed for the Africa estimates above.	Comment not clear.
79	17	Method?	The number was right but citation was incorrect; has now been published as Felix *et al.* 2011 - have made correction in text.
80	17	Annual rates?	Yes.

81	17	This trend only applies to one of the potential sub-stocks C1 which could be a DPS. This is a problem with this report that I am continually pointing out. By going to the 15 DPS, it is very easy to apply apples to oranges. There are many holes with other DPSs in terms of available data, but by 'lumping', one gets the appearance that certain data (especially trend which is important) could apply across the whole SW Indian Ocean for example.	This section has been moved into the extinction risk section, where the limitations of the trend inferences are more fully discussed.
82	17	Some general statement the first time trend data is noted about maximum plausible rate would be good, rather than note it within individual sections	This is done on page 10 in Chapter II section F.
83	18	I guess this answers my question, above.	No response necessary.
84	18	Are there older trends? Some of the other trends discussed are from ~20 years ago.	This section has been moved to the extinction risk section where it is treated in more detail.
85	18	There is also nuclear genetic information available for some sub-stocks and potential DPS.	This section has been revised to focus more on genetic differentiation among populations.
86	18	And northern hemisphere populations? But looking at the number of haplotypes listed in sections below doesn't seem like it is all that much more diverse?	Deleted S. Hemisphere.
87	18	The Breeding Stock B1/B2 substructure should be at least referred to here even if it is not considered as two DPSs. Two hypotheses currently stand: i) A single population with a wide ranging distribution that displays temporal heterogeneity in migration giving the genetic signal of two subpopulations; or ii) the existence of two genetically distinct subpopulations resulting from different breeding grounds (breeding ground for B2 not yet identified but assumed to lie further north of Gabon (see Van Waerebeek, K. *et al.* IWC paper in comment I4).	This structure is now explicitly discussed.

88	18	I presume the number of haplotypes is at least somewhat influenced by sample size, so it seems like reporting sample size in each case would be warranted. 65 haplotypes from 70 samples would tell you something very different than 65 haplotypes from 500 samples….	Sample size has been added.
89	18	More recent evidence of connectivity between these populations is available. **See supporting materials #8	It is not clear from the comment which populations are referred to.
90	18	So, can the same thing not be said about this stock as was said above about the Brazil stock? Genetically diverse?	This section has been revised to focus more on levels of genetic diversity among populations as this is most relevant to determining discreteness.
91	18	I'm sure these comparisons of genetic diversity in the different stocks are important for assessment and conservation decision making, but how and why aren't obvious to the average non-geneticist. The details given here are proportionally greater than those given for the abundance estimates, but without some coaching, I don't see how most readers will be able to interpret and apply this stuff.	This section has been revised to focus more on levels of genetic diversity among populations as this is most relevant to determining discreteness.
92	19	This implies East Australia is part of Oceania?	Removed "other".
93	19	Symbol use is not consistent	Corrected text.
94	19	and therefore…	Text was clarified.
95	19	If Arabian Sea is treated separately from Southern Hemisphere populations then it should not be mentioned in the intro to the section above.	Text was clarified.
96	20	The Arabian Sea is in the northern hemisphere. If they are in the Gulf of Aden presumably they could go through the Suez? Also with animals off Sri Lanka it seems like eastern movements to connect with the western North Pacific are possible.	Text was clarified.

97	20	Has there been a comparison with far western North Pacific samples collected during SPLASH? Either way this should be stated.	Added text to this section.
98	20	I think this is an important point that needs to be kept in mind. Not that this population isn't in big trouble, or that it's not sufficiently discrete to be classified and managed separately. What worries me is the degree to which this estimate is negatively biased, and how that could affect things down the road if/when it is "discovered" that there are quite a few more animals in the population. Recent examples are NA right whales and western Pacific gray whales.	We understand the reviewer's point, but believe the level of detail is sufficient as it stands. If new information becomes available, it can be considered at that time.
99	20	I keep reading this over and over again, trying to divine the take-home message of the entire paragraph. No luck. Once more, the lack of some kind of interpretive guidance as to what all the 'facts' mean, or even might mean, makes me wonder what the point of this document is. If just to compile facts and leave all interpretation to some other process, then I suppose that's 'ok'. But….	Text was clarified.
100	20	Perhaps it is because I don't study humpbacks but I find it strange that this comparison is "among all southern hemisphere breeding grounds" given that this population is in the northern hemisphere and is thought to be non-migratory (i.e., different from all S. hemisphere, and for that matter, northern hemisphere populations). At the least the genetic diversity should be compared to both N. and S. hemisphere populations	Removed S. Hemisphere.
101	20	Report haplotype diversity stats	Text was revised to add this information.
102	21	This is the most critical point and why I raise the point about consistency above. If anything that would merit sub-species (if we think to use this designation), then this would be one. Compare this level of differentiation with other SH populations to those that exist between NA, NP, and SH	We have revised the sub-species discussion. We also clarify that the Arabian Sea population is a DPS under any global taxonomic scenario.

103	23	This issue is not adequately described. First, additional explanation is needed as to why it makes a difference for determining a DPS if one considers humpbacks to be a single species with not subspecies vs several subspecies. In all cases the main rational for DPS findings is that their loss would represent a significant range reduction. In what case might one of these 15 DPSs not qualified as such if there were no subspecies. Second I do not believe the BRT and listing process is the appropriate place to make decisions about whether there are multiple unnamed subspecies. If the current scientific consensus and literature do not recognize subspecies, this group should not step in to express its view. Third, if there were multiple sub-species, what does that mean in terms of how the species would be listed? Would the ESA list have to note DPSs under three unnamed subspecies that have not been recognized in the scientific literature? That seems like a bad precedent.	We have revised this whole section to deemphasize the importance of identifying sub-species. Rather, we have noted that the differentiation among ocean basis is substantial (possibly to the level of sub-species) and therefore focus largely on whether there are any DPS within ocean basins. We have also added a discussion of whether any or all so-identified DPS are also DPS when considered with reference to the global taxon.
104	23	I think most taxonomists would agree that subspecies don't 'exist' – they are a construct that is used to sort variability (yes, species are too, but obviously the scale is different). My suggestion would be to change the wording here to say something like: Although in recent decades no subspecies of humpback whales have been recognized, it is relevant to consider whether such recognition is likely in the near future.	We agree, and have edited the text along these lines.
105	23	Line spacing changes	Corrected text.
106	23	Again, I think this phrasing misleads, implying that a subspecies is other than just a classificatory construct.	Text has been clarified.
107	23	Again, I think this phrasing misleads, implying that a subspecies is other than just a classificatory construct.	We agree, and have edited the text accordingly.
108	24	It is not a taxonomic committee; it's just a committee on taxonomy.	We agree, and have edited the text accordingly.

109	24	See above comment. Until the best information (meaning published information and not the opinion of any particular group of experts) has determined there are multiple species, it should be assumed to be one species with no subspecies..	In response to this and similar comments, we have extensively revised the section on sub-species and also conclude that the DPS identified are, for the most part, not very sensitive to the sub-species designations. We also note that several sub-species of humpback whale have now been proposed in the scientific literature.
110	24	Herein lies the problem with subspecies……it is very subjective process between populations (for which significant differences can be measured) and species (for which objective measures to delineate units exist under certain species definitions. I think the BRT did the most reasonable process to look at sub-species, but the broader question is should they have? What value does it add?	We have significantly revised the discussion of potential sub-species to address this and other similar comments.
111	24	Whoa. Assuming, as implied, that "this opinion" refers to the numbers just cited, does it mean the BRT consists of "noted experts on cetacean taxonomy"? I don't think that was the intention, but the syntax certainly points in that direction.	Text was clarified.
112	24	I guess I should give up on this – I know I'll be overruled.	See comments on sub-species above.
113	25	Inconsistent approach to 3 vs 4 subspecies	Text has been clarified.
114	25	This phenomenon occurs in the eastern South Atlantic regularly, and is noted in our publications.	Removed "eastern Pacific".
115	25	But those "current studies" have been very limited.	We don't agree that the studies concerned have been so limited as to leave open the possibility that the Cape Verdes hosts a large number of unobserved whales. It is clear from several surveys of various islands in this group that the density of humpbacks there is low.
116	25	Jann *et al.* (2003) provide direct (photographic) evidence linking Cape Verdes with Iceland and it should be cited here.	Citations were added.

117	25	Not clear why no mention is made of the evidence discussed by Reeves, Clapham and Wetmore (2002) and more extensively by Charif *et al.* (Mar Mamm Sci 17:751-68).	Added citations to text.
118	25	What is the basis for considering this a region separate from other parts of the Eastern (Norway) population since they both are said to go to Eastern NA calving areas? Consider deleting the reference to a central NA region?	As noted in the text, the basis for these divisions lies in genetic differences among whales from these three regions (Larsen *et al.* 1996). Larsen, A. H., J. Sigurjónsson, N. Øien, G. Vikingsson, and P. J. Palsbøll. 1996. Population genetic analysis of mitochondrial and nuclear genetic loci in skin biopsies collected from central and northeastern North Atlantic humpback whales (Megaptera novaeangliae): population identity and migratory destinations. Proceedings of the Royal Society of London Part B, 263:1611-1618.
119	25	Again, I worry about what this means – mating, calving, nursing, two or all three?	Text was clarified.
120	25	Does this include Iceland?	Yes, based references cited earlier in the report.
121	26	I don't think this makes any sense, if, as stated earlier, the 'breeding unit' is the relevant unit for present purposes.	Amended the text by replacing "when lumped together" with "which include…"
122	26	I agree with this although I also think it would be only fair to acknowledge the strong asymmetry in sample size between the two areas.	Text was revised to add this information.
123	26	Evidence for this? Certainly larger than seems to be present nowadays, but large is a relative and imprecise term.	Text was clarified.

124	26	I just don't get this. The Cape Verdes are "near Northwest Africa" (of course this depends on the meaning of "near" (see "large," above)). I'm concerned about that lack of any whaling or other evidence for such an area elsewhere in the region. It's hard for me to imagine, given that the American whalers managed to find the so-called Cintra Bay right whale ground, that they would not also have found any concentration of "breeding" humpbacks that was of appreciable scale etc.	The reviewer's contention that American whalers would have found a large concentration of humpback whales if one existed ignores two things. First, the hunting of humpback whales ("humpbacking") by Yankee whalers was a secondary aspect of the industry, which was primarily interested in sperm whales and balaenids; humpbacks were generally a lot less valuable in terms of oil and baleen and thus were the focus of a subset of whalers who typically operated for only a year or so in the North Atlantic (rather than the multi-year voyages of, say, sperm whalers). Thus, there was not much incentive for most whalers to make a search for humpbacks a principal focus of a voyage. Second, there are examples of whalers possibly "missing" what might have been significant concentrations of animals elsewhere (e.g. humpbacks on Silver Bank, and perhaps right whales in the Bay of Fundy).
125	26	Some reference to the Johnston *et al.* 2007 Endangered Species Research paper and the Lammers *et al.* 2011 MEPS paper seems appropriate, given that Lammers et al actually proposed the NWHI may be this additional breeding area	The text was edited to add these references.
126	27	How does this differ at the species and subspecies levels? That is if they are different at a subspecies level, would they not also be different at a species level. If so the discussion above about whether and how many subspecies there are seem irrelevant and distracting could be deleted	The section on sub-species was significantly revised to deal with this and similar comments.
127	27	Uniqueness does not have degrees. A signature is either unique or it is not. Need to rephrase to say what is meant here.	Text was clarified.

128	27	From each other and from all other populations – I think this needs to be said explicitly if true.	Text was clarified.
129	27	This doesn't seem to make sense. What is the basis for believing Ogaswara whales simply pass through the area? Also, the Ogasawara Islands are some 1000 mi due east of Okinawa and seem unlikely to on the same migratory path. Both Ogasawara and Okinawa could be on a migratory path to the Philippines but if the genetics say Ogasawara whales are genetically distinct from the Philippines/Okinawa whales, why is it considered Ogasawara whales why are parto ot that stock?	Text was revised to explain more fully.
130	29	So when complexity is evaluated and exists based on genetic and demographic evidence, DPSs were found to exist for the North Pacific. Based on available evidence, there should be several more DPSs for SH populations.	We disagree with this comment. In both the NP and the SH, we lumped proximate breeding locations with no strong genetic differentiation or other evidence of discreteness into common DPS.
131	29	See previous comment. Further explanation needed as to why this area might only be part of a migratory route rather than a destination	Text was revised to add this information.
132	29	This section does not sufficiently summarize available genetic differentiation which is essential for DPS delineation. The differentiation results contained in Rosenbaum *et al.* 2009 and Olavarria *et al.* are essential for DPS evaluation and could significantly inform DPS (and have significantly informed IWC Stock Assessments).	We revised to focus more on genetic differentiation and cite these references.
133	29	Is this word appropriate here? Not sure, seems a little prejudgmental.	Removed "discrete".
134	29	I understand why this is written as it is but don't think it's necessary and could confuse some readers.	We agree, and have edited the text accordingly.

135	30	Is this figure correct? Seems to show feeding areas, not breeding areas? Some reference to the A/B, B/C areas of overlap should be noted in the caption	We agree with the comment, and have replaced with figure 1 reproduced from IWC 2011, which shows the IWC hypothesized stock structure with breeding and feeding locations.
136	30	For consistency, the scores for this conclusion should be provided. Being able to compare scores between regions also helps with interpreting those other scores	Text was clarified.
137	30	So this makes it sound like "breeding" here means something specific, probably mating per se (independently of calving and nursing).	Text was clarified.
138	30	Isn't the Great Barrier Reef part of eastern Australia? Why this distinction?	Text was clarified.
139	30	Again, why no votes? Was everyone willing to provide all 100 votes in this one scheme? Hard to believe some would not have put at least a few points in other breakdown options. Knowing the degree of certainty on the BRT is important.	The BRT made some decisions by consensus, as noted in the report. The structured decision making process, particularly for population structure issues, was only employed when the BRT concluded that there was substantial uncertainty.
140	30	This is the justification for Section J above. So need to amend the introduction to Section I.	Text was clarified.
141	30	score?	The BRT made some decisions by consensus, as noted in the report. The structured decision making process, particularly for population structure issues, was only employed when the BRT concluded that there was substantial uncertainty.
142	30	This is a strange construction, comparing a population to "other … grounds." Oranges and grapefruit?	Text has been clarified.
143	30	But this isn't one	Text has been clarified.

144	31	But connections to the western Pacific seem quite plausible given "Arabian Sea" animals around Sri Lanka?	It is a long way and many degrees of longitude from the Arabian Sea to the western North Pacific; and it is not clear if the humpbacks occasionally found around Sri Lanka have any connection to the Arabian Sea. While we do not preclude the possibility of a connection with the North Pacific, based on current evidence this cannot be more than speculation.
145	31	Yes but sample size for the Philippines, the population with the highest likelihood of interchange, is small	Text was revised to add this information.
146	31	Names could be simplified	Text has been clarified.
147	31	Since this was already covered just a paragraph or two above, I think you can delete this	Agree; text has been clarified.
148	31	For the humpback populations assessed to date and where there is sub-structure, this list does not reflect what has been found by the IWC.	We discuss the relationship between the DPS we identify and the IWC population structure.
149	31	Perhaps add parenthetical re Arabian Sea.	Text has been clarified.
150	31	Since you were so careful above not to lump the Arabian population in the "Southern Hemisphere Group" why do it here?	Text has been clarified.

151	32	Note: this is an expansion of the policy criterion 2 which is any significant gap in its range. While I appreciate both feeding and breeding areas were considered, I don't know that you need to separate them here. What about the migratory corridor. Is it possible whales mate during migration? Are not migratory corridors a significant part of their range? Clearly treats along migratory corridors are a concern. I would combine them as in the policy statement but leave your discussion of this criteria as it is with an explanation why migratory corridors were not considered when evaluating this criterion.	In the revised text we clarified that we were simply applying the existing ‘gap in the range’ criteria; the breakdown between feeding and breeding ranges was purely for convenience of discussion and should be considered an expansion of the policy.
152	32	I am not convinced this term belongs in the mainstream of mysticete biology. It seems to me that the features discussed below fall comfortably under the terms behavior and ecology and therefore the diversity of behavior and ecology is what should be at issue here, rather than something ill-defined and not readily understood (and that provides a better “fit” to the significance criteria as they are given.	Text was clarified.
153	32	This is not in the Southern Hemisphere and there are other populations that eat fish. It is however the only population living entirely in the tropics and is therefore unique.	We agree, and have edited the text accordingly.
154	33	score?	The BRT made some decisions by consensus, as noted in the report. The structured decision making process, particularly for population structure issues, was only employed when the BRT concluded that there was substantial uncertainty.
155	33	So now they have ‘risen’ from proposed to putative. Is this the right place to be advancing this subspecies cause? I think not.	The entire sub-species section has been revised, and terminology regarding the possibility that whales from different ocean basins could be considered different sub-species has been made consistent throughout the report.

156	33	'where documented geographic overlap between hemisphere populations occurs' NB—it may also occur among populations of humpback whales in the eastern South Atlantic.	We are unaware of any solid evidence documented.
157	33	I find this reasoning bizarre.	Text was clarified.
158	33	There we are. Now the subspecies are no longer qualified by an adjective!	The entire sub-species section has been revised, and terminology regarding the possibility that whales from different ocean basins could be considered different sub-species has been made consistent throughout the report.
159	33	This would be true even if there were no subspecies.	The entire sub-species section has been revised, and terminology regarding the possibility that whales from different ocean basins could be considered different sub-species has been made consistent throughout the report.
160	33	Again, bizarre wording as here we have population segments constituting portions of feeding range. One is whales and the other is acreage.	Text was clarified.
161	33	Yes, there is some overlap. But there also appears to be some uncertainty about the total feeding range of CVI animals, so you cannot say this so conclusively and unreservedly.	Agree; text has been clarified.

162	33	I would suggest noting that the Cape Verde Islands (and perhaps also the Central American) population are also significant because there is some evidence that these areas are the only areas identified to date that may be use by individuals from both the N & S Hemisphere and thus are among the few areas were there might be an opportunity for genetic exchanges between the Hemispheres.. the Missing western North pacific calving grounds might be another given the NP genetic signal in the SE Pacific population.	The Pacific coast of Central America is known from photo-id matches to host humpbacks from both Northern and Southern Hemisphere populations, so the first point here is correct with regard to that area, although such a statement probably belongs elsewhere in the document rather than here. There is no direct evidence that the Cape Verde Islands host austral whales (the reviewer refers to a match between the CVI and the Antarctic Peninsula – this is wrong, and perhaps s/he is confusing this with matches between the Peninsula and the Pacific coast of Central America). Finally, the reviewer's idea about the "missing" North Pacific breeding area is completely speculative.
163	33	Do they constitute "most" of the feeding whales in that part of the range?	Text has been clarified.
164	33	If it is the majority of the individuals that count, do not the eastern North Atlantic "breeding" populations make up the majority of whales feeding in the northern parts of the eastern North Atlantic?	Text was clarified.
165	33	But don't these breeding groups constitute a majority of the whales feeding from Vancouver south?	Yes, but the text was referring to significance with regard to each other, not HI or WP. Section was edited for clarity.
166	33	Elsewhere it was the majority of whales on a feeding ground that determined whether a group was significant	Text was clarified.
167	34	Again what degree of overlap is required to make a DPS finding?	The BRT did not attempt to quantify this criterion, but rather considered this factor, along with others, in making a qualitative assessment of whether the whales utilized different feeding areas.

168	34	So, to many readers, and probably users, this will be plucked out of context and suddenly there will be literature referring to 'the Arabian Sea subspecies'. Sorry, but that's the most parsimonious interpretation of this sentence as is, if lifted out of context.	Text has been clarified.
169	34	Yes, this terminology makes more sense than the alternative which would follow from the earlier phraseology – e.g. "unique cultural features"?	No response necessary.
170	34	score?	The BRT made some decisions by consensus, as noted in the report. The structured decision making process, particularly for population structure issues, was only employed when the BRT concluded that there was substantial uncertainty.
171	34	Which might, might it not, call into question the subspecies split that has now become a fait accompli? In which case this argument gets circular, or specious.	The entire sub-species section has been revised, and terminology regarding the possibility that whales from different ocean basins could be considered different sub-species has been made consistent throughout the report.
172	34	What about photo matches between the Cape Verde Islands and the Antarctic Peninsula? Does that not also indicate a potential for genetic exchange between the N/S Hemispheres and make that portion of its range ecologically unique?	The Pacific coast of Central America is known from photo-id matches to host humpbacks from both Northern and Southern Hemisphere populations, so the first point here is correct with regard to that area, although such a statement probably belongs elsewhere in the document rather than here. There is no direct evidence that the Cape Verde Islands host austral whales (the reviewer refers to a match between the CVI and the Antarctic Peninsula – this is wrong, and perhaps s/he is confusing this with matches between the Peninsula and the Pacific coast of Central America). Finally, the reviewer's idea about the "missing" North Pacific breeding area is speculative.

173	34	I'm afraid that using this logic, and perhaps influenced by a bias of BRT individuals that aren't familiar with geographies around Africa, that additional DPSs in Breeding Stock B and C have not been sufficiently considered. This may also be the case for other areas that are now starting to examine population subdivision after completing single, broad comprehensive assessments. This may not be in the BRTs remit to 'open up' debate to some of the most recent IWCs or publications for 2012.	We disagree. Most SH populations have very modest levels of genetic divergence from each other, the one exception being SEP.
174	36	This is a key table and would be much easier to interpret if the no columns were deleted. All that counts are the yeses and if they are not yes, the reader will figure out it's also a "no"	Added a new table that shows pairwise comparisons among populations.
175	36	I think this is wrongheaded.	Not clear what s/he feels is wrong.
176	36	disagree	Not clear what s/he feels is wrong.
177	36	This very much upweighs the differences from the SE Pacific and Arabian Sea, and downgrades all the other oceanic differences (and sub-population structure detected)	The footnote was actually not really reflective of how the BRT considered genetic data. We have revised to make it clear that the BRT considered all available genetic data in evaluating DPS structure.
178	37	I think there has been a bias in BRT knowledge and/or review of material. 8 of the 15 DPSs come from either the NP or SP (Pacific Ocean). For the S. Atlantic and Indian Ocean, a total of 4 DPSs exist, but this does not fully consider the information previously published or summarized by the IWC.	The BRT reviewed the information available, and believes its DPS conclusions are reasonable.
179	37	Show overlap between DPS 4 and 11	Done.
180	38	And also because of possible overlap and genetic exchange between N & S Hemisphere whales?	We disagree; to our knowledge there is no evidence of this.

181	39	Since this includes the Northwestern Hawaiian Islands, yet all the studies to date focus within the main Hawaiian Islands, it would probably be good to specify main Hawaiian Islands, particularly given the NWHI could be the missing western Pacific DPS	Text was clarified.
182	40	As noted above, the basis believing this is a mixed in with the Okinawa/Philippines does not seem well supported and seems to me to be more likely part of the second western breeding group based on geography and genetics.	Text was clarified.
183	42	And possibly further north…sat tag evidence of whales continuing past Ghana (Rosenbaum *et al.* submitted to ConBio), and see Van Waerebeek, K. *et al.* "A newly discovered wintering ground of humpback whale on the Northwest African continental shelf exhibits a South Atlantic seasonality signature." Paper SC/64/SH4 presented to the IWC scientific committee, Panama, 2012. The fact that the entire breeding distribution has not yet been determined for this population might be relevant in terms of the uncertainty of the status of this population.	Text was revised to add this information.
184	42	~18*S is where some whales diverge from the African coastline during the southern migration, but uncertain that they actually begin to feed at this latitude. Satellite telemetry evidence suggests that whales still continue direct migratory south to the more productive regions of the Southern Ocean Convergence Zone (inc. Bouvet Island) (Rosenbaum *et al.*, submitted to ConBio).	This paper was not available to the BRT at the time of the review.
185	42	By this logic C1 and C3 are considerably differentiated, lack of matches—similar to that suggested for other areas of NP.	The degree of genetic divergence appears to be much lower among these areas than among the areas we have identified as DPS, however.

186	43	Longitude scale shifted ~45 degrees E! Show overlap between 4 and 11 – listed as Columbia and Ecuador but doesn't even include Columbia on map	The maps are only intended to illustrate rough locations of the DPS breeding locations.
187	48	This is a well-written section, fair to the facts etc. However, the logic of this concluding sentence is pretty strange. Taken out of context, it would lead the naïve reader to conclude that when the science is challenging, our policy is to err on the side of non-precaution. I do think a case could be made that the evidence for healthy, growing populations of humpbacks in nearly all regions where monitoring has been sufficient to assess trends provides a good basis for a provisional conclusion that contaminants are not having significant negative population effects. I also think though that the last clause – 'except where unknown' – completely undermines the message of the sentence, and it would be better if it were deleted.	Text was clarified.
188	48	What about pipelines? And what is a spill from a 'rig'? Is that how one would characterize Deepwater Horizon?	Text was clarified.
189	48	And gas?	Text has been clarified.
190	49	Characteristics that are relevant include much more than just 'age'!	Text was clarified.
191	49	This terminology is bizarre. It is not 'stranding events' that are the concern but rather the mortality of the animals.	Text was clarified.
192	49	The West Indies population probably was NOT 'significantly impacted' by the 1987-88 or 2003 HAB-related UMEs, judging by the uninterrupted pattern of population increase.	Text was clarified.
193	49	Faulty logic	Comment unclear.

194	50	I was not aware that Norway 'acquired' such a permit. Actually, as Mike Gosliner can attest, 'acquire' is the wrong word entirely, since the countries essentially issue the permits to themselves. They are not conferred by the IWC as implied here. Also, use of the term 'originally', especially so soon after reference to the 1946 convention, will be misinterpreted by some. The United States and other nations have used this 'loophole' in the past – e.g. to take gray whales (US), North Pacific right whales (Russia and Japan).	Text has been clarified.
195	50	This reference is now nearly 10 years old and things have changed, such that at least there is now a formal mechanism in place for SC review of permit proposals and results. Admittedly, that's not regulation, but one does need to wonder how 'regulation' and quota-setting would be accomplished for 'research whaling' – I think this sentence is disingenuous and has no place in the review.	This is a matter of opinion.
196	50	Those 'meetings' are 'completed'. See IWC Ann Rep 2011, p7 (agenda item 4.2).	Text was clarified.
197	50	What does this have to do with scientific whaling? It's a non-sequitur.	Text has been clarified.
198	51	This worries me, since the source cited (Reeves 2002) says nothing whatsoever about a block quota of 20 whales over a 5-yr period. I looked carefully!	Removed erroneous reference and corrected.
199	51	I suspect the Europeans introduced themselves, but never mind.	Text has been clarified.
200	51	These would be Greenland, St Vincent and the Grenadines, and ???? I think the honest term would be exactly two.	Text was clarified.
201	51	Poaching is, by definition, illegal.	Text has been clarified.

202	51	These are strong accusations to be making without citing credible references. Is there any evidence that humpback meat found in markets in Korea and Japan came from anything other than 'bycatch'?	Agree, and language has been clarified.
203	52	And satellite tagging, which is invasive	Added satellite tagging.
204	53	If undocumented, how do you know they occur?	Text has been clarified.
205	54	This would seem self-evident since most populations have been increasing steadily for decades now.	Text was clarified.
206	54	This statement begs for a reference to support it.	A reference was added.
207	54	Again, this needs more support. Are the whales feeding in these southern areas? Right whales die in fishing nets off the SE US but that doesn't mean they are feeding there. Humpback whales 'overlap' with fisheries in many parts of their range – unclear why this southern area would be singled out for attention here.	Was discussed as a threat in part due to the smaller size of this population.
208	55	Need to include reference for dB (e.g., re: 1 microPascal) to clarify whether this is in reference to air or water	The sentence was incorrect and has been deleted.
209	56	More likely to be "most" rather than "many", given the likelihood of strandings (<10% even for coastal populations) and even smaller likelihood of a detailed enough examination to confirm/rule out ship strike. Should be "the vast majority likely go undetected or unreported". Could cite the Williams *et al.* 2011 Conservation Letters publication in support. Antonelis *et al.* 2007 noted that several hundred humpback whales likely die in Hawaiian waters each year yet only one or two strandings are documented (17^{th} Biennial Conference abstracts).	Added the citation.

210	56	Has there been a comparison of strandings from ship strikes versus reports in these countries? I suspect compliance is low and this is worth noting.	We don't know of any such comparison. Making note of low compliance without supporting evidence would not be appropriate.
211	56	Laist et al is the source of the 10 of 123 whales finding and that refers to the entire U.S. east coast not the southeast.. They also note all but one of those ship strikes whales was between Delaware Bay ad Okracoke.	Changed reference.
212	56	Again, wrong references and inaccurate information re the 1975-1996 data. I did not check the accuracy of the Glass reference but given the other errors found here, the authors should do so.	Changed reference.
213	58	Would it not be helpful here to specify which DPSs were rated where on the scale? Or at least refer to a relevant table?	Referenced table.
214	58	Some information on Arabian Sea entanglements could be better summarized as significant cause for concern for this population	Addressed in C.13
215	59	This is bizarre reasoning. The point is that ‘Arctic waters’ are being redefined or at least rejiggered geographically, so the ‘however’ here doesn’t make sense. In other words, the last sentence does not, as implied, negate in any way the second to last one!	Changed "however" to "Currently"
216	59	Shouldn’t this sentence come after the following one?	Re-ordered sentences
217	59	The Commission’s “Report of the Workshop on Assessing the Population Viability of Endangered Marine Mammals in U.S. Waters” would be a useful reference to consult and reference on this issue. This report is also in the Commission’s report “The Biological Viability of the Most Endangered marine Mammals and the Cost-effectiveness of Protection Programs.	This section was revised to cite the suggested workshop report and to more fully discuss and justify the BRT’s decisions regarding use of PVAs for this particular status review.

218	60	Again the above report (available on the Commission's website), would be useful to consult and reference.	See above.
219	60	In practice, five, since Near Threatened is effectively another 'risk category'.	Text was clarified.
220	62	There are some respected modelers that would strongly disagree with this statement and the conclusion in the next sentence.	Text was revised.
221	62	Expense might be a reason for limiting use of PVAs and I agree some or even many may not be worth the cost but for some it I think it could help appreciably. This seems to be based on a poor rationale	Text was revised to explain more fully.
222	62	PVAs are not the only thing that should ever be considered. Rather they should be used to trigger a more subjective review per ESA criteria	Text was clarified.
223	62	Quantitative? All but perhaps external risk factor here is based on quantitative data, though there are varying degrees of uncertainty.	Changed to "measures".
224	64	But scale, and turnover, matters. I do not think this 13yr old reference does justice to what is now known about this population's pattern of winter occurrence in the West Indies region as a whole.	This is not correct. Since the cited papers were published, there has been no new information (published or otherwise) that would change the conclusions given in the text regarding the relative abundance and distribution of humpbacks in the West Indies region. There are no data to indicate the existence elsewhere of any concentration of whales on the scale of Silver/Navidad Banks (on a daily basis at the peak of the winter it's perhaps 2,000 whales on Silver, 100 – one order of magnitude lower – in Samana Bay, and in some places another order of magnitude below Samana).
225	64	Unclear to me what a 'geological activity' might be in this context.	Changed to "oil and gas".

226	66	I thought this document said earlier that the recent level of offtake by entanglement and ship strikes was unsustainable for the Gulf of Maine ‘subpopulation’.	True. Not sure how this contradicts that statement.
227	67	Although I certainly agree that NW Africa is a potentially hazardous area for these whales to calve, nurse, and generally overwinter, I don’t agree that some undiscovered ground there is a ‘plausible hypothesis’, so ….	This is what the BRT considered a plausible hypothesis.
228	68	With only 88 whales in the catalogue, while appreciate that there is uncertainty, I find little basis to conclude that this population is “not at risk.” In general where there seem to be relatively small populations for which there is no good abundance or trend data, it does not seem appropriate or precautionary to assume the population is “not at risk.”	The BRT was attempted to evaluate extinction risk, not to be precautionary.
229	68	So this DPS seems a good candidate for Data Deficient, but is that allowed? I guess not.	This was not a formal category, but the BRT noted the high degree of uncertainty due to limited data.
230	69	This actually might be a place to cite Reeves (2002) as there is not a lot of literature summarizing this.	Done.
231	70	The area should be identified.	Text was clarified.
232	70	Is this considered a moderate or minor threat?	Text was clarified to indicate that the threat was considered medium.
233	72	any tagging?	Text was clarified.

234	74	While I do not have difficulty accepting uncertainty as a need to assume the worst and err on the side of higher risk, I have trouble accepting the premise that that a lack of information on size and growth is justification for considering a species to be “not at risk.”	The BRT reviewed the available information and used that to categorize risk. No information absolutely was not equated with "not at risk"; rather limited information tended to lead to likelihood points being placed in multiple categories, reflecting uncertainty about extinction risk.
235	78	It would be helpful to be consistent with terms. Moderate is used elsewhere.	Text was clarified.
236	79	Low risk or not at risk? There is no definition or category for low risk	Text was clarified.
237	79	Same	Text was clarified.
238	79	If this is the case for Western Australia, then it has to also be for Gabon/West Africa given the number of range states with active and extensive hydrocarbon operations in their territorial waters.	Text was revised to add this information.
239	83	If this applies to eastern Australia humpbacks presumably it also applies to other S. Hemisphere populations that feed on Antarctic krill (e.g., W. Australian humpbacks).	We agree, and have edited the text along these lines.
240	83	This was not to be considered?	In the revised report the BRT did consider protective regulations.
241	83	It would be worth noting the uncertainty associated with this estimate	The uncertainty was included.
242	84	I thought this review was not considering adequacy of regulations?	In the revised report the BRT did consider protective regulations to the extent possible.
243	84	This could use some additional explanation. This might reduce population growth from perhaps 10 % to 8 %. Is this the basis for considering a potentially substantial effect on recovery?	Kept as is.

244	85	This does not seem consistent with the above description of “some whaling in the 20th century.”	We do not see the inconsistency.
245	85	The breeding range for this population has been inconsistently presented as “Columbia and Ecuador”, “Panama, Columbia and Ecuador”, “Panama to northern Peru”, and now Costa Rica to northern Peru. Would be good to be consistent throughout	Text was clarified.
246	86	Again, seems to be considering adequacy of regulations.	In the revised report the BRT did consider protective regulations to the extent possible.
247	87	Chile?	Comment not clear.
248	89	But given what has been said for other populations can be expected to be low or non-existent	Contaminants were generally ranked as “low” except where data were poor, in which case they were ranked as "unknown."
249	91	Is this just for part of Gabon? Since they range from 6N-6S presumably this estimate is only for a small portion of the total range? This should be clarified.	Text has been clarified.
250	91	Using a Bayesian estimation methodology...	BRT reviewed available material and is comfortable with decision.
251	91	Gabon may have a mixture of two breeding stocks to which those abundances cannot be prescribed. See Barendse et al 2011 for abundance of whales off south Africa—numbering about 500. **See supporting materials #9	Text has been clarified to discuss possible substructure within this DPS.
252	92	Cookie cutter shark wounds?	No response needed.
253	93	A major shipping lane does transect the Walvis Ridge which has been identified as a key migratory route for these whales. Again, incidence is likely to be low but worth mentioning.	Iguela region only; stated in sentence.

254	93	Information on Gabon and Congo contained in IWC reports but not cited here.	The IWC reports on climate change are referenced and discussed in that section.
255	93	See previous comment on updated abundance estimate. Should also include value range, this number alone conflicts with the previous one cited.**See supporting materials #7	The BRT utilized the available information.
256	93	Different from estimate above?	Text was clarified.
257	93	And currently detected by genetic results that have been endorsed by IWC SC. **See supporting materials #5	Included earlier in text.
258	93	This is interesting information and should be included in the sections above.	BRT is ok with its decision.
259	93	If the BRT had considered separate DPS for B1 and B2 whales, there would have likely been different conclusions with respect to extinction risk? It might be appropriate to add a sentence here identifying that there are still major uncertainties and that more research is needed.	Text was revised to add this information.
260	96	In particular what this estimate represents Arabian Sea humpbacks off Oman or the entire Arabian Sea humpback whale population has been questioned. Surveying in other parts of the range due to political issues is far more complicated than Oman.	Not particularly relevant to this paragraph.
261	98	See Pomilla et al 2006.	Text was revised to add this information.
262	100	I suggest including this appendix in the text. It's only a page These are important enough to include in the body of the report not the appendices.	Tables are now included in the main body of the report.
263	101	And the west coast of Africa as per comments above.**See supporting materials #1	Main text was revised to add this information.

264	101	The earlier analysis suggested whaling could have a substantial effect on this subpopulation if Japan were to move ahead with its pans to catch humpbacks in the Antarctic.	Text was revised to add this information.
265	101	I suggest referencing and moving the table in Appendix D into this section.	BRT reconfirmed its DPS decisions
266	101	As several DPS are potentially missing then perhaps the level of extinction would change in one of them (e.g. B2 subpopulation) and the others would remain the same.	BRT reconfirmed its DPS decisions
267	102	It is not clear how to interpret this table. An explanation is needed.	Explanation has been added.
268	103	This is inaccurate. Again, DPS broken into 2, with the trend for one but not the other.	Text has been clarified to note that in some cases trends are based on a portion of a DPS.

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