NOAA Technical Memorandum NMFS

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REPORT OF THE NATIONAL MARINE FISHERIES SERVICE GRAY WHALE STOCK IDENTIFICATION WORKSHOP

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NOAA-TM-NMFS-SWFSC-507

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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This **NOAA Technical Memorandum NMFS** issued by the Southwest Fisheries Science Center may be cited in following manner:

Weller, D.W., Bettridge, S., Brownell, R.L., Jr., Laake, J.L., Moore, J.E., Rosel, P.E., Taylor, B.L and Wade, P.R. 2013. Report of the National Marine Fisheries Service gray whale stock identification workshop. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-507

Executive Summary

The Marine Mammal Protection Act of 1972 (MMPA) requires that the National Marine Fisheries Service (NMFS) and the Fish and Wildlife Service develop stock assessment reports for all marine mammal stocks in waters under U.S. jurisdiction. NMFS considers stock structure as part of these assessments and has developed guidance for delineating separate population stocks under the MMPA. A single population stock of gray whales (*Eschrichtius robustus*), referred to as the eastern North Pacific (ENP) stock, is presently recognized in U.S. waters (Carretta *et al*. 2013). New information, however, suggests the possibility of recognizing two additional stocks of gray whales in U.S. waters: the Pacific Coast Feeding Group (PCFG) and the western North Pacific (WNP) stock. To evaluate the currently recognized and potentially emerging characterization of gray whale stock structure, NMFS established a scientific Task Force (TF). The overarching objective of this TF was to provide an objective scientific evaluation of gray whale stock structure as defined under the MMPA and implemented through the NMFS Guidelines for Assessing Marine Mammal Stocks (GAMMS; NMFS 2005). More specifically, the TF was convened to provide advice on the primary question – "*Is the PCFG a "population stock" under the MMPA and GAMMS guidelines"?* In addition, the TF was asked to provide advice on a question of developing importance – "*Is the WNP stock a "population stock" under the MMPA and GAMMS guidelines"?*

Both of these questions have immediate management implications, including: (1) how future NMFS stock assessment reports will address gray whale stock structure in the North Pacific, and (2) how to interpret any new information in the context of the Makah Indian Tribe's MMPA waiver request to resume hunting gray whales off Washington State, USA.

As the agency lead for gray whale science, the Southwest Fisheries Science Center convened a meeting of the aforementioned TF from 31 July to 2 August 2012. Using the best scientific information available at the time of the workshop, the TF worked to: (1) review new information relevant to gray whale stock structure, and (2) provide advice on revisions to stock structure so as to be available for management consideration. The TF conducted its work as an advisory rather than prescriptive body and therefore its conclusions should viewed as scientific advice based on review and discussion of the available science.

The implications of new data pertinent to stock structure, including considerable information related to the PCFG and WNP gray whales, were thoroughly reviewed during the workshop. Evaluating the new findings relevant to the status of the PCFG proved particularly complex. After review of results from photo-identification, genetics, tagging, and other studies within the context of the GAMMS guidelines (NMFS 2005) there remains a substantial level of uncertainty in the strength of the lines of evidence supporting demographic independence of the PCFG. Consequently, the TF was unable to provide definitive advice as to whether the PCFG is a population stock under the MMPA and the GAMMS guidelines. Members of the TF ranged in their opinions from strongly agreeing to strongly disagreeing about whether the PCFG should be recognized as a separate stock.

In the case of WNP gray whales, the work of the TF was more straightforward. The mitochondrial DNA and nuclear DNA genetic differentiation found between the WNP and ENP stocks provided convincing evidence that resulted in the TF providing unambiguous advice that the WNP stock should be recognized as a population stock pursuant to the GAMMS guidelines and the MMPA.

Additional research may narrow the uncertainty associated with the question of whether the PCFG should be recognized as a population stock. To work towards this objective, the TF recommended further investigation of recruitment into the PCFG. Presently, both the photo-identification and genetics data indicate that the levels of internal versus external recruitment are comparable, but these are not quantified well enough to determine if the population dynamics of the PCFG are more a consequence of births and deaths within the group (internal dynamics) rather than related to immigration and/or emigration (external dynamics). The TF offered a number of research recommendations, using the existing photo-identification and genetics datasets, that could provide increased resolution on the issue of recruitment and, in turn, the question of stock identification.

While the need for additional data collection was apparent, especially with regard to recruitment into the PCFG, the purpose of the workshop was for the TF to determine whether the *existing* best available science was sufficient to advise that the PCFG be recognized as a population stock under the language of the MMPA and GAMMS guidelines. Therefore, the advice of the TF offered in this report should be viewed as a contemporary "snapshot" taken from an emerging and ever-changing body of knowledge regarding the PCFG.

The TF emphasizes that the PCFG is relatively small in number and utilizes a largely different ecosystem from that of the main ENP stock. While the status of the PCFG as a population stock has yet to be resolved, continued research on these whales should be undertaken with particular attention dedicated to collecting data relevant to the question of stock identification.

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List of Acronyms

AFSC	Alaska Fisheries Science Center
ALJ	Administrative Law Judge
AWMP	Aboriginal Whaling Management Procedure
BRT	Biological Review Team
DIPs	Demographically Independent Units
DPSs	Distinct Population Segments
EIS	Environmental Impact Statement
ENP	Eastern North Pacific
ESA	Endangered Species Act
FEMAT	Forest Ecosystem Management Assessment Team
GAMMS	Guidelines for Assessing Marine Mammal Stocks
HCM	Human Caused Mortality
HWE	Hardy-Weinberg equilibrium
IR	Implementation Review
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
K	Carrying Capacity
Makah U&A	Makah Usual and Accustomed (Fishing Ground)
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act
MNPL	Maximum Net Productivity Level
MSA	Magnuson-Stevens Act
MSYR	Maximum Sustained Yield Rate
mtDNA	Mitochondrial DNA
nDNA	Nuclear DNA
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NPS	Northern Puget Sound
NWR	Northwest Regional Office
OPR	Office of Protected Resources
OSP	Optimum Sustainable Population
PBR	Potential Biological Removal
PCFG	Pacific Coast Feeding Group
SAR	Stock Assessment Report(s)
SEFSC	Southeast Fisheries Science Center
SJF	Strait of Juan de Fuca
SRG	Scientific Review Group
SWFSC	Southwest Fisheries Science Center
SVI	Southern Vancouver Island
TF	Task Force
UME	Unusual Mortality Event
WNP	Western North Pacific

1. Introductory Remarks

Dr. Lisa Ballance, Director of the Marine Mammal and Turtle Division at Southwest Fisheries Science Center (SWFSC), welcomed the workshop participants. She noted that this workshop represented a significant event, in that it: (1) brings agency scientists together to review research that continues to evolve and reveal unexpected patterns, (2) provides results that will be relevant to management activities for the National Marine Fisheries Service (NMFS), and (3) typifies the ideal model for how NMFS works, illustrating science addressing management actions and highlighting the collaboration between NMFS scientists, regional offices, and headquarters.

The technical and scientific expertise required on the Task Force (TF) was determined by SWFSC in consultation with the NMFS Northwest Regional Office (NWR) and the NMFS Office of Protected Resources (OPR). TF members were experts in their respective fields with ample experience and ability to bridge scientific and policy issues related to marine mammal stock structure. Members of the TF included the following eight NMFS scientists:

Dr. Shannon Bettridge	NMFS – Office of Protected Resources
Dr. Robert L. Brownell, Jr.	NMFS – Southwest Fisheries Science Center
Dr. Jeffrey L. Laake	NMFS – Alaska Fisheries Science Center
Dr. Jeffrey E. Moore	NMFS – Southwest Fisheries Science Center
Dr. Patricia E. Rosel	NMFS – Southeast Fisheries Science Center
Dr. Barbara L. Taylor	NMFS – Southwest Fisheries Science Center
Dr. Paul R. Wade	NMFS – Alaska Fisheries Science Center
Dr. David W. Weller (Chairman)	NMFS – Southwest Fisheries Science Center

In addition to the TF, a number of agency scientists and NMFS affiliates (e.g., post-docs, contractors, etc.) attended the workshop to observe and provide information. These participants included: Eric Archer (SWFSC), Lisa Ballance (SWFSC), Laurie Beale (NOAA General Counsel), Jim Carretta (SWFSC), Donna Darm (NWR), Kirsten Erickson (NOAA General Counsel - by phone), Jason Foreman (NOAA General Counsel), Annette Henry (SWFSC), Aimee Lang (SWFSC), Karen Martien (SWFSC), Sarah Mesnick (SWFSC), Phil Morin (SWFSC), Vicki Pease (SWFSC), Bill Perrin (SWFSC), Wayne Perryman (SWFSC) and Steve Stone (NWR). At the request of the TF, several of these participants provided valuable information to the workshop in the form of expert knowledge, presentations and/or written documents. Aimee Lang and Annette Henry generously agreed to serve as workshop rapporteurs.

The agenda for the workshop was circulated amongst the TF for input in advance of the meeting (Appendix 1). It was agreed, however, that the agenda would serve to guide the workshop proceedings but be viewed as flexible so as not to constrain discussion. Documents for the workshop were made available on a file sharing website. Appendix 2 provides a list of the workshop documents available for review and consideration by the TF in preparation for the workshop.

1.1 Workshop objectives

NMFS presently recognizes a single stock of gray whales (*Eschrichtius robustus*) in U.S. waters that is referred to as the eastern North Pacific (ENP) stock (Carretta *et al*. 2013). New information, however, suggests the possibility of recognizing two additional stocks of gray whales in U.S. waters, including: (1) the Pacific Coast Feeding Group (PCFG) - defined as whales observed between 1 June to 30 November within the region between northern California and northern Vancouver Island (from 41°N to 52°N) and photo-identified within this area during two or more years (see section 3.3), and (2) western North Pacific (WNP) gray whales - defined as whales observed feeding during summer and fall off Sakhalin Island, Russia, and other areas in the WNP (see section 3.2). The main objective of the TF was to provide scientific advice regarding gray whale stock structure using the definitions given in the GAMMS guidelines (NMFS 2005; see also Moore and Merrick 2011). More specifically, the TF was convened to provide advice on two questions: (1) *Is the PCFG a "population stock" under the MMPA and GAMMS guidelines?*, and (2) *Is the WNP stock a "population stock" under the MMPA and GAMMS guidelines?* Both of these questions have immediate management implications, including: (1) how future NMFS stock assessment reports (SAR) will address gray whale stock structure in the North Pacific, and (2) how to interpret any new information in the context of the Makah Indian Tribe's MMPA waiver request to resume hunting gray whales off Washington State, USA.

1.2 Workshop relationship to stock assessment reports

At the request of the TF, Carretta (SWFSC) summarized the relationship of the workshop to future gray whale stock assessment reports (SARs). The current eastern North Pacific gray whale SAR (Carretta *et al*. 2013) provides a summary of present knowledge but is expected to evolve based on the input received at this workshop as well as from input from the scientific review groups (SRG)[1], NWR and OPR. The TF expected that the outcome of the workshop would influence how the SAR is structured in the future, including how various data sources (i.e., genetics, movements, distribution) are evaluated for future stock designation. The workshop report will also serve as a useful SRG background document on gray whale stock structure.

1.3 Workshop relationship to Makah waiver request

Newly available information from genetic, photo-identification and tagging studies suggests that more than one stock of gray whales may occur in U.S. waters (Lang *et al*. 2010; Frasier *et al.* 2011; Lang *et al.* 2011a; Lang *et al*. 2011b; Mate *et al*. 2011; Calambokidis *et al.* 2012; Weller *et al*. 2012). With that in mind, the TF requested that Darm (NWR) present a summary of the Makah Indian Tribe's request to hunt gray whales off northwest Washington State, USA.

The Makah's right to hunt whales is secured by the 1855 Treaty of Neah Bay, where the Makah ceded lands to the U.S. government but reserved the right to hunt, fish, seal and whale. The Ninth Circuit Court of Appeals decision in 2004 (Anderson v. Evans) held that for the Makah to exercise their right to hunt whales they must comply with the requirements of the MMPA. In 2005, the Makah requested authorization from NOAA/NMFS, under the MMPA and the Whaling Convention Act, to resume limited hunting of gray whales for ceremonial and subsistence purposes in the coastal portion of their usual and accustomed (U&A) fishing grounds off the coast of Washington State (NMFS 2008). The spatial overlap of the Makah U&A with the summer distribution of PCFG whales has management implications. The proposal by the Makah Tribe includes time/area restrictions designed to reduce the probability of killing a PCFG whale and to focus the hunt on whales migrating to/from feeding areas to the north.

The NWR was assigned responsibility for evaluating the Tribe's request under the MMPA and National Environmental Policy Act (NEPA) process. Section 101(a) of the MMPA imposes a

[1] Pursuant to Sec. 117 of the MMPA, independent scientific review groups, representing Alaska, and the Pacific and Atlantic coasts, were established in 1994. These groups consist of individuals with expertise in marine mammal biology and ecology, population dynamics and modeling, commercial fishing technology and practices, and stocks taken under section 101(b).

moratorium on the take of all marine mammals, although the statute provides for certain exemptions allowing the take of marine mammals. Section 101(a)(3)(A) allows for a waiver of the take prohibition; this exemption applies to a specific stock and is only authorized to the extent provided for in the waiver. Determination of whether the waiver will be granted must be made based on the best scientific information, in consultation with the Marine Mammal Commission, and with due regard to the distribution, abundance, breeding habits, and movements of the stock in question. For the waiver to be granted there must also be a finding that the requested take is in accord with sound principles of resources protection and conservation as provided for in the MMPA.

Unlike most rulemaking by the agency, this determination will entail a formal rulemaking process in which the agency presents evidence before an administrative law judge (ALJ) to support the rule. This process may involve presenting evidence on the status of relevant stocks, including their optimum sustainable population level (OSP)[2], and whether the stocks are at or below that level (i.e., depleted).

Although the NWR made substantial progress in evaluating the waiver request during the past few years, this progress had been slowed by: (1) new information pertinent to the question of whether the PCFG is a separate stock, and (2) the potential implications of movements of whales between the WNP and ENP. Therefore, the advice of the TF will provide a collective "best professional judgment" useful to the ongoing evaluation of the waiver by the NWR.

In discussion, the TF asked Darm if there would be a potential need to get more than one waiver to the MMPA if it was determined that three stocks of gray whales occur in U.S. waters (i.e., ENP, PCFG and WNP stocks). In that case, Darm replied that there would be some possibility of needing to request multiple exemptions (waivers). However, the need for a waiver would be informed by the likelihood of take and obtaining a waiver for WNP gray whales (if the group is recognized as a stock) is highly unlikely given that they are listed as endangered under the Endangered Species Act (ESA) and as such, would be considered depleted under the MMPA.

2. Overview of MMPA Language, GAMMS Guidelines and Related Key Concepts

From the outset of the workshop, the TF concurred that it was important to review the existing language of the MMPA and GAMMS with regard to the definition of "population stock". In addition, it was also agreed important to discuss three key concepts inherent to defining a population stock, including: (1) "demographic independence", (2) "interbreed when mature", and (3) "functioning element of the ecosystem".

Under the MMPA, population stock (used interchangeably with "stock" and "population" hereafter) is the fundamental conservation unit. The MMPA (Sec. 3) defines population stock as: "*a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature.*" The purposes and polices underlying the stated definition, as follows, are found in Sec. 2(2) and Sec. 2(6) of the MMPA:

[2] The maximum net productivity level is described in the National Marine Fisheries Service's definition of "optimum sustainable population" (OSP) (50 CFR 216.3) as the abundance level that results in the greatest net annual increment in population numbers or biomass resulting from additions to the population due to reproduction and/or growth less losses due to natural mortality. Under the U.S. Marine Mammal Protection Act, populations above MNPL are considered to be at OSP; populations below MNPL can be designated as 'depleted' and are afforded a greater level of protection.

(1) *"[marine mammal] species and population stocks should not be permitted to diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part, and, consistent with this major objective, they should not be permitted to diminish below their optimum sustainable population."*

(2) *"… the primary objective of their management should be to maintain the health and stability of the marine ecosystem."*

Acknowledging the above definitions and objectives of the MMPA, the TF then considered the related guidelines contained in the "Definition of Stock" section of the GAMMS guidelines (NMFS 2005):

(1) *"For the purposes of management under the MMPA, a stock is recognized as being a management unit that identifies a demographically isolated biological population."*

(2) *"Demographic isolation means that the population dynamics of the affected group is more a consequence of births and deaths within the group (internal dynamics) rather than immigration or emigration (external dynamics). Thus, the exchange of individuals between population stocks is not great enough to prevent the depletion of one of the populations as a result of increased mortality or lower birth rates."*

The TF noted that within the broader field of population biology, the term "isolation" generally implies little or no exchange (emigration or immigration of individuals) between stocks and is a criterion commonly used to distinguish taxonomic units higher than that of a population (e.g., species, subspecies). In contrast, the GAMMS guidelines and definition of stock clearly allow for the "*exchange of individuals between population stocks"* (NMFS 2005), a distinction more in line with use of the term "demographic independence" rather than "demographic isolation". The use of the term "independence" as opposed to "isolation" is potentially confusing and has been noted by a number of NMFS reviewers and workshops (Eagle *et al*. 2008). To avoid this confusion, Eagle *et al*. (2008) suggested that the term "demographic isolation" be replaced by "demographic independence".

Moore (SWFSC) provided the TF with an overview of the GAMMS III workshop, convened by NMFS in February 2011, which also noted the potential confusion over the use of "isolation" as opposed to "independence". The GAMMS III workshop recommended revising the SAR guidelines to reflect that the intent of the GAMMS II guidelines (NMFS 2005) was to base stock identification on demographic independence as noted in Eagle *et al.* (2008) and proposed that the term demographic isolation be replaced with "demographic independence" as follows:

(1) *"For the purposes of management under the MMPA, a stock is recognized as being a management unit that identifies a demographically independent biological population."*

(2) *"Demographic independence means that the population dynamics of the affected group is more a consequence of births and deaths within the group (internal dynamics) rather than immigration or emigration (external dynamics). Thus, the exchange of individuals between population stocks is not great enough to prevent the depletion of one of the populations as a result of increased mortality or lower birth rates."*

In other words, the participants at the GAMMS III workshop viewed this as a semantic issue where the term demographic independence is a better description for the current GAMMS guidelines definition than is the term demographic isolation.

2.1 Discussion of "demographic independence"

This interpretation of "isolation" differs substantively from how it is used within the GAMMS guidelines definition above, wherein allowance is made for some level of exchange of individuals between stocks. The TF concurred that in spite of using the term "isolation", the actual definitions under the current GAMMS guidelines (see above) are more consistent with MMPA objectives to protect population stocks than with the objective of protecting just subspecies and species.

Given that the draft GAMMS guideline revisions from the GAMMS III workshop have not yet been formally approved, the TF agreed to use the current GAMMS guidelines definition (NMFS 2005) for the purposes of their discussions and deliberations but noted that the actual definition used in the two versions (for demographic isolation and demographic independence) is essentially the same in that neither implies true "isolation" within the context of the MMPA.

2.2 Discussion of "interbreed when mature"

Bettridge (OPR) presented a brief overview of relevant language under the MMPA and GAMMS guidelines pertaining to NMFS interpretation of "interbreed when mature". She explained that the draft second revision to the SAR guidelines (from the GAMMS II workshop held in Seattle in 2003) included a definition of interbreed when mature. This term was interpreted to mean cases in which either:

(1) "*mating occurs primarily among members of the same demographically isolated group*"

or

(2) "*the group migrates seasonally to a breeding ground where its members breed with members of the same group as well as with members of other demographically distinct groups which have migrated to the same breeding ground from a different feeding ground."*

When comments were solicited on the draft GAMMS II guidelines (69 FR 67541, 18 November 2004), the Marine Mammal Commission (MMC) supported the aforementioned interpretations, but suggested that a more rigorous analysis was needed of how the revisions fit with the language of the MMPA. Additionally, the MMC stated that NMFS should develop criteria for applying the modified guidelines to determine when a population is demographically isolated to an extent that it is a discrete group that warrants recognition as a separate stock.

In its response to comments on this issue (70 FR 35397, 20 June 2005), NMFS stated that public comments were sufficient to raise questions about the proposed interpretation, and the agency removed the proposed text pertaining to "interbreed when mature" from the final GAMMS II guidelines.

Subsequent NMFS review and consultation with MMC staff and NOAA General Counsel suggest that the GAMMS II workshop definition of "interbreed when mature" is consistent with NMFS GAMMS guidelines and the review undertaken in Eagle *et al.* (2008, see below). In those forums NMFS has consistently interpreted a population stock not as one that is completely reproductively isolated but rather as something less restrictive.

Regarding the MMC request for scientific criteria for how much interbreeding would be consistent with the proposed GAMMS II guidelines definition, the TF noted that specific quantitative criteria would be impractical to apply consistently across all contexts of uncertain stock definition and that determining whether a population is demographically independent or an isolated unit would likely have to be conducted on a case-specific basis. Some TF members felt that the "interbreed when mature" component of the MMPA definition of stock should merely be viewed as a necessary but not sufficient criterion for defining a stock. In other words, individuals "in a common spatial arrangement" would not constitute a stock unless there is some interbreeding (satisfying the need criterion), but this would not preclude individuals of a stock from also breeding with members of other stocks.

For the purposes of the workshop, the TF agreed they would continue to interpret "interbreed when mature" consistent with "demographic independence" as suggested by Eagle *et al*. (2008) and GAMMS II (NMFS 2005), with the minor change of "isolation" being replaced with "independence".

2.3 Discussion of "functioning element of the ecosystem"

Sec. 2 of the MMPA states that marine mammals are "resources of great international significance, esthetic and recreational as well as economic" and "that the primary objective of their management should be to maintain the health and stability of the marine ecosystem". The TF therefore considered whether the functioning element of the ecosystem criteria is aesthetically or ecologically based (or both) but no clear resolution on how to best define functioning element of the ecosystem was reached by the TF.

The TF then focused its discussion on defining the ecosystem and appropriate scale of management with respect to gray whales. The TF agreed the matter was complex given the species' seasonal use of different ecosystems. In general, the TF agreed that the Chukotka Peninsula/Bering Strait feeding areas were not part of the same ecosystem as that found off the Pacific Northwest and used by the PCFG. In discussion of this concept, it was noted by some TF members that even for the largest-scale classification system for marine ecosystems (Longhurst 1998, discussed in Moore and Merrick 2011), it could be argued that the PCFG is in a different ecosystem than other gray whales. Other TF members pointed out, however, that this was only true for part of the year, and that the interpretation was complicated because non-PCFG animals migrate through the area defined for PCFG whales and, in some cases, may feed there in a given year but not return in a subsequent year.

2.4 Additional information on the definition of "population" for marine mammals

In addition to applying the MMPA language and GAMMS guidelines definitions, the TF considered two documents relevant to the question of stock definition under the MMPA. In the first (Taylor 1997), simulation analyses were used to explore the potential consequences, in terms of the risk of violating MMPA ecosystem function objectives, of defining a population stock as a unit akin to an evolutionarily significant unit or reproductively isolated group. Briefly, this analysis considered scenarios in which a single reproductively isolated population was distributed as a network of discrete groups occupying distinct habitat areas throughout its range, with some level of dispersal between discrete groups. The major analytical finding was that, if allowable human caused mortality (HCM) for the entire population (i.e., sum of all discrete groups) were to act disproportionately on certain groups, those groups could be extirpated, depending on whether the amount of immigration from other groups was below a certain dispersal rate threshold (which varied with simulation conditions). In conclusion, to achieve MMPA objectives of maintaining marine mammals as "functioning elements of their ecosystem", distinct groups should be managed as separate stocks if their connectivity to other groups via dispersal is low, although how low is context specific.

Taylor (1997) provides several examples (Figure 1) where localized removals lead to local extirpation which arguably violates the ecosystem goals of the MMPA. For all of the models tested, when dispersal fell below a few percentage of the population per year, recruitment into the population with HCM was insufficient to compensate for removal, and population levels declined below those sought by management objectives. Therefore, populations should be managed separately if dispersal between them is less than several percent per year.

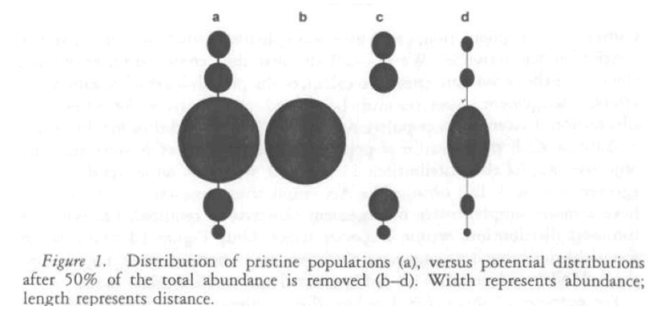

Figure 1. Original figure from Taylor (1997).

Taylor (SWFSC) cautioned the TF, however, that it is impossible to have a "one number fits all" criterion and that a better approach would be to have an objective that states what is important in terms of maintaining the extent and connectivity of the range. There are some cases where it is obvious that a stock is no longer a functioning element of its ecosystem, such as example C in Figure 1 where the large central group is extirpated. Extirpation of the PCFG would be more analogous to removing one of the smaller groups outside of the main group (e.g., example B). Further discussion is needed to better define the intent of the MMPA with respect to maintaining marine mammals within different parts of their range.

The second document discussed by the TF, as pertains to the agency's definition of population stock, was the report of a 2006 workshop entitled "Conservation Units of Managed Fish, Threatened or Endangered Species, and Marine Mammals" (Eagle *et al.* 2008). This workshop was convened by NMFS with the objective of bringing together scientists, managers and policy advisers to discuss differences and recommend revisions to how NMFS defines units to conserve under three statutes – the MMPA, ESA and Magnuson-Stevens Act (MSA). The workshop sought to address two overarching questions: (1) why are conservation units different under the three statutes? and (2) is there a biological paradigm that can be used to explain the differences?

In brief, it was agreed by the participants of the 2006 workshop that the differences in how NMFS defines conservation units under the three statutes are appropriate given the differing objectives of the three laws. Under the ESA, major objectives are to prevent *species* extinction and preserve evolutionary potential. Thus, conservation units under this Act should be substantially reproductively isolated. Under the MMPA, objectives correspond to maintaining population and ecosystem goals. Therefore, conservation units align with demographically independent units (DIPs), which are demographically discrete from other populations but not necessarily genetically discrete due to a low but sufficient degree of interbreeding between them. Participants of the 2006 workshop concluded that while the GAMMS guidelines "…*clearly support the use of DIPs as stocks of marine mammals […] the MMPA does not indicate to what extent breeding should occur within a stock instead of among stocks*" and that future revisions to the GAMMS guidelines "*should, therefore, include a rationalization for recognizing DIPs as stocks in cases where males from one stock may breed with females from the same and other stocks*".

There was discussion amongst the TF regarding where to reasonably draw the line in defining small stocks, given that for some marine mammal species very small groups of animals could be considered DIPs. For example, individual pods of killer whales (*Orcinus orca*) could potentially be considered demographically independent. However, other TF members noted that the intent of the GAMMS guidelines was not to recognize very small population units – such as individual killer whale pods or a small group of animals occupying a small habitat fragment – as population stocks. It was similarly suggested that other criteria besides demographic independence, such as whether the unit can be considered a significant functioning element of the ecosystem, should also be considered in defining stocks. The TF understood that most biological "populations" and "stocks" do not exist as truly distinct groups, nor are individuals within the same population typically part of a truly panmictic group (Waples and Gaggiotti 2006). Rather, population differentiation occurs along a continuum, and placing discrete boundaries along this continuum for management purposes is a challenge. The TF acknowledged that marine mammal social structure can further complicate determining whether a unit should be considered demographically independent. In these areas of uncertainty, decisions will likely be case specific, and ultimately rely on scientific judgment and the factors identified for consideration in the MMPA and GAMMS guidelines.

The TF considered the report by Eagle *et al.* (2008) and the recommendations from that workshop as support for the NMFS interpretation of "interbreed when mature" as one that includes cases where individuals interbreed primarily within their stock but occasional interbreeding amongst stocks may occur and agreed to use such as the operational definition for the purposes of their work.

3. Overview of Eastern, Western and Pacific Coast Feeding Group Gray Whales

Like many species of baleen whales, gray whales exhibit seasonal movements between high-latitude summer feeding grounds and low- latitude wintering areas. The current distribution of this species is limited to the North Pacific, where a small western population (<150 individuals) and a much larger eastern population (~19,000 individuals) are recognized.(Reilly *et al.* 2008).

Lang (SWFSC) presented a brief overview of information on the biology of ENP, WNP, and PCFG gray whales. The purpose of this overview was not to discuss gray whale stock structure in detail but rather to provide a summary of relevant background information.

3.1 Eastern North Pacific (ENP) gray whales

During summer and fall most ENP whales feed in the Chukchi, Beaufort and northwestern Bering Seas (Figure 2). An exception is the relatively small number (100s) of whales that summer and feed along the Pacific coast between Kodiak Island, Alaska and northern California (Darling 1984; Calambokidis *et al.* 2002; 2012; Gosho *et al.* 2011). By late November, the southbound migration of the ENP stock is underway as whales begin to travel from summer feeding areas to winter calving areas off the west coast of Baja California, Mexico (Rugh *et al.* 2001; Swartz *et al.* 2006). The southbound migration is segregated by age, sex and reproductive condition (Rice and Wolman 1971). The northbound migration begins about mid-February and is also segregated by age, sex and reproductive condition.

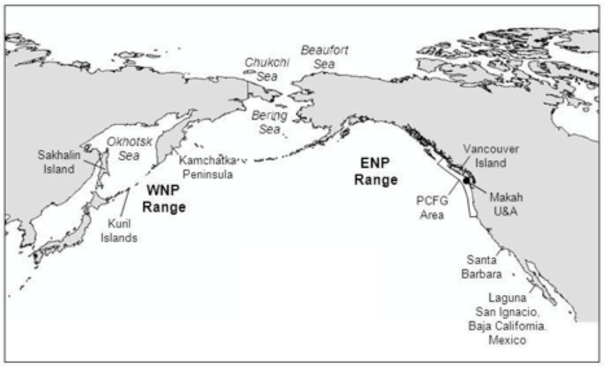

Figure 2. Geographic range of ENP, WNP and PCFG whales. In summer, WNP whales are typically found in feeding areas off the coasts of Sakhalin Island and the Kamchatka Peninsula, in Russia. Most ENP whales are typically found in summer north of St. Lawrence Island (in the northern Bering Sea), including the Bering Strait, the Chukotka Peninsula in Russia, the Chukchi Sea, and along the Beaufort Sea coast (north slope) of Alaska. Additional summer ENP feeding areas include Kodiak, AK, and areas between Southeast Alaska and Northern California. ENP whales migrate to the Baja Peninsula, Mexico in the autumn and return to feeding areas in the spring. The region used by the PCFG is defined to be the area between northern California and northern Vancouver Island (from 41°N to 52°N).

Gray whale breeding and calving are seasonal and closely synchronized with migratory timing. Sexual maturity is attained between 6 and 12 years of age (Rice 1990; Rice and Wolman 1971). Gestation is estimated to be 13 months, with calving beginning in late December and continuing to early February (Rice and Wolman 1971). Some calves are born during the southbound migration while others are born near or on the wintering grounds (Shelden *et al.* 2004). Females produce a single calf, on average, every 2 years (Jones 1990). Calves are weaned and become independent by six to eight months of age while on the summer feeding ground (Rice and Wolman 1971). Three primary calving lagoons in the ENP are utilized during winter, and some females are known to make repeated returns to specific lagoons (Jones 1990).

The abundance of the ENP population, which includes the PCFG, is presently estimated to be about 19,000 whales (Laake *et al.* 2012). The potential biological removal (PBR) level for the ENP stock of gray whales is calculated as the minimum (20th percentile) estimate of population size, times one-half of the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), times a recovery factor of 1.0 for a stock above its maximum net productivity level (MNPL) (Punt and Wade 2012). The minimum population estimate (N_{MIN}) for the ENP stock is calculated from Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{1/2})$. Using the 2006/07 abundance estimate of 19,126 and its associated CV of 0.071, N_{MIN} for this stock is 18,017. Therefore, PBR is 558 animals. A recent analysis conducted by Punt and Wade (2012) estimated a probability of 0.884 that the ENP gray whale stock is above its MNPL, which means there is a 0.884 probability that it is at its OSP as defined by the MMPA.

Genetic studies suggest some sub-structuring may occur on the wintering grounds, with significant differences in mitochondrial DNA (mtDNA) haplotype frequencies found between females (mothers with calves) utilizing two of the primary calving lagoons and females sampled in other areas (Goerlitz *et al.* 2003). Other research, employing both mtDNA and microsatellites, identified significant departure from panmixia between two of the lagoons using nuclear data, although no significant differences using mtDNA were observed (Alter *et al.* 2009). Significant mtDNA and nuclear (nDNA) genetic differences have been found between whales in the WNP and those in the ENP (LeDuc *et al*. 2002; Lang *et al.*, 2011b).

In discussion, the TF agreed that the information presented by Lang represented an up to date overview of the ENP population and had no follow up questions.

3.2 Western North Pacific (WNP) gray whales

Information on the distribution and migration patterns of gray whales in the WNP is incomplete. There is no doubt that the historical distribution of gray whales in the Okhotsk Sea once greatly exceeded what is found at present (Reeves *et al*. 2008). Today, the main feeding ground is in the Okhotsk Sea off the northeastern coast of Sakhalin Island, Russia (Figure 2) but some animals also occur off eastern Kamchatka and in other coastal waters of the northern Okhotsk Sea (Weller *et al.* 2002; Vertyankin *et al.* 2004; Tyurneva *et al.* 2010). Whales associated with the Sakhalin feeding area can be absent for all or part of a given feeding season (Bradford *et al*. 2008), indicating they probably use other areas during the summer and fall feeding period. For example, some whales observed off Sakhalin have been sighted off the northern Kuril Islands in the eastern Okhotsk Sea and Bering Island in the western Bering Sea (Weller *et al*. 2003).

The WNP migration route(s) and winter breeding ground(s) are poorly known (Weller *et al*. 2002; Weller and Brownell 2012). Information collected over the past century indicates that whales migrated along the coasts of Japan and South Korea (Andrews 1914; Mizue 1951; Omura 1984) to wintering areas somewhere in the South China Sea, possibly near Hainan Island (Wang 1984). At present, observations of gray whales off Japan are rare. Nambu *et al*. (2010) reported 13 known sighting or stranding records in Japanese waters between 1990 and 2007. Between 2005 and 2007, four female gray whales were fatally entrapped in set nets along the Pacific coast of Honshu, Japan. One of these females, entrapped in January 2007, was matched to earlier photographs of it as a calf (with its mother) while on the Sakhalin feeding ground in July and August 2006 (Weller *et al*. 2008). This match provided the most contemporary link between the summer feeding ground off Sakhalin and a winter location along the coast of Asia. More recently, in March 2012 a gray whale was sighted and photographed in Mikawa Bay (Aichi Prefecture), east of Ise Bay near Nagoya on the Pacific coast of Honshu (Japan Times, 3 May 2012).

Observations of gray whales in China are also exceptionally rare. Although 24 capture, sighting or stranding records exist since 1933 (Wang 1984; Zhu 2002), including observations of two mother-calf pairs, some of these (especially the sightings) have not been reported in sufficient detail to validate species identification. More recently, an 11.5 m female stranded live at Zhuanghe (Bohai Sea ca. 39˚N) in December 1996 (Zhao 1997) and a 13 m female gray whale was taken in fishing gear offshore of Baiqingxiang (Pingtan County), in the Taiwan Strait in November 2011 (Zhu 2012). The last known sighting of a gray whale off Korea was in 1977 (Park 1995).

The WNP gray whale population is redlisted by the IUCN as Critically Endangered. The most recent population assessment (for 2012), using a Bayesian individually-based stage- structured model, resulted in a median 1+ (non-calf) estimate of 155 individuals, with 95% CI = 142-165 (IUCN 2012). A collaborative Russia-U.S. research program on WNP gray whales summering off northeastern Sakhalin Island, Russia, has been ongoing since the mid-1990s. When data collected between 1994-2011 are combined, a catalog of 200 photo-identified individuals has been compiled. Beginning in 2002, photo-identification studies off Sakhalin have also been conducted by Russia scientists working with oil and gas companies (Tyurneva *et al*. 2010). This research largely corroborates the work of the Russia-U.S. team and in some cases collaborative analyses utilizing combined datasets have been conducted.

Recently, results from photo-identification (Urbán *et al.* 2012; Weller *et al.* 2012), genetic (Lang 2010; Lang *et al.* 2011b), and telemetry studies (Mate *et al.* 2011) have documented spatial and temporal overlap between WNP and ENP gray whales. Observations of such overlap include: (1) six whales photographically matched from Sakhalin Island to southern Vancouver Island, (2) two whales genetically matched from Sakhalin to Santa Barbara, California, (3) 13 whales photographically matched from Sakhalin Island to San Ignacio Lagoon, Mexico, and (4) 2 satellite tagged whales that migrated from Sakhalin Island to the west coast of North America. In combination, these studies have recorded a total of 23 gray whales observed in both the WNP and ENP. Despite this overlap, significant mtDNA and nDNA differences are found between whales in the WNP and those summering in the ENP (Lang *et al.* 2011b). Although it is clear that some whales feeding off Sakhalin Island during the summer/fall migrate to the west coast of North America during the winter/spring, past and present observations of gray whales in the WNP off Japan, Korea and China during the winter/spring suggest that not all gray whales in the WNP share a common wintering ground (Weller and Brownell 2012).

In discussion, the TF agreed that the occurrence of WNP gray whales in U.S. waters presented previously unexpected implications with respect to the SAR process and the Makah waiver request. More specifically, two questions were discussed at length, including: (1) given the occurrence of WNP gray whales in U.S. waters, is a WNP gray whale SAR required? and (2) given the potential occurrence of WNP gray whales in the proposed Makah hunt area, what are the implications regarding the existing wavier request?

TF members also noted that these new findings of gray whales moving between Sakhalin Island and the ENP had significance to our understanding of the status of gray whales in the WNP. That is, given that some of the whales sighted off Sakhalin appear to overwinter in the ENP, the number of animals remaining in the WNP year-round may be much smaller and of greater conservation concern than is currently recognized (Weller and Brownell 2012).

3.3 Pacific Coast Feeding Group (PCFG)

Gray whales using the Pacific Northwest area during summer and autumn include two components: (1) whales that return frequently and account for most of the sightings between 1 June and 30 November, and (2) whales that are sighted only in one year, tend to be seen for shorter time periods in that year, and are encountered in more limited areas. For the purposes of their work to evaluate the proposed Makah Indian Tribe gray whale hunt, the International Whaling Commission (IWC) defined PCFG gray whales as: whales observed between 1 June to 30 November within the region between northern California and northern Vancouver Island (from 41°N to 52°N) and photo-identified within this area during two or more years (IWC 2011; IWC 2012a). This same definition has been adopted in the analyses of Calambokidis *et al.* (2012). In this report, the TF defines "PCFG whales" following the IWC definition.

Recent research has provided new information on movements and habitat utilization of PCFG whales (for example Frasier *et al.* 2011; Lang *et al.* 2011a; Calambokidis *et al.* 2012). While PCFG whales are known to feed during summer and fall off the Pacific coast between northern California and southeastern Alaska, they also occasionally occur as far north as Kodiak (Gosho *et al.* 2011) and Barrow, Alaska (Calambokidis *et al.* 2012). The sighting from Barrow suggests that some PCFG whales (meaning whales seen in summer in the defined area used by the PCFG and in more than one year), at least occasionally occur in one of the most northern gray whale feeding areas in the ENP (Calambokidis *et al.* 2012). Similarly, of the 121 whales identified off Kodiak from 1998-2010, there have been 30 sightings of 17 individuals between June-November in areas extending from northern California to northern British Columbia (Table 9, Calambokidis *et al.* 2012). These observations indicate that at least some PCFG whales have used both the Kodiak feeding area in addition to the 41°N to 52°N area defined for the PCFG.

Satellite tagging studies between 3 September and 4 December 2009 off Oregon and California provide additional movement data for whales considered to be part of the PCFG (Mate *et al.* 2010). While duration of tag attachment differed between individuals, some whales remained in relatively small areas within the larger PCFG seasonal range while others traveled more widely. All six individuals whose tags continued to transmit through the southbound migration utilized the wintering area within and adjacent to Laguna Ojo de Liebre (Scammon´s lagoon). Three whales were tracked north from Ojo de Liebre and displayed the following movement patterns: (1) one whale traveled at least as far as Icy Bay, Alaska, and (2) two whales were tracked to coastal waters off Washington (Olympic Peninsula) and California (Cape Mendocino). In combination, satellite tag and photo-identification data suggest that the range of the PCFG may, at least for some individuals, exceed the pre-defined 41°N to 52°N boundaries that have been used in a number of PCFG-related analyses (e.g., abundance estimation).

Further support of the PCFG range extending beyond the pre-defined 41°N to 52°N boundaries comes from a study of six whales satellite tagged off the central west coast of Vancouver Island in March. This study was designed to determine northern migration routes in the greater Vancouver Island area (Ford *et al.* 2012). Three of the tagged whales had been previously sighted within the seasonal range used by PCFG whales (41°N to 52°N) and two had multi-year sighting histories there. These three whales moved north to between ~55°N to 57° N before their tags stopped transmitting. One of these whales was later observed in the seasonal range of the PCFG off southern Vancouver Island. These findings suggest that in the spring at least some PCFG whales may migrate northward, past the defined seasonal range used by the PCFG, along with the larger ENP stock before "circling back" to within the range of the PCFG summer feeding area.

It is unknown how long gray whales have used the PCFG area in summer and autumn; it may have been colonized as recently as the last century or during the Little Ice Age (~1540-1850) or other glacial periods when it was difficult or impossible for gray whales to feed further north. Records of gray whales feeding between northern California and Alaska during summer/fall date back to at least 1926 (Howell and Huey 1930), including reports of whales feeding on the southern feeding ground during the 1940s, 1950s, and 1960s (Gilmore 1960; Pike and MacAskie 1969; Rice and Wolman 1971). The consistent return of individuals to the southwestern coast of Vancouver Island, British Columbia, was first documented in the early 1970s (Hatler and Darling 1974).

A unique characteristic of PCFG whales is an apparent flexibility in their feeding habits. That is, whales summering in the seasonal range of the PCFG consume a varied diet including mysids, amphipods, crab larvae, and herring eggs/larvae. This is in contrast (generally speaking) to gray whales feeding in the arctic where they seem to be more focused on an amphipod food base (Nerini 1984). That being said, whales that utilize the seasonal range of the PCFG in only a single year (i.e., non-PCFG whales) must also be flexible, at least to some degree, in their feeding habits.

Abundance estimates of PCFG gray whales reported by Calambokidis *et al.* (2012) show a high rate of increase in the late 1990s and early 2000s, but have been relatively stable, albeit with some decline, since about 2003. No statistical analysis of trends in abundance is currently available for this population. The PCFG is estimated to contain about 200 individuals (Calambokidis *et al*. 2012). As stated in the 2012 gray whale SAR "because the PCFG appears to be a distinct feeding aggregation and may warrant consideration as a distinct stock in the future, a separate PBR was calculated" (Carretta *et al*. 2013). Calculation of a PBR for the PCFG allows NMFS to assess whether levels of HCM are likely to cause local depletion of this group. In keeping with that management objective, NMFS used the 2008 abundance estimate of 194 (SE = 17.0)[3] from Calambokidis *et al*. (2010) and the range of the PCFG (between 41°N to 52°N) as defined by the IWC to calculate a potential PBR for PCFG whales (Carretta *et al*. 2013). This calculation used the minimum population size (180 animals), times one half the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), times a recovery factor of 0.5 (for a population of unknown status), resulting in a PBR of 2.8 animals (NMFS 2012). Further, a review of annual HCM in the PCFG between 2006 and 2010 was estimated and averaged 0.6 animals/year known deaths (Carretta *et al*. 2013).

In discussion, the TF asked Lang if there was any evidence that oceanographic changes have influenced the abundance or recruitment of whales into the PCFG. Lang replied that Calambokidis *et al.* (2012) reported a higher than usual "pulse" of animals recruited into the PCFG in the years following the 1999-2000 gray whale Unusual Mortality Event (UME). This UME has been theorized to be the result of limited food resources on the northern feeding grounds (see Gulland *et al.* 2005), and as such, this "pulse" of gray whale immigration[4] into the PCFG could potentially be considered a response to oceanographic changes. Given that the photo-identification effort on PCFG whales expanded greatly in 1998 (data from years prior to 1998 exist but not at the same level of effort), coinciding closely in time with the UME, it makes it impossible to resolve with certainty the occurrence or magnitude of the hypothesized pulse recruitment.

In response to the observations of PCFG whales in northern areas such as Kodiak and Barrow, Alaska, some members of the TF asked why the boundaries of the PCFG area defined by the IWC were not extended further north? The TF noted that the IWC definition was not intended to define the stock but rather to provide a conservative basis on which to evaluate the gray whale hunt proposed by the Makah Indian Tribe. With respect to low survey effort north of 52°N, the TF agreed that the PCFG could have a higher abundance than currently estimated and that this might affect a number of analyses including determination of annual sighting patterns of individual whales (e.g., a PCFG whale may have been present in a larger area but not photographed because it was located in an region not surveyed). The TF concurred that these issues are important to assignments of PCFG whales (i.e., those seen in two or more years between 41°N and 52°N) and highlighted the importance of expanding the spatial and temporal coverage of the photo-identification effort. In addition, further satellite tagging of known PCFG whales would also help to better define habitat use and delineate the seasonal feeding range.

Additional discussion was devoted to addressing the possibility that HCM (e.g., ship strikes and commercial fisheries bycatch) for whales in the PCFG area could be higher than for whales that migrate through the area. That is, PCFG whales spend more time near shore where ship traffic and fishing gear are concentrated. Despite this concern, little information is available on where

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[3] This estimate will be updated in the 2013 SAR to include the now available 1999-2010 time series presented in Calambokidis *et al*. (2012).

[4] Immigration, as used here, means a permanent change of feeding ground fidelity and is considered interchangeable with "external recruitment".

HCM actually occurs. The TF asked Carretta how whales were classified as being PCFG in his analysis. He replied that the estimate was based on NMFS stranding data for the most recent 5-year period and included whales that stranded within the defined PCFG time period (1 June and 30 November) and range (41°N to 52°N). Carretta noted that his estimate of 0.6 animals/year, based on only the most current 5-year period (as per protocol of the SAR guidelines), is lower than the 20-year average of 1.5 animals/year reported elsewhere (IWC 2012a). The TF agreed that both of these estimates of HCM for the PCFG were likely to represent minimum estimates because there is no correction for incidents that go unobserved or unreported.

Related to the issue of HCM, the TF also discussed the results presented in Connor *et al.* (2011), which found that PCFG whales had higher rates of scarring than other gray whales. It was noted that crab pots are common off the Washington and Oregon coasts and as such may pose an increased threat in some parts of the PCFG range. Carretta noted that when looking through the HCM records, a fair number of southern California crab pot interactions were reported, which suggests that fisheries interactions of this nature could be a pervasive issue along the coast. The TF noted that PCFG animals could have more interactions (compared to non-PCFG whales) with crab pots and coastal fishing gear given their extended residency in nearshore areas. Therefore, the TF recommended that the existing photo-identification time series be used to examine scarring patterns of PCFG whales to possibly provide a better assessment of their interactions with fishing gear.

4. Population Dynamics of the Pacific Coast Feeding Group

Laake (AFSC) provided a summary of information regarding the PCFG (following the IWC definition) based on photo-identification research as described in Calambokidis *et al.* (2012). Photo-identification studies from 1998 to 2010 between northern California and northern British Columbia have categorized gray whales using that region during summer and autumn in two components: (1) whales that frequently return to the area, are seen in more than one year between 1 June and 30 November, and account for most of the sightings during that time period, and (2) whales that are sighted only in one year, tend to be seen for shorter time periods in that year, and are encountered in more limited areas.

4.1 Definition of Pacific Coast Feeding Group whales based on timing and area

Defining the PCFG involves analysis that spans both time and space. The temporal component of the PCFG range is better defined than the spatial component, but neither can be considered absolute. As mentioned previously, the IWC defines the PCFG as: gray whales observed between 1 June to 30 November within the region between northern California and northern Vancouver Island (from 41°N to 52°N) and photo-identified within this area during two or more years (IWC 2012a). The spatial boundaries of the PCFG range under the IWC definition were chosen for the following reasons: (1) samples used for the genetic analyses were taken from whales across this range, (2) the work of Calambokidis *et al.* (2012) showed movements of whales throughout the area (Figure 3), (3) only a small number of PCFG whales have been observed north or south of the area during the 1 June to 30 November time period, and (4) few if any whales are still migrating north through the 41°N to 52° N region from 1 June to 30 November. The temporal definition (1 June to 30 November) was based, in part, on the disparity in sighting rates across months. Whales observed after 1 June were more likely to be sighted (i.e., photographed) more than one time, in more than one year, and in more than one region (Figure 4).

In discussion, the TF asked whether the results presented in Figure 3 were effort-corrected. Laake explained that the proportions are only dependent on the effort in the region from the Makah U&A to Southern Vancouver Island (SVI) and not in the other areas. Variation in effort in areas outside of the Makah U&A-SVI region will change the sample size that could be detected in the Makah U&A-SVI but not the proportion of individuals resighted in the Makah U&A-SVI.

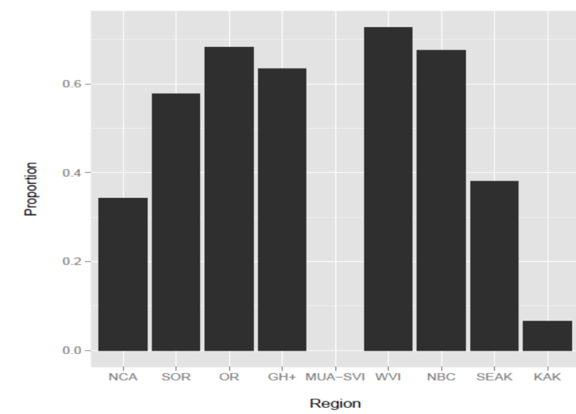

Figure 3. Proportion of whales sighted in the MUA-SVI region of whales seen in the identified areas. MUA and SVI were collapsed due to their proximity and high exchange rate. NCA = Northern California, SOR = Southern Oregon, OR = Central Oregon, GH+ = Gray's Harbor and surrounding coastal waters, MUA-SVI – Makah Usual and Accustomed Area to Southern Vancouver Island, WVI = West Vancouver Island, NBC = Northen Vancouver Island and coastal areas of British Columbia, SEAK = Southeast Alaska, KAK = Kodiak, Alaska.

The spatial range of PCFG whales was then discussed by the TF, including apparent gaps in survey coverage. Surveys in the seasonal range of the PCFG tend to focus on regions where gray whales have been seen and so the surveys are not randomly designed to cover the entire possible range. There is a large gap in survey effort north of 52° N (i.e., between northern Vancouver Island and Kodiak, Alaska). Because only a limited amount of gray whale survey effort has been undertaken in this region, it is unknown whether this area represents a true distributional gap. Even with this limitation, it is nevertheless possible to document observed movements of known individuals and estimate a related minimum range. Figure 5 presents the observed range of maximum distances between sighting locations for individual whales. Overall, approximately 40% of PCFG whales are known to have utilized areas spanning at least one degree of latitude. Further, there are documented movements of PCFG whales to Kodiak (Gosho *et al.* 2011) and Point Barrow, Alaska (Calambokidis *et al.* 2012), in years they were not seen in the PCFG area. Finally, information from tagging (see section above) also supports the idea that the range of some PCFG whales extends outside of the presently defined boundaries.

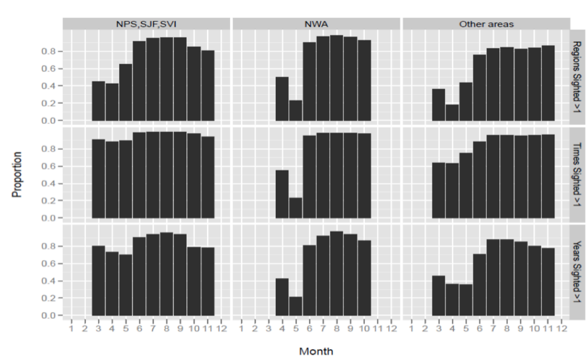

Figure 4. Proportion of whales sighted in more than one region (top), on more than one day (center) and in more than one year (bottom) as defined by the region and month they were seen. NPS = Northern Puget Sound, SJF = Strait of Juan de Fuca, SVI = Southern Vancouver Island, NWA = Northern Washington Coast.

It was noted by the TF that site fidelity of known reproductive mothers to the WNP Sakhalin Island feeding area is very strong (Weller *et al.* 2002). The TF therefore recommended that the existing PCFG photo-identification data be examined to see if moms/calves demonstrate higher levels of fidelity than other whales.

4.2 Pacific Coast Feeding Group abundance and survival

The photo-identification data collected annually in the seasonal range of PCFG whales (following the IWC definition) between 1998 and 2010 have been used to estimate abundance. In these analyses, the term "transient whale" was used to refer to whales seen in only one year and never seen again in any other year, and "non-transient whale" was used to refer to whales seen in at least two years, such that an estimate of the number of non-transient whales would be equivalent to an estimate of the number of whales defined to be in the area used by the PCFG. The total number of gray whales in the area used by the PCFG in summer would include both transient and non-transient whales, and is therefore higher than the number of defined PCFG whales in the area. In the following discussion of abundance estimates, whether an estimate is biased or not is relative to the true number of defined PCFG whales (not to the total number of gray whales in the area).

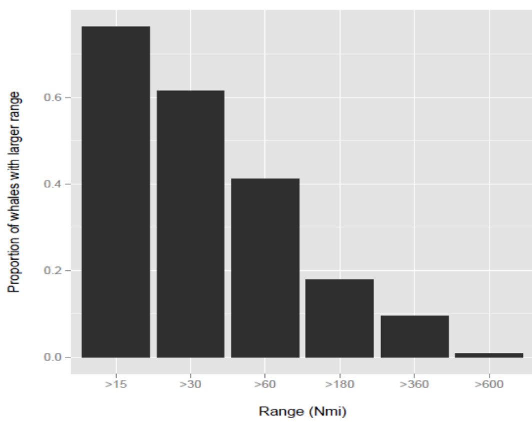

Figure 5. Distribution of maximum distance, in nautical miles, between photo-id locations for PCFG gray whales during 1 June – 30 November 1998-2010. The distance for 40% of the whales exceeded 1 degree latitude (60 nautical miles).

A number of different estimators were used including: (1) Lincoln-Peterson (LP), (2) Limited Lincoln-Peterson (LLP), and (3) Modified Jolly-Seber (JS1). The first two estimators constructed estimates from consecutive years of data. The LP estimator assumes a closed population and is unbiased if there are only losses or only gains. There are both losses and gains to the PCFG due to transient whales and therefore induces a positive bias. The LLP estimator removes the positive bias of the LP estimator by restricting the data to whales seen during the 2-year period but also in another year prior or after the 2-year period. This restriction eliminates whales that were transients in either of the years. The JS1 estimator is an open population model that estimates the abundance of non-transient whales. A fourth estimator, JS2, is an alternate JS modification that produced similar results except at the end of the time series (Calambokidis *et al*. 2012).

Calambokidis *et al.* (2012) considered the JS1 estimator to be the best suited for analysis of the PCFG (Figure 6). The Jolly Seber 1 (JS1) estimator assumes that any gray whale joining the PCFG is seen the first year it enters. The assumption is made to model the data adequately with the strong relationship between minimum tenure (time between first and last sighting in the year) and the probability it remains in the PCFG. The magnitude and trend of the LP abundance estimates do not match up well with the limited LP and the JS1 estimates; this is due to the fact that the LP

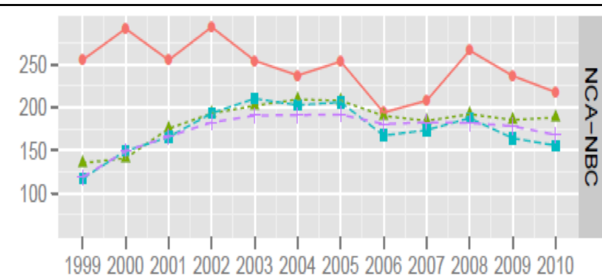

Figure 6. Estimates of the abundance of PCFG gray whales between northern California and northern British Columbia (NCA – NBC) using four different estimators based on photo-id data collected annually between 1998 and 2010. LP = Red Circle, JS1=Green Triangle, LLP=Blue Square, JS2=Purple Dotted Line

estimator was positively biased and the bias was greater at the beginning of the time series when there was more immigration and emigration into and out of the area used by the PCFG.

In discussion, the TF focused on whether the increase in the JS1 abundance estimates from 1999-2002 (Figure 6) was real or a reflection of the discovery of "new" whales that were present in the area used by the PCFG but not observed (i.e., photographed). Some of that discussion also focused on the related topic of recruitment described below. Laake responded that there were 13 whales not sighted in 1998 that were seen after 1998 (most of them were sighted in 1999) and were in the catalog for sightings prior to 1998. These results indicate that the assumption of JS1 (i.e., that any gray whale joining the PCFG is seen the first year it enters) was not met entirely. That being said, Laake argued that the bias was small or negligible after 1999 for the following reasons: (1) values from the JS1 estimator correspond closely to the value from the limited LP estimator which does not make the same assumption, (2) simulation results using similar values for capture probability estimated from the data showed a minimal amount of bias after 1999, and (3) the UME in 1999-2000 provides a plausible explanation for the coincident increase in PCFG abundance.

4.3 Pacific Coast Feeding Group IWC implementation review

Wade (AFSC) presented a brief overview of the status of the Implementation Review (IR) process conducted by the IWC. The IR includes trials based on three hypotheses: (1) Hypothesis P (Pulse) assumes that there is no bias in the PCFG abundance estimates (but dropping 1998) and that a pulse of immigration occurred in 1999 and 2000; (B) Hypothesis B (Bias) assumes a strong time-varying bias in the abundance estimate but no pulse of immigration; and (3) Hypothesis I (Intermediate) includes a moderate time-varying bias in the abundance estimates and a pulse of 10 immigrants into the PCFG in both 1999 and 2000. These hypotheses were evaluated because the model used in the IWC IR trials could not produce simulated abundance trajectories that fit the abundance estimates without incorporating a pulse or a bias into their model. For these trials the IWC Scientific Committee agreed that a sufficient fit to the data could be achieved with maximum annual immigration of up to six animals.

Wade noted that for the most part there was broad similarity between the population trajectories in the IWC trials and the population trajectories in the OSP determinations performed by Moore and Punt (pers. comm.), which only use Hypothesis P (a pulse of immigrants in 1999 and 2000, see related item below). The IWC implementation trials produce final statistics related to conservation status and catches.

There was some discussion about the need to evaluate trials that produced worrying conservation statistics and that it would be valuable to look at what the depletion level could be in those trials. Wade noted that the trials incorporating a low growth rate with little immigration or the trials in which the probability of taking a PCFG whale were doubled were the trials which do not do well with respect to conservation statistics such as final depletion level. Note that "final depletion level" is defined by the IWC to be the final population level as a percent of K. This is related to, but can be slightly different from, the U.S. MMPA definition of "depletion", which is defined to be a population level below the Maximum Net Productivity Level (MNPL). In U.S. MMPA depletion determinations, MNPL is generally assumed to either be a range from 50-70% of K, or a single value such as 50% or 60% of K. The only practical difference occurs when a range is used in MMPA determinations, where one calculates the probability a population is below MNPL over a range of percentages of K. If a single value is used for MNPL (e.g., 60%), than the IWC final depletion level is identical.

Some of the simulations conducted by the IWC with worrisome conservation performance (with respect to final depletion below 60%) are those using Maximum Sustained Yield Rate (MSYR) of 1% or 2%, implying a relatively low maximum population growth rate (Annex E, IWC 2012b). Note that the IWC Scientific Committee parameterizes population models with MSYR rather than Rmax (used in U.S. MMPA calculations). MSYR is the population growth rate at the Maximum Sustained Yield level, which is equivalent to MNPL if human-caused removals are unbiased with respect to age. Therefore, if MNPL is 50% of K, a population with an MSYR of 2% has an Rmax of 4%, and a population with an MSYR of 1% has an Rmax of 2%. Taylor noted that although she would have initially thought population growth rates that low were unlikely, after seeing some of the results presented she felt that relatively low population growth rates cannot be ruled out. She also noted that all trials in the table (which was a summary of trials that performed poorly with respect to conservation statistics) have annual immigration = 0 to 2, at the low end of the range considered. It appears that rates of annual immigration higher than 2 provide just enough of an offset to low MSYR rates of 1 or 2%.

The TF asked how the rescaled final depletion level was related to final depletion level in the IWC results. The rescaled final depletion statistic is used by IWC in trials whose specifications cause the population to decline even in the absence of catches. To evaluate those trials, the final population level for the trial (with catches) is compared to the final population level that would have been obtained in the absence of catches. That ratio is termed the rescaled final depletion, and represents the fraction of the population size that would have been obtained in the absence of catches. Since a low MSYR rate results in low population growth, the IWC found it is useful to compare depletion levels both with and without catches. The rescaled final depletion results for the PCFG only differ from the final depletion statistic for trials with a low value for MSYR, where the PCFG would decline and become depleted regardless of whether a hunt occurred due to the combination of a low population growth rate and bycatch.

4.4 Pacific Coast Feeding Group recruitment

Although new whales are identified each year in the range of the PCFG, about 50% of these individuals are seen in only one year and considered "transients" or "visitors" (Figure 7). Other whales are resighted in subsequent years and are considered "recruits" into the PCFG. Whales with a longer minimum tenure in the first year they were sighted have higher first year apparent survival and higher probability of return (i.e., do not permanently emigrate). This relationship might be expected given a hypothesis that whales are more likely to return if they find a suitable prey base during their first year in the seasonal range of the PCFG.

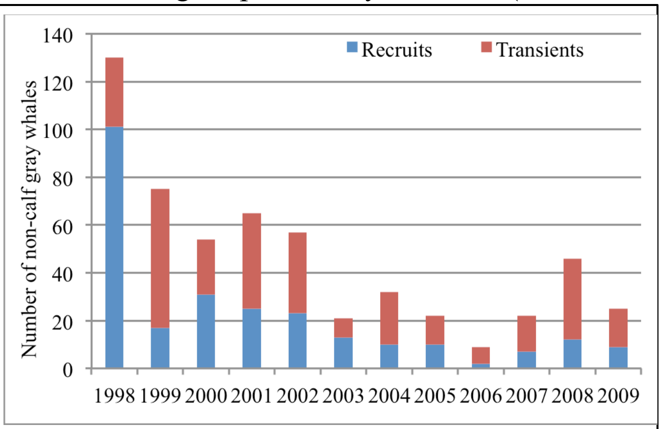

Figure 7. Number of "new" whales seen each year in the PCFG area that are transients (only seen in one year) and recruits (seen in more than one year).

Whales that recruited into the PCFG in 1999 or a subsequent year had lower first year apparent survival than whales that were first identified in 1998. Approximately 75% of the whales whose minimum tenure was 100 days or more in 1999 or later were resighted in a following year. For whales identified in 1998 (the first year of the study) whose minimum tenure was 100 days, nearly 100% were resighted in a following year (Figure 8). This suggests that some of the animals that recruited into the PCFG in 1999 or later may have subsequently emigrated out; this could explain why the abundance has declined somewhat in the later years (Figure 6). The high number of new whales identified in the seasonal range of the PCFG between 1999 and 2002 is hypothesized to have been in response to the 1999-2000 UME.

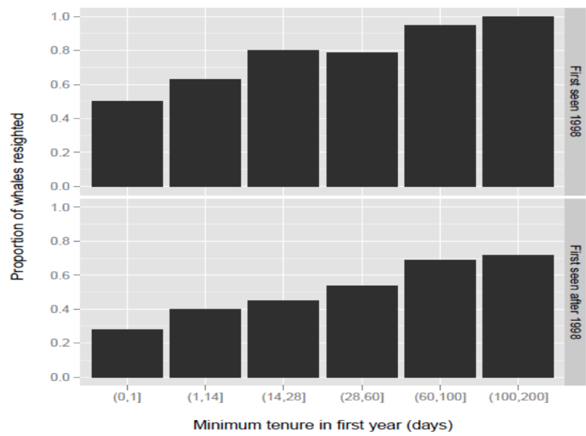

Figure 8. Relationship between minimum tenure in first year (# of days between first and last sighting plus 1) and the proportion resighted in at least one following year. The data series starts in 1998 so all whales are "new" so while the pattern is similar, the proportions are higher for 1998 because most whales are not truly new to the PCFG.

The TF discussed several alternative explanations for the relatively high numbers of recruits into the PCFG in the early part of the time series (1999-2002). For example, whether the increase in abundance during early years could be due to a "discovery" effect, such that it took a number of years for all the whales which were part of the PCFG to be photographed and "discovered". Alternatively, the heterogeneity in survey coverage over time and space could lead to some animals being considered "new" in a given year even if they had been utilizing areas with limited or no survey coverage in previous years. However, overall capture probabilities are high, suggesting it is unlikely a whale would be in the area for several years and not photographed. The TF concurred that on an annual basis, whales observed in the area used by the PCFG could be characterized as a collection of individuals whose residence patterns vary along a continuum such that some whales use the area for a single year (e.g., transients), some for a few years, and others on a consistent long-term basis.

By way of an analogy, Laake characterized the PCFG as a "leaky bucket", in that some whales are immigrating in while others are emigrating out. The "leaky bucket" phenomenon is not a random process, however, because a "core group" of whales appear to stay in the bucket over time. The dataset cannot discriminate between PCFG whales that die versus those that emigrate. Animals that recruit into the PCFG as non-calves may be more likely to emigrate out of the area than calves recruited to the PCFG in the year they were born. That is, calves of the year have been taught to feed on prey types common to the PCFG area (various swarming prey for instance) by their mothers and may obtain "local knowledge" that allows them to be successful long-term inhabitants of the PCFG area. To evaluate this, the TF recommended that the existing PCFG photo-identification time series be examined to see if moms/calves demonstrate higher degrees of fidelity than other whales.

In thinking about the "core group" of PCFG whales that return to the area on a consistent basis, the TF questioned if biopsy efforts in the area could be potentially biased towards these whales. If sampling efforts are unintentionally concentrating on the "core group" of PCFG whales, then the results of genetic comparisons may be driven by matrilineal fidelity of this "core group". In addition, the biopsy efforts are not spread evenly over time and space (more heterogeneity than the photo-identification survey efforts). If "core group" animals predominantly use the areas with high biopsy effort, then this potential bias could be magnified.

Some newly seen whales are calves with their mothers (Figure 9). As described in Calambokidis *et al.* (2012), much of the sighting effort occurs in August and later when many calves are likely to already be weaned and thereby more difficult to identify as a calf (versus a yearling). The TF noted that many of the whales identified as calves off Sakhalin Island in the WNP are not resighted for many years subsequent to their birth year but eventually they are again resighted in the area. This pattern suggests that young animals (1+ years old) may use other areas to feed during their first several years. Therefore, in the case of the PCFG, if a whale was not seen as a calf but returned in a later year it would appear to be an external rather than internal recruit. With that in mind, the TF recommended that the existing PCFG photo-identification time series be examined following a protocol developed by Bradford et al. (2011) that uses barnacle and pigmentation characteristics on young gray whales to reliably distinguish calves of the year from yearlings.

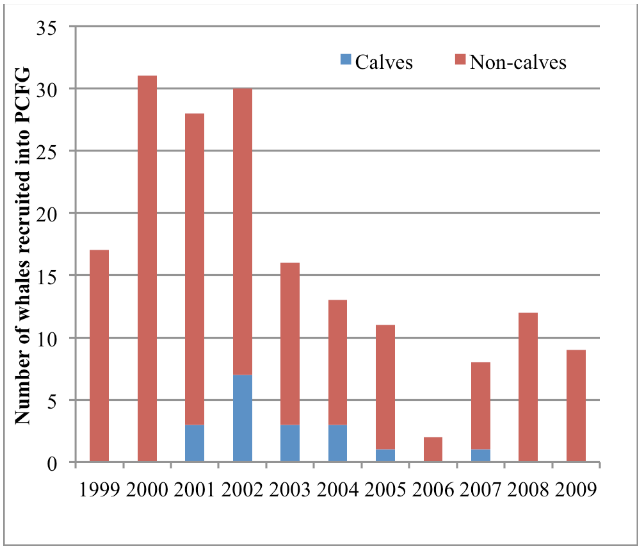

Figure 9. Number of whales first seen and recruited (seen in a following year) by year and calf and non-calf designation.

In summary, the TF discussion about the magnitude and source of recruitment into the PCFG focused on: (1) incomplete survey coverage of the entire seasonal range used by the PCFG and the potential for whales to be missed and then "recruited" in a subsequent year, (2) the proportion of "recruited" whales that were calves of mothers from the PCFG that may have been missed as a calf or misidentified as an external recruit, (3) the potential of the 1999/2000 UME to create a pulse of immigration into the PCFG, (4) to what degree gray whales recruited in 1999 or later were either emigrating back to the northern feeding areas or experiencing higher mortality, and (5) whether the biopsy sampling effort was prone to sample whales that spent more time in the range used by the PCFG.

All of these issues are relevant to assessing the amount of external recruitment into the PCFG and thereby especially pertinent to determining if it should be recognized as a population stock under the MMPA and GAMMS guidelines. That is, if the PCFG experiences little external recruitment then it would be considered demographically independent and should be recognized as a stock. If most of the recruitment into the PCFG were external, however, then it would not be considered demographically independent and would not be recognized as a stock. The TF concurred that the resolution of the existing photo-identification data in combination with uncertainly surrounding the accuracy of assigning whales as external or internal recruits prevent this question from being fully resolved. Increased genetic sampling in tandem with increased photo-id effort over both space and time may be the only way to better address this question.

4.5 Pacific Coast Feeding Group trend and optimum sustainable population determination

Moore presented an update on work he conducted in collaboration with Andre Punt (University of Washington) to determine if the PCFG, as a putative stock, is at OSP. The OSP assessment is based on the two-stock population model that has been developed as part of the IWC gray whale

Implementation Review (see section 4.3). Both assessments use the same definition for a PCFG whale. There are some differences, however, between the IWC model framework and the one used for the OSP assessment. First, in the OSP analysis, a Bayesian approach is used in which prior distributions are specified for input parameters and the time series of abundance estimates (for the ENP and PCFG) are used to the update priors and output posterior distributions. This contrasts with the IWC approach of generating outputs for many models each based on alternative fixed combinations of values for some parameters. Second, the IWC trials consider several hypotheses that attempt to explain the rapid increase in abundance estimates in the first few years of the time series; these include bias in the early abundance estimates, a pulse of immigration, and a combination of these two factors. In the OSP assessment, only the pulse immigration hypothesis is considered, based on work by Calambokidis *et al.* (2012) which suggested that the most recent abundance estimates should be fairly unbiased apart from the first estimate in 1998, which is not used in the OSP analysis.

At the time of the workshop, the OSP analysis considered two hypotheses pertaining to the regular annual immigration rate: one in which there is no immigration (PCFG is closed) and one in which the annual immigration rate is estimated, given a uniform prior distributed between 0 and 6 individuals per year. Different versions of the model allow the density-dependent (or inflection point) parameter θ to be estimated separately for each putative stock (PCFG vs. rest of the ENP) or to be constrained so that the two groups share a common θ. Outputs from both versions and immigration rate considerations (none vs. U[0, 6]) are similar in models run thus far. The primary parameter of interest in the OSP assessment is the probability that PCFG abundance is above MNPL (MSYL in IWC terms).

The analysis was not able to generate useful assessment results because, apart from the rapid population increase in the late 1990s attributed to an immigration pulse, the abundance time series is fairly flat and therefore not very informative for estimating *in situ* population growth parameters. The data have also not been informative for estimating population carrying capacity (K), a parameter necessary to determine whether current abundance is above MNPL. Posterior distributions for K have been strongly dependent on the upper bound used for the prior. Given that the abundance has been stable throughout most of the 2000s, it appears to be regulated at this level (of around 200 - 250 animals) by some factor, and thus it is somewhat puzzling that the data do not seem more informative with respect to estimating K. Moore suggested that annual levels of incidental take included in the model (about 2 animals per year) could be making it difficult to estimate whether the population is being regulated at K or some level below K, given that the data do not inform the estimates of MSYR (the population growth parameter in IWC models). For example, given annual bycatch mortality of 1%, a combination of being well below K and having a low MSYR may describe the data equally well as being close to K and having a high MSYR, since in both cases, the realized value for population growth would be low and potentially balanced by the additive mortality. It was also suggested that the population might be regulated at its current level as a result of emigration and bycatch offsetting the combination of immigration and *in situ* growth.

Moore and Punt were continuing to troubleshoot the problem by running alternative models that, for example, exclude incidental take from the model or constrain estimates of MSYR for the PCFG to be equal to those of the ENP. The goal of this troubleshooting is to explain why estimates of K and hence probability of being at OSP are elusive, which in turn may enable a decision as to whether an OSP assessment may be possible.

The TF thanked Moore and Punt for their work on this complicated matter and raised several points for clarification. It was asked where the estimates of incidental mortality for the model had come from. Moore reported that the bycatch estimate being used is based on a summary compiled at the 2011 IWC Aboriginal Whaling Management Procedure (AWMP) intersessional workshop (IWC 2012a). Carretta clarified that those estimates included data from over a 20-year period that tried to assign animals as being part of the PCFG (or not) based on time and space. Carretta also noted that the bycatch values used in the OSP analysis (as well as the SARs) account for only observed bycatch, which is likely to be an underestimate of actual bycatch.

It was also noted that emigration is a possible explanation for the difficulty in estimating K in spite of apparent PCFG population size stability. That is, all recruits are assumed in the model to have the same annual survival rate but as discussed above, whales that recruited into the PCFG in 1999 or later had lower first year survival than whales that were first identified in 1998. Not including this extra survival parameter may explain some of the lack of fit of the model to the abundance time series (plots show that the model underestimates abundance in the first half of the time series and overestimates abundance in the second half of the series).

The TF asked if the model assumed immigration was constant across years in the assessment given that in reality immigration into the PCFG is thought to vary across years. In the model, immigration to the PCFG occurs at a constant rate, with the number of immigrants being proportional to the northern stock (non-calf) abundance. The rate is equal to the estimated immigration parameter (*I*, specified with the uniform [0,6] prior) divided by 20,000. In other words, for recent abundance levels of the northern stock, annual immigration to the PCFG is approximately *I* individuals. Emigration from the PCFG group is similarly assumed to occur at a constant rate, specified by an additional survival parameter ($1 - S$), with the number of emigrants proportional to PCFG abundance. *S* is set so that when both stocks (northern and PCFG) are at carrying capacity, immigration and emigration to the PCFG is balanced, i.e., $IK_{\text{north}}/20000 = (1 - S)K_{\text{PCFG}}$.

Some members of the TF commented that based on this model it seems plausible that the pulse of immigration into the PCFG is larger than what the IWC is modeling or what the genetic simulations have modeled. If that were the case, then the estimates of regular annual immigration would be lower than estimated in the genetic simulations. In the light of this discussion, the TF noted that the genetic simulations should try pulses of 30 animals to see if that is consistent with the empirical genetic data. This line of thinking led to additional discussion as to how common pulse immigration events might be, and whether, for the purposes of the workshop and deliberations on internal versus external recruitment, the TF should be considering the pulse as part of the average level of immigration or if the pulse should be considered a one-time event and only annual immigration should be considered (in assessing how demographically independent the PCFG is).

It was further noted that if a UME event the size of the one in 1999-2000 had occurred previously, some record of it would be expected. Wade noted that it was due to this reasoning that they did not incorporate additional mortality events in the northern stock OSP analysis conducted by Punt and Wade (2012). Wade also noted, however, that there had been a drop in the northern stock abundance in earlier years of the time series but these were not accompanied by a record of increased strandings. The TF suggested that pulses could occur regularly on decadal time scales or as a result of a variety of other environmental or anthropogenic factors.

The TF discussed if the genetic data may reflect a sampling bias toward "core" PCFG animals. This follows other lines of evidence showing that there is a relationship between minimum tenure and probability of photographically capturing animals in the PCFG area (see section 4.4 above). If "core" PCFG whales are more approachable, then they are potentially more likely to be biopsied, meaning that these whales may be disproportionately selected for in the biopsy process.

Lang noted that she had looked at the current genetic sample set to see if the rare haplotypes found in the PCFG sample set came from animals that were sighted in 1999 or later, which might suggest that they were immigrants as the expectation would be that immigrants would be likely to bring in rare haplotypes. The results were mixed, with some rare haplotypes found in long-term PCFG whales while others were found in animals that came into the PCFG in 1999 or later.

This led to a discussion about what additional information might help the PCFG OSP assessment and improve inference generally about the level of internal versus external recruitment to the PCFG. The TF agreed that additional genetic sampling to improve estimates of immigration and residency times (emigration), and improved estimates of incidental mortality would be useful.

5. Probability of a Western North Pacific Gray Whale Being Taken by the Makah

Mixing of whales identified in the WNP and ENP has recently been reported (Weller *et al.* 2012). Lang (2010) reported that two adult individuals from the WNP, sampled off Sakhalin in 1998 and 2004, matched the microsatellite genotypes, mtDNA haplotypes, and sexes (one male, one female) of two whales sampled off Santa Barbara, California in March 1995. In 2010 and 2011, Mate and colleagues (Mate *et al.* 2011) satellite-tracked three whales from the WNP to the ENP (Mate *et al.* 2011; IWC 2012a; IWC 2012b). Finally, photographic matches between the WNP and ENP, including resightings between Sakhalin and Vancouver Island and Laguna San Ignacio, have further confirmed use of areas in the ENP by whales identified in the WNP (Urbán *et al.* 2012; Weller *et al.* 2012). Despite this level of mixing, significant mtDNA and nuclear genetic differences between whales in the WNP and ENP have been found (Lang *et al.* 2011b).

Observations of gray whales identified in the WNP migrating to areas off the coast of North America raise concern about placing the WNP population at potential risk of incurring mortality incidental to the ENP gray whale hunt proposed by the Makah Indian Tribe off northern Washington, USA (see IWC 2012a; IWC 2012b). Given the ongoing concern about conservation of the WNP population, in 2011 the Scientific Committee of the IWC emphasized the need to estimate the probability of a western gray whale being killed during aboriginal gray whale hunts (IWC 2012a). Additionally, NOAA is required by NEPA to prepare an Environmental Impact Statement (EIS) pertaining to the Makah's waiver request. The EIS will need to include an analysis of the likelihood of a western gray whale being killed during the proposed Makah gray whale hunt.

Moore summarized the work that he and Weller (SWFSC) have done to estimate the probability that a WNP whale might be taken during the proposed gray whale hunt (Moore and Weller 2013). Four alternative models were evaluated; these models made different assumptions about the proportion of WNP whales that would be available for the hunt or utilized different types of data to inform the probability of a WNP whale being taken. The probability of striking at least one WNP whale over the course of five years was estimated to range from 0.034 – 0.058 across different scenarios of the preferred model, with upper 95% CI estimates ranging from 0.107 –

0.170. This result may be compared to an estimate of PBR. If the recovery factor for calculating PBR is set to 0.1, and discounting the estimate for the proportion of the population that may be migrating through U.S. waters and the proportion of time (months out of a year) they are in U.S waters, then the 5-year PBR estimate is between 0.1 and 0.6 animals, depending on different assumptions about the amount of mixing between the WNP and ENP. Thus, if a WNP whale were to be struck during the 5-year period, PBR would be exceeded.

6. Status of Gray Whale Stocks as Defined by, MMPA, ESA and IUCN

At the request of the TF, Stone (NWR) provided a review of the status of ENP, WNP and PCFG gray whales under the MMPA, ESA, and the International Union for Conservation of Nature (IUCN) redlist.

(1) ENP – The ENP stock is not considered *"strategic/depleted"* under the MMPA and is listed as "*Least Concern*" by the IUCN. Gray whales in the ENP were delisted from the ESA in 1994. Although there have been two petitions (2001 and 2010) to relist the ENP stock under the ESA, both petitions were denied.

(2) WNP – The WNP stock is considered "*strategic/depleted*" under the MMPA and is redlisted as "*Critically Endangered*" by the IUCN. WNP whales are considered "*Endangered*" under the ESA, although there is no stand-alone SAR for WNP whales. Given that ENP whales were delisted in 1994, gray whales in the WNP would be considered a Distinct Population Segment (DPS) under the ESA. Use of the DPS terminology was not common at the time of the delisting and thus the listing documents do not describe the WNP as a DPS.

(3) PCFG - The PCFG does not have a formal status under the MMPA, IUCN nor ESA.

In addition to the above, the TF discussed the status of gray whale stocks as defined by the IWC. Under the IWC implementation review (IR) process, the IWC considers all plausible hypotheses of stock structure, and then determines which hypotheses have high or medium plausibility. Those stock hypotheses with high or medium plausibility are used to evaluate the management variants proposed by hunters. In the case of gray whales, the IWC traditionally considered only the hypothesis of a single ENP stock. New information presented to the IWC in 2010 (Frasier *et al.* 2011) suggesting that the PCFG could be a separate stock resulted in the IWC evaluating a two-stock hypothesis. Members of the TF reminded the group that the IWC does not have to decide if there are one or two gray whale stocks, but only if it is plausible that there is one stock and if it is plausible that there are two stocks (or three stocks). The objective of the IWC is to make sure that the stock or stocks are robust to the proposed hunt under all plausible scenarios. Thus, the IWC process is currently considering both stock hypotheses (1-stock and 2-stock). Future work by the IWC may need to incorporate a third stock (i.e., WNP) but for now the calculation of the probability of a WNP whale being killed during the Makah hunt (see section 5 above) is a stand-alone calculation.

7. Overview of Evidence Used in Recently Defined Population Stocks

Stone provided an overview of the lines of evidence used by NMFS to delineate stocks as inferred from the text of each SAR. It became clear during discussion of the summary that many of the SARs do not explicitly lay out the lines of evidence and justifications for originally delineating a stock but instead only present recent information. The killer whale SARs, for example, do not describe the acoustics data and other lines of evidence that were originally used to identify the stocks. There was general agreement that an updated summary, in spreadsheet form, would be useful as it could capture the history and provide a long-term record of how each stock was delineated, but this would not be a trivial task. In the end, the TF concurred that agency practices for delineating stocks were not based on a set standard but were more variable and fact-specific so as to use the best available information.

8. Review of Stock Definition Cases Relevant to the Pacific Coast Feeding Group

The TF reviewed several examples of stock delineations for other species exhibiting some similar characteristics to the PCFG. Similar characteristics included: (1) use of mtDNA as the sole genetic marker necessary for stock structure determination and (2) mixing with individuals from other stocks during parts of the year.

8.1 Atlantic harbor porpoises

Rosel (SEFSC) presented an overview of stock structure in Atlantic harbor porpoises (*Phocoena phocoena*) with a focus on the Gulf of Maine/Bay of Fundy stock. A single stock was designated in U.S. waters of the Northwest Atlantic based on published literature of Gaskin (1984) who hypothesized four populations in the Northwest Atlantic (three in Canadian waters and one in U.S. waters). While following Gaskin (1984), the first SAR for U.S. Gulf of Maine/Bay of Fundy harbor porpoises stated "*Presently there is insufficient evidence to accept or reject this hypothesis*" (Blaylock *et al*. 1995). In subsequent years, mtDNA evidence supported four stocks in the Northwest Atlantic, including the Gulf of Maine stock, but nuclear microsatellite data did not (Rosel *et al.* 1999). Organopollutant levels (Westgate *et al.* 1997, Westgate and Tolley 1999) and life history characteristics (Read and Hohn 1995) also differed between the Gulf of Maine/Bay of Fundy and other populations in the Northwest Atlantic. The weight of evidence supported delineation of the Gulf of Maine/Bay of Fundy stock and the lack of nDNA differentiation between this stock and others in the Northwest Atlantic was taken to indicate female philopatry coupled with male-mediated gene flow. Microsatellite data indicated that porpoises from the Gulf of Maine/Bay of Fundy probably overlap in winter in the mid-Atlantic with porpoises from other regions of the Northwest Atlantic (Hiltunen 2006), but this is outside the breeding season.

8.2 Alaska harbor seals

Taylor summarized the history of recognizing stocks of harbor seals in Alaska. Harbor seals (*Phoca vitulina*) are continuously distributed throughout Alaskan waters, but mtDNA indicates that genetic differentiation among sampled sites increases with increasing geographic distance (O'Corry-Crowe *et al.* 2003). The continuous distribution implies that there will be movement of animals across stock boundaries drawn on a map, but if no stock boundaries are designated, there is the risk of local depletion and loss of portions of the species' range. The first SARs for Alaska harbor seals comprised three stocks- Bering Sea, Gulf of Alaska and Southeast Alaska (Hill and DeMaster 1998). In 2011, the three stocks were changed to twelve (Allen and Angliss 2012). MtDNA, satellite telemetry, trend and distributional data were used to delineate these 12 stocks. At that time, nDNA data were not available and mtDNA analyses were considered sufficient to meet the criteria of demographic independence under the GAMMS guidelines.

8.3 Humpback whales

Lang presented a review of humpback whale (*Megaptera novaeangliae*) stocks, with a focus on the North Atlantic. There are multiple humpback whale feeding grounds in the Northwest Atlantic, but individuals from these different feeding grounds share one breeding ground in the

West Indies. Humpback whales throughout the Northwest Atlantic were originally classified as a single stock (Waring *et al.* 1999). However, genetic studies have revealed small but significant differences in mtDNA between animals sampled on different feeding grounds (Palsbøll *et al.* 2001) and photo-identification studies have documented strong site fidelity of individuals to the Gulf of Maine feeding area (Clapham *et al.* 1993). The 2000 SAR recognized whales utilizing the Gulf of Maine feeding area as a separate stock (Waring *et al.* 2000). Although this SAR covers only Gulf of Maine whales, individuals from other feeding areas have been identified in U.S. mid-Atlantic waters (Barco *et al.* 2002).

The stock structure of humpback whales in the Pacific is complex (Baker *et al.* 2008; Calambokidis *et al.* 2008) and differs from the western North Atlantic with respect to the "interbreed when mature" criteria. That is, humpback whales from different feeding grounds in the NW Atlantic have the opportunity to interbreed with each other in a single breeding area, while in the North Pacific not all animals have the opportunity to interbreed with each other because there are multiple breeding areas. There is some similarity between North Pacific humpbacks and those in the central and eastern North Atlantic, in that whales on the Norway and Iceland feeding areas may breed in different areas (Palsbøll *et al.* 1997; Stevick *et al.* 1998; Wenzel *et al.* 2009). Three humpback whale stocks are currently recognized in the North Pacific, based on three feeding areas (Allen and Angliss 2012; Carretta *et al.* 2013). The SAR for the Central North Pacific stock includes calculations of PBR for three different feeding areas (Allen and Angliss 2012), as is done for the PCFG in the current SAR (Carretta *et al*. 2013).

9. Review of Gray Whale Genetic Research on Population Structure

Lang provided a chronological summary of genetic research performed on North Pacific gray whales. Steeves *et al*. (2001) used mtDNA control region sequence data to compare 16 samples collected in summer in Clayoquot Sound, British Columbia, representing the PCFG, to 41 samples collected elsewhere in the ENP. Some haplotypes were shared between the two groups and no significant differentiation was found between them. Additional genetic analysis utilizing an extended set of samples (n=45) collected from whales within the seasonal range of the PCFG indicated that the genetic diversity and the number of mtDNA haplotypes identified among these samples were inconsistent with measures that would be expected (based on simulations) if recruitment into the group were exclusively internal (Ramakrishnan *et al*. 2001). Alternative scenarios, such as limited dispersal of whales from other areas into the PCFG, were not explored. LeDuc *et al*. (2002) examined mtDNA control region differences between ENP and WNP gray whales. The ENP sample consisted primarily of stranded animals along the migratory route with some samples from Chukotka, Russia (no distinctions between PCFG and non-PCFG whales were made). The WNP samples were collected off the northeastern coast of Sakhalin Island, Russia. Seven of the 36 identified haplotypes were shared between the two regions and significant genetic differentiation was found. In addition, haplotypic diversity of the WNP sample was lower than that seen for the ENP samples.

Within the ENP, Goerlitz *et al*. (2003) made comparisons between two wintering lagoons and between females sampled in wintering lagoons and those sampled outside the lagoons (in Clayoquot Sound and along the migration route- *i.e.,* "non-lagoon females"). They found small but significant differences in mtDNA data between Laguna San Ignacio cows (females with calves) and non-lagoon females and between Laguna Ojo de Libre cows and non-lagoon females but not when cows from the two lagoons were compared. Alter *et al*. (2009) compared both mitochondrial and nuclear microsatellite markers across three wintering lagoons and found small but significant differences between only one of the three pairwise comparisons using the microsatellite data set only. Similar to Goerlitz *et al.* (2003), they did not find significant differentiation between Laguna San Ignacio and Laguna Ojo de Libre at mitochondrial or nuclear DNA.

More recently, Frasier *et al*. (2011) examined mtDNA differences between whales sampled in Clayoquot Sound, British Columbia (representing the PCFG) and a more carefully constructed data set of ENP whales from LeDuc *et al.* (2002) in which known PCFG whales were specifically removed. They found significant genetic differentiation between the two sample sets and high levels of haplotype diversity in the PCFG sample, comparable to samples thought to represent the larger ENP population. Using this dataset, Frasier *et al.* (2011) also performed a likelihood ratio test using Theta (Θ) as a proxy for effective population size to examine whether the two sample sets come from the same population. The likelihood ratio test indicated that Θ for the PCFG did not equal Θ for the ENP and the authors concluded that the two groups were demographically independent.

D'Intino *et al*. (2012) made a comparison of whales sampled off Vancouver Island and representing the PCFG to whales sampled at the calving lagoon at San Ignacio. Using 15 microsatellite loci, they found no evidence for population differentiation between these two areas and concluded that the two sampled groups come from the same interbreeding population and that maternally-directed site fidelity to different feeding areas leads to genetic differentiation at mtDNA among feeding areas. Lang *et al*. (2011a) expanded on this result and compared whales sighted over two or more years within the PCFG seasonal range to animals sampled on the feeding ground(s) north of the Aleutians using both mtDNA and nuclear microsatellite markers. Significant differentiation was seen for the mtDNA data but not the microsatellite data, supporting the conclusion of Frasier *et al.* (2011) that structure is present among different feeding areas and this structure may be directed by matrilineal fidelity[5] to feeding grounds. Of note, when all samples collected on the PCFG seasonal range (including those collected from animals seen in only one year) were utilized in the mtDNA analyses, no significant differences were detected in the comparison to samples collected from whales off Chukotka. When all samples collected on the PCFG seasonal range were compared to all samples collected north of the Aleutians, the mtDNA F_{ST} comparison detected a significant difference although the χ^2 test did not.

Finally, Lang *et al.* (2011b) re-examined differences between ENP and WNP gray whales, expanding on the previous study of LeDuc *et al*. (2002) by using larger sample sizes, better characterized sampling and both mtDNA and nuclear microsatellite data. Comparisons of whales sampled off Sakhalin Island with whales feeding north of the Aleutians (i.e., ENP whales) and with the PCFG demonstrated significant differentiation at both nuclear and mtDNA markers. The extent of mtDNA differentiation between ENP strata (PCFG and whales feeding north of the Aleutians) and Sakhalin Island was higher than that observed in comparisons within ENP strata. As with previous studies, significant differentiation among ENP feeding areas was not seen in the microsatellite data. The Sakhalin stratum again displayed reduced haplotype diversity compared to the ENP strata. The authors conclude that the mtDNA data support demographic

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[5] Matrilineal fidelity as used here means the learned behavior of a calf (male or female) returning to the feeding ground of its mother.

independence for ENP and WNP gray whales. However, in examining the microsatellite genotypes, Lang *et al.* (2011b) found two individuals biopsied at the Sakhalin feeding ground and off the coast of southern California. These matches, in combination with recent photo-identification and telemetry data (Mate *et al.* 2011; Urbán *et al*. 2012; Weller *et al.* 2012), suggest that some animals summering off Sakhalin overwinter in the ENP in at least some years. Given that recent records document gray whales in the waters off Japan and China during winter and spring (see review in Weller and Brownell 2012) these results suggest that population structure in gray whales may be more complex than previously believed, such that not all of the animals that feed off Sakhalin share a common wintering ground, or that some animals may switch between wintering grounds.

In discussion, TF members suggested some further avenues for exploration including examining whether any microsatellite loci were out of Hardy-Weinberg equilibrium (HWE) for the Sakhalin samples, which might be an indication of mixing of multiple breeding populations on that feeding ground. It was noted that at the 2012 IWC Scientific Committee meeting a paper evaluating the use of HWE tests to look at mixing of stocks was presented and it might be worthwhile to see if the approaches in this paper could be applied to the Sakhalin dataset (IWC 2012b). There was also discussion regarding what proportion of mixing would have to take place before it would be detected by a relatively weak test like HWE.

9.1 Genetic modeling of immigration rates

Lang presented an overview of recent work utilizing a simulation-based approach to evaluate the plausible level of immigration (i.e., a permanent change of feeding ground fidelity, used interchangeably with external recruitment) that might be occurring into the PCFG. While the empirical studies summarized above have shown significant differences in mtDNA between the PCFG and other ENP gray whale feeding areas, suggesting that matrilineal fidelity is important in structuring feeding ground use, other evidence (some from genetics, mostly from photo-id) suggests that some immigration into the PCFG may be occurring. Lang and Martien (2012) used simulations to examine how much immigration into the PCFG could occur to produce results consistent with the empirical genetic (mtDNA) analyses. The results suggested that the plausible range of immigration is >1 and <10 animals/year on top of a two-year pulse of immigration (of 20 animals each year in 2000 and 2001). Annual immigration of 4 animals (with the 2 year pulse of immigration) produced simulated results that were most consistent with the empirical data. If the PCFG had been founded more recently or the abundance of the PCFG is greater than used in the simulations, it is plausible that no annual immigration could be occurring (still assuming the occurrence of a 2-year pulse of immigration).

In discussion of these results, the TF noted several important caveats to the approach used by Lang and Martien (2012), including: (1) the results may be overly precise because so many model parameters are set, and (2) the simulated abundance trajectories do not match well with the mark-recapture estimates (Calambokidis *et al*. 2012) when immigration is 4 immigrants/yr or more. The simulated population trajectories assumed that the PCFG split from the larger ENP population in 1930. Task Force members thought that the 1930 split might be unrealistic, as oceanographic conditions during the Little Ice Age (and earlier) would have limited access to the northern feeding ground(s) and thus may have caused some gray whales to utilize more southern waters for feeding. Lang commented that there were plans to model a split of the PCFG from the larger ENP in the Little Ice Age, but that this work is not yet complete. She also noted that there were many possible histories and it would be difficult to encompass all of them.

10. Discussion of Makah Documents Concerning the Pacific Coast Feeding Group

Weller introduced three documents drafted by or on behalf of the Makah Indian Tribe regarding the PCFG. These documents were provided to the TF in advance of the meeting for review and consideration. In combination, these three documents provided important summary information on the PCFG, including reviews of what is known about the history of the PCFG and summaries of the current status of the group.

The 2011 Makah document (Makah 2011) was drafted by the Tribe and their attorneys and provided to the Pacific and Alaska SRGs as a background paper to help inform their respective reviews of the draft 2012 gray whale SAR (NMFS 2012). This document provides the Makah perspective on whether the PCFG should be recognized as a stock and was therefore deemed important for the TF to review and consider. Information provided in Scordino *et al*. (2011) is largely the same as that presented in the Makah 2011 document.

The 2012 Makah document (Makah 2012) contains comments from the Makah Tribe and their attorneys on the 2012 draft gray whale SAR (NMFS 2012). This document was considered important for the TF to review. In response to the Tribe's request for government-to-government consultation, the SWFSC met with representatives from the Makah Tribe and their attorneys in person to review comments provided in the 2012 document. These comments, where appropriate, were incorporated as changes to the draft text of the SAR (NMFS 2012).

10.1 Discussion of genetics sections of Makah documents

In discussion of these documents, the TF agreed that it was most important to focus on the Makah comments and perspective regarding genetics research on the PCFG. Rosel agreed to lead the TF through the genetics sections of the Makah documents that called into question the strength of the genetic data presented with respect to demographic independence of the PCFG. These points were summarized as: (1) the samples used to represent the overall ENP stock may not be a random sample of the entire stock but could come from different and unknown feeding grounds. This calls into question what the PCFG is being compared to in the genetic analyses, (2) sample sizes from many locations are small relative to overall population size (i.e., relative to the size of the larger ENP population) and to the total level of genetic diversity and that this could cause misleading results, (3) many population comparisons of gray whales have yielded significant but low-level differences in haplotype frequencies; if this is considered sufficient evidence to classify the PCFG as a stock then every group of gray whales utilizing a particular feeding area should be considered a stock, and (4) the genetics results do not support reproductive isolation of the PCFG.

The first two points were related to sampling effects. In discussion, some members of the TF noted that it is not necessarily the sample size that is potentially problematic but rather if related animals are grouped together and multiple biopsies are taken from that "group" then the effective sample size is much smaller. It was further noted that small sample sizes may add variability, but it would only be a problem if there were additional (unrecognized) structure in the samples. From a genetic standpoint, many analyses rely on haplotype frequencies, but if a good sample relative to the genetic diversity of the group is not obtained then the genetic diversity may not be well characterized, especially if there are many rare haplotypes. Since haplotype frequency data also go into analyses for F_{ST} and Chi-square, then poor frequency estimates due to small sample size could affect the accuracy of the genetic differentiation results as well. Lang noted that there is some evidence from North Atlantic humpbacks that the migration to the West Indies is segregated according to feeding ground origin (Stevick *et al.* 2003).

The TF noted, however, that the recent PCFG genetic analyses show high diversity indicating that sampled animals have different haplotypes and are thus not related (maternally). The TF asked if the question at hand is whether gray whales have feeding aggregations or whether the group that migrates north of the Aleutians is different from the group that does not migrate north of the Aleutians. Lang noted that the original intent of the project was to compare samples collected from different feeding areas north of the Aleutians to the area used by the PCFG but in the end sample sizes were insufficient for areas other than Chukotka. Nevertheless, although there could be multiple feeding aggregations north of the Aleutians, one of the comparisons conducted by Lang *et al.* (2011a) used only samples collected off Chukotka to try to avoid including unrecognized structure.

The TF recognized the continuing need for additional data to be collected, but for the purposes of the workshop the focus was whether the lines of evidence from existing genetic analyses are strong enough to counter lines of evidence that put the demographic independence of the PCFG into question. The primary question in the short-term is what can be done with the information that is currently available.

The TF noted that Frasier *et al.* (2011) compared animals from the PCFG with a sample set primarily derived from stranded animals along the U.S. west coast during migration. They agreed that these samples might not be a random representation of the larger ENP, as was also pointed out in the Makah documents.

Overall, the TF felt it was important to recognize that the current research questions being addressed center around feeding-ground-based groups of animals. The genetics work has already shown that when the PCFG is compared to a sample set from northern feeding area (Chukotka) animals or to the Sakhalin animals (also a feeding area) differences have been found (Lang *et al.* 2011b). That is, the PCFG has been shown to be different from two other well-characterized feeding grounds.

While interpretation of the currently available genetic results as relevant to the PCFG has lead to debate amongst different groups, the TF concurred that it represents the best available science. In discussion, some members of the TF agreed that although more progress on this issue could be made over the next few years if resources were available for more intensive sampling, they did not think that the current interpretation of results would change much. That is, even if 1% of the 19,000 or so animals going through Unimak Pass were sampled, a mtDNA difference with the PCFG (as already observed) would remain. So far the PCFG has been compared to samples from feeding areas and from the migratory route and both comparisons detected a genetic difference. It was agreed that the critical issue for additional research to address was better determining the levels of internal versus external recruitment in the PCFG.

At this point the TF returned to discussing the remaining points raised by the Makah documents. The third point was that since multiple genetic comparisons have found low but significant differences, every group of gray whales should be considered a stock. The TF concurred and noted that there is nothing wrong with incrementally adding stocks as new evidence is uncovered, and that decisions have to be made based on the best available science.

The final point discussed was that the genetics results do not support reproductive isolation of the PCFG. The TF agreed in general that the pattern and timing of migration provide ample opportunity for breeding between PCFG whales and other ENP whales. Little is known about gray whale social and mating systems, however, and presently unrecognized mechanisms facilitating selective breeding could exist. If a form of selective breeding does exist, then it could be a long time before nDNA differences appear. A suggested approach to resolving this question is to look at the relatedness of animals in the PCFG. Despite this, the TF agreed that it is most likely that PCFG animals are interbreeding with animals coming from other areas.

11. Research Recommendations

The TF agreed that the following set of recommendations represent key research needs that could help provide additional insight regarding if the PCFG should be recognized as a population stock under the MMPA and GAMMS guidelines.

Given the limited photo-identification and biopsy effort north of 52°N but knowing that at least some observations of PCFG whales in northern feeding areas (e.g., Kodiak and Barrow, Alaska) have been recorded, the TF highlighted the importance of expanding the spatial and temporal coverage of the photo-identification and biopsy effort. In addition, the TF also recommended that further satellite tagging of known PCFG whales be conducted to better delineate habitat use and define the summer/fall feeding area boundaries.

The TF noted that PCFG animals might more regularly interact (compared to non-PCFG whales) with crab pots given their extended residency in coastal waters. Therefore, the TF recommended that the existing photo-identification time series be used to examine scarring patterns of PCFG whales to better understand the incidence of interactions with fishing gear.

Since much of the photo-identification sighting effort occurs in August and later, when many calves are likely to already be weaned and thereby more difficult to identify as a calf (versus a yearling), the TF recommended that the existing PCFG photo-identification time series be examined following a protocol developed by Bradford *et al*. (2011). This photo-based method uses barnacle and pigmentation characteristics on young gray whales to reliably distinguish calves of the year from yearlings.

Knowing that several lines of evidence demonstrate a relationship between minimum tenure and the probability of photographically capturing animals in the 42°N-52N° PCFG area, the TF recommended that the existing PCFG photo-identification time series be examined to see if moms/calves demonstrate higher degrees of fidelity than other whales.

Although photo-identification studies of the PCFG by Calambokidis and colleagues have been ongoing for over a decade, a relatively high number of "new" animals (not previously sighted in the area) are identified each year and subsequently show consistent return to the area (Calambokidis *et al*. 2012). These "new" animals could represent calves born into the group (i.e., internal recruitment) and not identified in their first year, or they could represent animals that traditionally feed in northern areas but now show fidelity to the seasonal range of the PCFG (i.e., external recruits). To better address this question, the TF recommended that relatedness analysis, in which microsatellite genotypes are used to identify animals that represent putative mother-offspring pairs, be used to assess the proportion of internal recruitment occurring within the PCFG. A sufficient understanding of recruitment to make a stock definition determination could potentially be achieved with a concerted effort to sample known mothers and recruits and determine their relatedness.

Related to the recommendation above, some TF members felt that it was plausible that the pulse of immigration into the PCFG could be larger than what the genetic simulations have modeled. If so, then the estimates of annual immigration into the PCFG could be lower than that estimated in the genetic simulations. With this in mind, the TF recommended that the genetic simulations should try pulses of 30 animals and see if that is consistent with the empirical genetic data.

12. Structured Decision-Making Process

At the request of the TF, Bettridge provided an overview of the FEMAT-style structured decision-making process[6]. In some NMFS status reviews, Biological Review Teams (BRTs) formed pursuant to the ESA have adopted formal methods to express plausibility for use in guiding its analysis of DPSs and in assessing the risks to the population(s). These formal methods are important in a setting where quantitative measures of uncertainty derived from the empirical data are unavailable. This point allocation method is often referred to as the "FEMAT" method because it is a variation of a method used by scientific teams evaluating options under the Northwest Forest Plan (Forest Ecosystem Management Assessment Team). In this approach, for example, each expert is asked to distribute plausibility points among the choices/scenarios for a given decision, reflecting his or her opinion of how likely that choice or option correctly reflected the population status. If the expert is certain of a particular option, or feels it is the only plausible scenario, he or she could assign all points to that option. An expert with less certainty about which option best reflected reality or best reflected the population's status could split the points among two or more options. This method has been used in all status review updates for anadromous Pacific salmonids since 1999, as well as in reviews of Southern Resident killer whales, West Coast rockfishes, Pacific herring (*Clupea pallasii*), Pacific groundfish, North American green sturgeon (*Acipenser medirostris*), black abalone (*Haliotis cracherodii*), Hawaii false killer whale (*Pseudorca crassidens*), and humpback whales.

In the humpback whale status review, BRT members distributed 100 likelihood points among the defined scenarios or options, reflecting their expert opinion of the relative likelihood that the status of a specific DPS falls into each of three risk categories. Then the team discussed how they had allocated points and subsequently had a chance to revise their scores. Scorer identity was known.

In the Hawaii false killer whale status review, BRT members distributed 10 points between the arguments for and against each factor. Team members agreed to view resulting scores with names associated to facilitate discussion and assure that linguistic uncertainty was not responsible for any disparate votes. The BRT discussed the scores and, in some cases, adjusted scores when prior articulation of the arguments had been unclear.

After presentation of the structured decision-making approach, Bettridge asked the TF the following questions: (1) Does the TF want to use this approach? (2) If so, how many points will each member allocate among scenarios? (3) Does the TF wish to disclose names, or keep scores anonymous? (4) Does the TF wish to allow for rescoring after discussion? The TF members agreed to employ the structured decision-making approach, allocating 100 points per person. The

[6] The TF agreed that Bettridge, as leader of the decision-making process, should refrain from allocating points on the decision questions.

group agreed to disclose names with scores for the purposes of internal discussion and possible rescoring but to retain anonymity in the final report.

The TF further agreed that they needed to carefully formulate the questions to be addressed and clearly understand what it means to put likelihood points in one category or another so as to provide the necessary advice for management-related issues such as: (1) how future NMFS stock assessment reports will be drafted with regard to gray whale stock structure in the North Pacific and (2) how to interpret any new information in the context of the Makah Indian Tribe MMPA waiver request to resume hunting gray whales off Washington State, USA.

Some TF members with experience using this approach in other situations found that when one or a few members allocated points very differently it was often due to misunderstanding of the question or what the answers implied. Therefore, it was agreed that the questions and the categories of answers should be as clear as possible to make the process both efficient and transparent.

12.1 Question formulation

In keeping with the objectives stated above for developing questions, the TF dedicated significant time during day 2 of the workshop agreeing on questions to be considered during the decision-making process. A key objective of this exercise was to focus on existing lines of evidence to help create the questions while at the same time being mindful of the existing definitions of the terms (e.g., demographic independence, interbreed when mature, functioning element of the ecosystem) contained in the MMPA and GAMMS guidelines. For instance, a simple example of this might be; "*evidence of demographic independence is when the number of internal recruits is greater than the number of external recruits*". In general, this philosophy of creating questions was adopted by the TF and maintained during its deliberations.

After considerable work, the TF agreed to 11 questions. Overnight, TF members privately completed their point allocations for each of the questions. Point allocations were tallied and ready for discussion on the final day of the workshop. Allocating points in this manner allowed individual TF members to express their level of certainty on each of the questions, such that placement of all points in a single category indicated relative certainty in the lines of evidence discussed during the workshop. The TF agreed to view resulting scores with names associated to facilitate discussion and assure that linguistic uncertainty was not responsible for any disparate votes. The TF discussed the scores and, in some cases, members adjusted them when prior articulation of the lines of evidence had been unclear. The final 11 questions and likelihood point allocations for each of the TF members (anonymous, labeled A – G), as well as the proportional distribution of points overall, are provided below.

Question 1.	Overall	A	B	C	D	E	F	G
	Does the ecosystem occupied by the PCFG when they are feeding differ from the ecosystems occupied by other ENP gray whales?							
Strongly Agree	53	100	0	80	100	90	0	0
Somewhat Agree	47	0	100	20	0	10	100	100
Neutral	0	0	0	0	0	0	0	0
Somewhat Disagree	0	0	0	0	0	0	0	0
Strongly Disagree	0	0	0	0	0	0	0	0

Question 2.	Overall	A	B	C	D	E	F	G
	If gray whales in the ENP continued to be managed as a single stock, would the future abundance of PCFG gray whales be maintained above 60% of their current abundance if annual HCM in the PCFG was 5?							
Strongly Agree	38	0	95	0	0	20	50	100
Somewhat Agree	23	20	5	5	0	80	50	0
Neutral	25	50	0	25	100	0	0	0
Somewhat Disagree	14	30	0	70	0	0	0	0
Strongly Disagree	0	0	0	0	0	0	0	0

Question 3.	Overall	A	B	C	D	E	F	G
	If gray whales in the ENP continued to be managed as a single stock, would the future abundance of PCFG gray whales be maintained above 60% of their current abundance if annual HCM in the PCFG was 10?							
Strongly Agree	10	0	50	0	0	0	0	20
Somewhat Agree	24	10	50	0	0	25	30	50
Neutral	21	40	0	0	0	25	50	30
Somewhat Disagree	17	40	0	10	0	50	20	0
Strongly Disagree	29	10	0	90	100	0	0	0

Question 4.	Overall	A	B	C	D	E	F	G
	If gray whales in the ENP continued to be managed as a single stock, would the future abundance of PCFG gray whales be maintained above 60% of their current abundance if annual HCM in the PCFG was 20?							
Strongly Agree	0	0	0	0	0	0	0	0
Somewhat Agree	4	0	25	0	0	0	0	0
Neutral	7	0	50	0	0	0	0	0
Somewhat Disagree	22	10	25	0	0	50	50	20
Strongly Disagree	67	90	0	100	100	50	50	80

Question 5.	Overall	A	B	C	D	E	F	G
	Given the lack of significant differences found in nuclear markers between PCFG whales and other eastern Pacific whales, how would you allot points to:							
There is complete random mating within the eastern NP	63	70	70	70	50	80	60	40
There could be some non-random mating within PCFG whales that is either too recent or at too low a level to be detected given current sample sizes and marker numbers	37	30	30	30	50	20	40	60
PCFG whales breed primarily with each other	0	0	0	0	0	0	0	0

Question 6.	Overall	A	B	C	D	E	F	G
	Based on the genetic data and simulations, how would you allot points to:							
Nearly all recruitment into the PCFG area results from external recruitment (immigration)	0	0	0	0	0	0	0	NA
Most recruitment into the PCFG area results from external recruitment	21	20	30	20	0	20	33	NA
Recruitment is about equal between internal (births) and external (immigration) recruitment	56	60	50	60	100	30	34	NA
Most recruitment into the PCFG area results from internal recruitment	24	20	20	20	0	50	33	NA

Question 7.	Overall	A	B	C	D	E	F	G
	Based on the photo-identification data, how would you allot points to:							
Nearly all recruitment into the PCFG area results from external recruitment (immigration)	0	0	0	0	0	0	0	0
Most recruitment into the PCFG area results from external recruitment	38	30	55	50	0	30	50	50
Recruitment is about equal between internal (births) and external (immigration) recruitment	48	40	35	35	100	50	35	40
Most recruitment into the PCFG area results from internal recruitment	14	30	10	15	0	20	15	10
Nearly all recruitment into the PCFG area results from internal recruitment	0	0	0	0	0	0	0	0

Question 8.	Overall	A	B	C	D	E	F	G
	Do the genetic and photo-identification data indicate that the PCFG is a demographically independent population?							
Strongly Agree	0	0	0	0	0	0	0	0
Somewhat Agree	35	25	10	80	100	30	0	0
Neutral	21	50	30	10	0	40	20	0
Somewhat Disagree	25	25	50	10	0	30	40	20
Strongly Disagree	19	0	10	0	0	0	40	80

Question 9.	Overall	A	B	C	D	E	F	G
	Given all lines of evidence, is the PCFG a "population stock" under the agency's interpretation of the MMPA?							
Strongly Agree	14	0	0	0	100	0	0	0
Somewhat Agree	22	25	10	80	0	30	10	0
Neutral	21	50	30	10	0	40	20	0
Somewhat Disagree	24	25	50	10	0	30	35	20
Strongly Disagree	18	0	10	0	0	0	35	80

Question 10.	Overall	A	B	C	D	E	F	G
	Given that some whales identified in the WNP migrate through U.S. waters to Mexico, should a separate SAR be developed for the WNP?							
Yes	79	100	70	100	100	50	80	50
No	21	0	30	0	0	50	20	50

Question 11.	Overall	A	B	C	D	E	F	G
	Given the differences found in mtDNA and nDNA between Sakhalin Island (WNP) and ENP gray whales, is there a "population stock" within the WNP under the agency's interpretation of the MMPA?							
Strongly Agree	100	100	100	100	100	100	100	100
Somewhat Agree	0	0	0	0	0	0	0	0
Neutral	0	0	0	0	0	0	0	0
Somewhat Disagree	0	0	0	0	0	0	0	0
Strongly Disagree	0	0	0	0	0	0	0	0

12.2 Question outcomes and discussion

The outcomes of each question above are discussed below and follow the convention of using "percentage of total points" to describe the results. For example, in Question 1 the "strongly agree" category was allotted 53% of the total available TF points (370 points allotted/700 total points = 53%).

Question 1

The TF expressed general agreement, by allocating 100% of the their combined points to the categories "somewhat agree" (47%) and "strongly agree" (53%) that PCFG whales seasonally feed in a unique ecosystem that differs from other gray whale feeding areas in the Pacific. Therefore, the TF concurred that it is reasonable to consider that if the PCFG no longer existed and the region was not reoccupied via immigration, summer feeding gray whales would no longer be a functioning element of the coastal Pacific Northwest ecosystem. Although such a circumstance is plausible, keeping all other things equal (e.g., habitat, prey availability), the current lines of evidence from photo-identification studies suggest it is unlikely that the level of annual immigration into the PCFG in the past decade would cease. Thus, the likelihood of gray whales not being found in the PCFG area seems low. However, the time it might take for "recolonization" of the PCFG via immigration is undetermined and thereby puts into question whether this scenario would meet the MMPA objectives of maintaining stocks not only for ecological purposes but also for aesthetic, recreational and economic reasons.

Questions 2, 3 and 4
These three questions were meant to address the MMPA objective of maintaining population stocks as significant functioning elements in the ecosystem of which they are part, and that population stocks should not be permitted to decline below OSP. GAMMS II state that where mortality is greater than a PBR level calculated from the abundance for the region where human caused mortality (HCM) occurs, serious consideration should be given to identifying an appropriate management unit in the region. While estimates of PBR and HCM for a putative PCFG stock have been generated (Carretta *et al*. 2013), there is uncertainty about both estimates, especially with respect to: (1) whether HCM (e.g., ship strikes and fisheries bycatch) for whales in the PCFG area is indeed higher than for whales that migrate through the area, and (2) where HCM actually occurs. In response to these questions, the TF expressed increasing concern about the ability of the PCFG to be maintained above 60%[7] of its current abundance once HCM exceeded 5 whales per year.

The point allocation in Question 2 indicates that the TF overall tended to agree that the future abundance of PCFG gray whales would be maintained above 60% of their current abundance if annual HCM in the PCFG was 5. However, the relatively equal distribution of likelihood points in all categories except "strongly agree" indicates a high level of uncertainty among the TF.

For Question 3, points were allocated more broadly across categories, indicating a higher level of uncertainty among TF members as to whether the PCFG could sustain levels of HCM at 10 whales per year.

There was increased consensus among the TF for Question 4 in that none of them responded "strongly agree". Overall, the TF concurred that it somewhat (22%) or strongly disagreed (67%) that the future abundance of PCFG gray whales would be maintained above 60% of their current abundance if annual HCM in the PCFG was 20.

Question 5
The TF found no evidence to suggest that PCFG whales breed primarily with each other. While there was general agreement (63%) that the lack of significant differences found in nuclear DNA markers between PCFG whales and other ENP whales suggests random interbreeding among all ENP whales, the allotment of 37% of the total points to the intermediate category suggests TF members thought it was possible that some breeding segregation may exist based on migratory timing (see Lang *et al*. 2011) but there is no direct evidence presently available to support or further test this theory.

Question 6
The TF found no evidence in the results from genetics studies to suggest that nearly all recruitment into the PCFG area results from external recruitment (immigration). Based on the genetic data and simulations discussed during the workshop, the highest average TF response (56%) indicates that TF members believe recruitment is most likely about equal between internal (births) and external (immigration) recruitment. That being said, the remaining 45% of the total points were split between most recruitment into the PCFG area resulting from either internal or

[7] The management goal of the MMPA is to prevent populations from "depletion". NMFS considers a population depleted if it fall below its Maximum Net Productivity Level (MNPL). For marine mammals, this level is thought to be between 50% and 85% of carrying capacity and is more likely to be in the lower portion of that range (Taylor and DeMaster 1993). Therefore, populations are considered depleted by the U.S. government if they are directly estimated to be below their MNPL, or if they are estimated to be below 50%-70% of a historic population size which it thought to represent carrying capacity (Gerrodette and DeMaster 1990).

external recruitment, indicating some overall uncertainty among members regarding the presently available lines of evidence about recruitment in the PCFG. It should be noted that one member of the TF refrained from assigning any points to this question, so these results represent 6 of 7 TF members actively involved in the point assignment process.

Question 7
Based on the photo-identification data, the TF found no evidence to suggest that nearly all recruitment was either external or internal, but rather some combination of the two. As with the genetics evidence, the highest average TF response (48%) indicates that the TF felt recruitment from internal (births) and external (immigration) sources are comparable. That being said, 38% of the total points were allocated to most recruitment into the PCFG area resulting from external recruitment. Therefore, a majority of the total points were allocated to either recruitment being about equal between internal (births) and external (immigration) recruitment (48%) or most recruitment into the PCFG area results from external recruitment (38%). As was also true with the genetic lines of evidence, these results from the TF suggest a fairly high level of uncertainty regarding recruitment into the PCFG.

Question 8
Based on the genetic and photo-identification data, the TF did not strongly agree that the PCFG is a demographically independent population. Although the highest average TF response (35%) was "somewhat agree" that the PCFG is a demographically independent population, the combined categories of "somewhat disagree" and "strongly disagree" elicited 44% of the total points allocated. Overall, these results from the TF suggest a high level of uncertainty regarding recruitment in the PCFG.

Question 9
Given all lines of evidence, the point allocation of the TF reflects broad uncertainty as to whether the PCFG should be regarded as a population stock under the MMPA and GAMMS guidelines. Perhaps more than all of the other questions considered, Question 9 reflects the highest degree of uncertainty. For instance, the "strongly agree" (14%) and somewhat agree (22%) categories are almost perfectly counter-balanced by the "somewhat disagree"(24%) and "strongly disagree" (18%) categories. An additional level of uncertainty is indicated by the "neutral" category (21%). Given these results, it seems clear that TF was unable to reach a definitive response with respect to the PCFG being a population stock. That is, members of the TF ranged in their opinions from strongly agree to strongly disagree as to whether the PCFG should be considered a separate stock.

Given that this question represents the primary purpose of the workshop, the following two sections provide insight into the deliberations of the TF with regard to arguments for and against the PCFG being a demographically independent unit.

❖ *Arguments for the PCFG being a demographically independent unit*

The return of individual whales to specific feeding areas for as long as the PCFG has been studied (30+ years) strongly suggests that site fidelity is key to maintaining gray whales as a functioning element of this ecosystem. There was agreement that this ecosystem differs from other feeding ecosystems occupied by gray whales. Gray whales are unique among the great whales in being found in only a single ocean basin. Within this ocean basin the PCFG is the only feeding group that does not rely on the dynamics of a sub-arctic ecosystem. As such, the PCFG deserves the protections afforded by being an MMPA stock because the ecosystem role of these animals is unique and also because it provides gray whales, as a species, the flexibility they may need given potential challenges in a changing sub-arctic ecosystem.

Although there is evidence of recruitment from other feeding aggregations, there is also evidence of direct internal recruitment because calves have been shown to return to the PCFG area and reside there. Furthermore, because photographic efforts take place after most claves would be weaned, the recruits into the population not first seen as calves are actually of unknown origin and cannot be definitively assigned as external recruits.

PCFG whales show a low but significant level of genetic differentiation at the mtDNA control region when compared to samples collected in Chukotka [representative of the ENP population and sampled at a single feeding location in the Bering Sea], and when compared to a set of samples collected primarily from animals that stranded along the west coast of the U.S. [representative of a broader sampling of the ENP population]. The significant differences found when the mtDNA haplotype data from the PCFG is compared with that of groups representing the larger ENP population provide indirect evidence of internal recruitment and matrilineally-directed site fidelity to feeding grounds. The level of differentiation is on par with levels identified among humpback whales feeding in different areas of the western North Atlantic (Palsbøll *et al*. 2001) as well as humpback whales using different breeding grounds in the Southern Hemisphere (Rosenbaum *et al*. 2009), suggesting that the PCFG exhibits demographic independence similar to what has been inferred for other large whales. Within the western North Atlantic, humpback whales feeding in the Gulf of Maine are managed as a separate stock despite the fact that they share a common breeding ground with humpbacks feeding in other areas. Although evidence for nuclear DNA differentiation between PCFG whales and other areas has not been found, nuclear genetic differentiation has not always been required for stock delimitation. Pacific harbor seal stocks were delimited on mtDNA differentiation alone (nuclear data were not available at the time), while the Gulf of Maine/Bay of Fundy stock of harbor porpoises was delimited based on significant differentiation at mtDNA, contaminant loads, and life history differences, and despite a lack of differentiation at nuclear markers.

❖ ***Arguments against the PCFG being a demographically independent unit***

The evidence that external recruitment is not a rare event is quite strong. The genetic data have numerous rare haplotypes that are not consistent with a small, closed population. Indeed, simulations are not consistent with a closed population. A sizable number of individuals seen in the main feeding season are identified as transients, which is consistent with an on-going level of the main ENP population investigating this new habitat but then moving on. Further, when all samples collected in summer in the PCFG area are used there is not a significant difference found in mtDNA frequencies compared to all samples collected north of the Aleutian Islands. The number of recruits into the PCFG has been estimated, through genetic data, to be 4 to as high as 8 individuals per year. Photo-identification data suggest similarly high numbers of non-calf recruits per year (8-11). These numbers exceed the estimated number of internal recruits and, given that PCFG numbers appear to be relatively stable, an addition of 4 or more external recruits per year cannot be considered trivial. These external recruitment rates suggest the PCFG is not demographically independent from the larger ENP population.

Furthermore, unlike other large whale populations, the annual coastal migration of the vast majority of ENP gray whales brings most individuals into contact with the habitat used by the PCFG. Should there be increased removals from this area, the continual visitation to this area by a large number of gray whales would make it likely that external recruitment would increase to fill any voids. The apparent pulse recruitment in 1999-2000 when conditions in the sub-arctic feeding areas resulted in a large mortality event shows that gray whales can adapt to a new habitat when conditions dictate. Using data collected since 2002 (post-pulse recruitment event), an average of 29.3 new whales have been identified in summer in the area used by the PCFG, with 18.5 animals that are not seen in later years and 10.8 whales that are seen in later years. Given that an average of 18.5 new whales (at least, as this does not account for new whales not photographed) visit the PCFG area each summer but do not return, this suggests that something on the order of 10% of the whales that occur in the PCFG area each summer are transients that otherwise feed north of the Aleutians, and serve as a substantial and continuous source of potential recruitment into the PCFG.

To date, there is no evidence for nDNA differentiation between Chukotka and PCFG whales based on 8 microsatellite loci or between the PCFG and one Mexican calving lagoon based on 15 loci. These results may be interpreted as female directed site fidelity to the PCFG area coupled with random mating between PCFG and ENP whales on the breeding ground. Lack of nuclear differentiation diminishes support for demographic independence.

All lines of evidence (photo-identification and genetics) are consistent with ongoing external recruitment that could be at a magnitude that is not trivial to the persistence of the feeding aggregation (more than a percent or two per year). Uncertainty in the number of recruits per year and exactly who those recruits are (PCFG calves misidentified as recruits, true recruits of adults, temporary immigrants who do not stay more than a few years and may not even be contributing to the gene pool) creates significant uncertainty as to whether internal recruitment exceeds external recruitment. Given the high level of mtDNA haplotypic diversity, the precision of F_{ST} estimates is also uncertain. Taken together, the available evidence is weak for concluding the PCFG is demographically independent.

Question 10
Given that some whales identified in the WNP have been observed to migrate through U.S. waters to Mexico, in combination with the 1994 amendments to the MMPA requiring that SARs be published for all stocks of marine mammals in U.S. waters, the TF agreed to a high degree (79%) that a separate SAR should be developed in the future for the WNP stock of gray whales.

Question 11
Based on the differences found in mtDNA and nDNA between Sakhalin Island (WNP) and ENP gray whales, the TF unanimously (100%) agreed that it qualifies as a population stock under the MMPA and GAMMS guidelines.

13. Concluding Remarks

The implications of new data pertinent to stock structure, including considerable information related to the PCFG and WNP gray whales, were thoroughly reviewed during the workshop. Evaluating the new findings relevant to the status of the PCFG proved particularly complex. After review of results from photo-identification, genetics, tagging, and other studies within the context of the GAMMS guidelines there remains a substantial level of uncertainty in the strength of the lines of evidence supporting demographic independence of the PCFG. Consequently, the TF was unable to provide definitive advice as to whether the PCFG is a population stock under the MMPA and the GAMMS guidelines. Members of the TF ranged in their opinions from strongly agreeing to strongly disagreeing about whether the PCFG should be recognized as a separate stock.

In the case of WNP gray whales, the work of the TF was more straightforward. The mitochondrial DNA and nuclear DNA genetic differentiation found between the WNP and ENP stocks provided convincing evidence that resulted in the TF providing unambiguous advice that the WNP stock should be recognized as a population stock pursuant to the GAMMS guidelines and the MMPA.

Additional research may narrow the uncertainty associated with the question of whether the PCFG should be recognized as a population stock. To work towards this objective, the TF recommended further investigation of recruitment into the PCFG. Presently, both the photo-identification and genetics data indicate that the levels of internal versus external recruitment are comparable, but these are not quantified well enough to determine if the population dynamics of the PCFG are more a consequence of births and deaths within the group (internal dynamics) rather than related to immigration and/or emigration (external dynamics). The TF offered a number of research recommendations, using the existing photo-identification and genetics datasets, that could provide increased resolution on the issue of recruitment and, in turn, the question of stock identification.

While the need for additional data collection was apparent, especially with regard to recruitment into the PCFG, the purpose of the workshop was for the TF to determine whether the *existing* best available science was sufficient to advise that the PCFG be recognized as a population stock under the language of the MMPA and GAMMS guidelines. Therefore, the advice of the TF offered in this report should be viewed as a contemporary "snapshot" taken from an emerging and ever-changing body of knowledge regarding the PCFG.

The TF emphasizes that the PCFG is relatively small in number and utilizes a largely different ecosystem from that of the main ENP stock. While the status of the PCFG as a population stock has yet to be resolved, continued research on these whales should be undertaken with particular attention dedicated to collecting data relevant to the question of stock identification.

14. Acknowledgements

The Task Force appreciates the dedication and hard work of Aimee Lang and Annette Henry. Their contributions to the workshop and related report were indispensable. We also thank Lisa Ballance, Donna Darm, Jeremy Rusin, and Wayne Perryman for their advice and support in bringing the workshop to fruition. Jim Carretta and Steve Stone provided astute summaries of information that greatly benefitted the work of the Task Force. Cisco Werner and Kristen Koch provided encouragement for the workshop to be held and made available the facilities of the Southwest Fisheries Science Center. Barb Taylor kindly hosted a wonderful social gathering at her home.

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16. Appendix 1 – Workshop Agenda

GRAY WHALE STOCK IDENTIFICATION WORKSHOP AGENDA

Southwest Fisheries Science Center
La Jolla, California
31 July-2 August 2012

Day 1 (31 July 2012)

8:30-8:45
1. Introductory Items
1.1 Convenor's opening remarks (Ballance)
1.2 Arrangements for the meeting (Henry)
1.3 Appointment of chair, task force and rapporteurs
1.4 Adoption of agenda
1.5 Documents available

8:45-9:15
2. Workshop Objectives
2.1 Provide scientific advice on gray whale stock structure (Weller)
2.2 Workshop relationship to stock assessment reports (Carretta/Bettridge)
  2.2.1 Confirm current stock structure
  2.2.2 Assess new information on putative or prospective stocks
  2.2.3 Provide advice on necessary changes to stock structure
2.3 Workshop relationship to Makah waiver request (Darm/Stone)
  2.3.1 History
  2.3.2 Key considerations
  2.3.3 Current status of waiver request
  2.3.4 Need to know information

9:15-10:30
3. Working Group on Stock Identification (Bettridge and Moore)
3.1 Overview of MMPA language and GAMMS guidelines pertaining to stock definition (Moore)
  3.1.1 Existing GAMMS language
  3.1.2 Proposed GAMMS revisions from the GAMMS III workshop
3.2 Overview of recent history pertaining to NMFS interpretation of "interbreed when mature" (Bettridge/Beale)
  3.2.1 Draft GAMMS II language pertaining to "interbreed when mature"
  3.2.2 Status of current legal analysis of NMFS proposed definition
3.3 Additional relevant history concerning definition of "population" for marine mammals (e.g., Taylor 1997, excerpts from Eagle *et al.* 2008) (Moore/ Taylor)

BREAK 10:30-10:45

10:45-12:00
3.4 Current status of gray whale SAR development (Bettridge)
3.5 Discuss key concepts: interbreed when mature, population, demographic independence, functioning element of ecosystem
3.6 Proposed TF voting protocol and process: examples from FEMAT and the ESA (humpback whale BRT, false killer whale BRT) (Bettridge)

3.7. Proposed questions to be voted on by the Task Force

12:00-12:45

4. Working Group on Other Information (Weller and Brownell)

4.1 Overview of gray whale "population stocks" (Lang)
- 4.1.1 Eastern North Pacific Stock
- 4.1.2 Western North Pacific Stock
  - 4.1.2.1 Genetic lines of evidence as being a stock
  - 4.1.2.2 Movements of whales between the WNP and ENP

4.2 Brief overview of the Pacific Coast Feeding Group (PCFG) putative stock (Lang)
- 4.2.1 History
- 4.2.2 Range
- 4.2.3 Abundance
- 4.2.4 Diet
- 4.2.5 Movements (tagging, photo-ID)
- 4.2.6 Incidental Take (Carretta)
- 4.2.7 Emerging issues and areas of uncertainty
  - 4.2.7.1 Probability of a WNP Being Taken by the Makah (Moore)

4.3 Status of the ENP, WNP and PCFG as stocks (NMFS/MMPA/ESA/IWC) (Stone)

4.4 Proposed questions to be voted on by the Task Force

LUNCH 12:45-1:30

13:30-14:15

5. Working Group on Genetic Population Structure (Taylor and Rosel)

5.1 Broad overview of evidence used in recently defined stocks (Stone)

5.2 Review of stock definition cases relevant to the PCFG case
- 5.2.1 Atlantic harbor porpoises (Rosel)
- 5.2.2 Alaska harbor seals (Taylor)
- 5.2.3 Humpback whales (Lang)

14:15-15:00

5.3 Review of gray whale genetic research relating to population structure (Lang)
- 5.3.1 Summary of early work (LeDuc, Ramakrishnan, Alter breeding lagoon)
- 5.3.2 Summary of recent work
  - 5.3.2.1 Frasier and D'Intino
  - 5.3.2.2 Lang – empirical genetics
  - 5.3.2.3 Lang – modeling genetics

5.4 Proposed questions to be voted on by the Task Force

BREAK 15:00-15:30

15:30-17:00

6. Discussion of Documents Drafted by the Makah Tribe and Other General Matters (Task Force)

6.1 Makah Tribe documents (Weller)
- 6.1.1 Introduce GWLJ33: "Is the Pacific feeding group of gray whales a "population stock" within the meaning of the Marine Mammal Protection Act?"
- 6.1.2 Introduce GWLJ32: "Comments on Draft 2012 Stock Assessment Report for eastern North Pacific stock of gray whales"
- 6.1.3 Introduce GWLJ34: "What is the PCFG? A review of available information"
- 6.1.4 Discuss genetics sections of Makah Tribe document GWLJ33 (Taylor/Rosel)

6.2 General discussion of Day 1 information

Day 2 (1 August 2012)

9:00-10:30
7. Working Group on Population Abundance and Trends (Laake and Wade)
7.1 Photo-identification and population dynamics of the PCFG (Laake)
- 7.1.1 Definition of PCFG whales based on timing/area
- 7.1.2 Movements of know PCFG whales (photo-identification and telemetry)
- 7.1.3 Abundance/survival estimates
- 7.1.4 Trends (Wade)
- 7.1.5 Recruitment
- 7.1.6 PCFG Trend/OSP (Moore)
- 7.1.7 Discuss photo-identification and telemetry sections of Makah Tribe document GWLJ33 (Laake/Wade)

7.2 Proposed questions to be voted on by the Task Force

BREAK 10:30-11:00

11:00-12:30
8. Review and Agree on Workshop Questions for Voting

LUNCH 12:30-13:30

13:30-15:30
9. Description of Vote Procedure (Bettridge)
10. TF Voting on Workshop Questions (TF Only)

Overnight
11. Compile and Tally Votes (Lang/Henry)

Day 3 (2 August 2012)

9:00-12:00
12. Review of Vote Outcomes (Lang/Henry)
13. Discussion of Vote Outcomes
14. Revision of Questions for voting if Necessary
15. Revote if Necessary

LUNCH 12:00-13:30

13:30-16:30
16. Review of Revote Results if Necessary (Lang/Henry)
17. Other Business
18. Workplan for Workshop Report Completion
19. Adjourn

17. Appendix 2 - Workshop Document List

GWLJ01

Moore, J. E., and Merrick, R., eds. *Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS III Workshop, February 15 – 18, 2011, La Jolla, California*. Dept. of Commerce, NOAA Technical Memorandum NMFS-OPR-47.

GWLJ02

Andrews, K. R., Karczmarski, L., AU, W. W. L., Rickards, S. H., Vanderlip, C. A., Bowen, B. W., Grau, E. G., and Toonen, R. J. (2010), Rolling stones and stable homes: social structure, habitat diversity and population genetics of the Hawaiian spinner dolphin (*Stenella longirostris*). Molecular Ecology **19**: 732–748.

GWLJ03

Chivers, S. J., Dizon, A. E., Gearin, P. J., and Robertson, K. M. 2002. Small-scale population structure of eastern North Pacific harbour porpoises (*Phocoena phocoena*) indicated by molecular genetic analyses. Journal of Cetacean Research and Management **4**: 111–122.

GWLJ04

Courbis, S. S. 2011. Population Structure of Island-Associated Pantropical Spotted Dolphins (*Stenella attenuata*) in Hawaiian Waters. PhD Thesis, Portland State University, Oregon.

GWLJ05

Taylor, B. L. 2005. Identifying Units to Conserve. In: J. E. Reynolds III, W. F. Perrin, R. R. Reeves, S. Montgomery, and T. J. Ragen, eds. *Marine Mammal Research: Conservation beyond Crisis*. The John Hopkins University Press, Baltimore, MD.

GWLJ06

Carretta, J. V., Oleson, E., Weller, D. W., Lang, A. R., Forney, K. A., Baker, J., Hanson, B., Martien, K. Muto, M. M., Lowry, M. S., Barlow, J., Lynch, D., Carswell, L., Brownell Jr., R. L., Mattila, D. K., and Hill, M. C. *In press*. DRAFT: Gray whale (*Eschrichtius robustus*): Eastern North Pacific Stock and Pacific Coast Feeding Group. In: U.S. Pacific Marine Mammal Stock Assessments: 2012. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-XXX.

GWLJ07

Lang, A. R. 2010. The population genetics of gray whales (*Eschrichtius robustus*) in the North Pacific. PhD Thesis, University of California, San Diego, California.

GWLJ08

N/A

GWLJ09

Pyenson N. D., and Lindberg, D. R. 2011. What Happened to Gray Whales during the Pleistocene? The Ecological Impact of Sea-Level Change on Benthic Feeding Areas in the North Pacific Ocean. PLoS ONE **6**: e21295. doi:10.1371/journal.pone.0021295.

GWLJ10

Spalding, M. D., Fox, H. E., Allen, G. R., Davidson, N., Ferdana, Z. A., Finlayson, M. A. X., Halpern, B. S., Jorge, M. A., Lombana, A., Lourie, S. A., Martin, K. D., McManus, E., Molnar, J., Recchia, C. A., and Robertson, J. 2007. Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. BioScience **57**: 573-583.

GWLJ11

Calambokidis, J., Laake, J. L., and Klimek, A. 2010. Abundance and population structure of seasonal gray whales in the Pacific Northwest, 1998-2008. Paper SC/62/BRG32 presented to the IWC Scientific Committee.

GWLJ12

N/A

GWLJ13

Oleson, E. M., Boggs, C. H., Forney, K. A., Hanson, M. B., Kobayashi, D. R., Taylor, B. L., Wade, P. M. and Ylitalo, G. M. 2010. Status review of Hawaiian insular false killer whales (*Pseudorca crassidens*) under the Endangered Species Act. U. S. Dept Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-22.

GWLJ14

NMFS. 2005. Revisions to Guidelines for Assessing Marine Mammal Stocks. 24 pp. Available at: *http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf*.

GWLJ15

Eagle, T. C., Cadrin, S. X., Caldwell, M. E., Methot, R. D., Nammack, M. F. 2008. Conservation Units of Managed Fish, Threatened or Endangered Species, and Marine Mammals Report of a Workshop: February 14-16, 2006 Silver Spring, Maryland. U. S. Dept of Commerce, NOAA Technical Memorandum NMFS-OPR-37.

GWLJ 16

Taylor, B. L. 1997. Defining "Population" to Meet Management Objectives for Marine Mammals. Molecular Genetics of Marine Mammals **3:** 49-65.

GWLJ17

DRAFT Status Review of the Humpback Whale under the Endangered Species Act (confidential)

GWLJ18

Lang, A. R., Weller, D. W., LeDuc, R., Burdin, A. M., Pease, V. L., Litovka, D., Burkanov, V., and Brownell Jr., R. L. 2011. Genetic analysis of stock structure and movements of gray whales in the eastern and western North Pacific. Paper SC/63/BRG32 presented to the IWC Scientific Committee.

GWLJ19

Lang, A. R., Taylor, B. L., Calambokidis, J. C., Pease, V. L., Klimek, A., Scordino, J. Robertson, K. M., Litovka, D., Burkanov, V., Gearin, P., George, J. C., and Mate, B. 2011. Assessment of stock structure among gray whales utilizing feeding grounds in the Eastern North Pacific. Paper SC/M11/AWMP4 presented to IWC Scientific Committee.

GWLJ20

Lang, A. R. and Martien, K. K. 2012. Update on the use of a simulation-based approach to evaluate plausible levels of recruitment into the Pacific Coast Feeding Group of gray whales. Paper SC/64/AWMP4 presented to IWC Scientific Committee.

GWLJ 21

Alter, S. E., Rynes, E., and Palumbi, S. R. 2007. DNA evidence for historic population size and past ecosystem impacts of gray whales. Proceedings of the National Academy of Sciences **104**: 15162-15167.

GWLJ22

Alter, S. E., Ramirez, S. F., Nigenda, S., Ramirez, J. U., Bracho, L. R., and Palumbi, S. R. 2009. Mitochondrial and nuclear genetic variation across calving lagoons in eastern North Pacific gray whales (*Eschrichtius robustus*). Journal of Heredity **100**: 34-46.

GWLJ23

Alter, S. E., Newsome, S. D., and Palumbi, S. R. 2012. Pre-whaling genetic diversity and population ecology in eastern Pacific gray whales: insights from ancient DNA and stable isotopes. PLoS ONE **7**:e35039. doi: 10.1371/journal.pone.0035039.

GWLJ24

D'Intino, A. M., Darling, J. D., Urbán-Raminez, J., and Frasier, T. R. 2012. Substructuring of mitochondrial, but not nuclear, markers in the "southern feeding group" of eastern North Pacific gray whales. Paper SC/64/AWMP2 presented to IWC Scientific Committee.

GWLJ25

Frasier, T. R., Koroscil, S. M., White, B. N., & Darling, J. D. 2011. Assessment of population substructure in relation to summer feeding ground use in the eastern North Pacific gray whale. Endangered Species Research **14**: 39-48.

GWLJ 26

Goerlitz, D. S., Urbán, J., Rojas-Bracho, L., Belson, M., and Schaeff, C. M. 2003. Mitochondrial DNA variation among Eastern North Pacific gray whales (*Eschrichtius robustus*) on winter breeding grounds in Baja California. Canadian Journal of Zoology, 81: 1965-1972.

GWLJ27

Lang, A. R., Weller, D. W., LeDuc, R. G., and Burdin, A M. 2010. Delineating Patterns of Male Reproductive Success in the Western Gray Whale (*Eschrichtius robustus*) Population. Paper SC/62/BRG10 presented to IWC Scientific Committee.

GWLJ28

LeDuc, R. G., Weller, D. W., Hyde, J., Burdin, A. M., Rosel, P. E., Brownell Jr., R. L., Würsig, B., and Dizon, A. E. 2002. Genetic differences between western and eastern North Pacific gray whales (*Eschrichtius robustus*). Journal of Cetacean Research and Management **4**: 1-6.

GWLJ29

Ramakrishnan, U., & Taylor, B. L. (2001). Can gray whale management units be assessed using mitochondrial DNA? Journal of Cetacean Research and Management **3:** 13-18.

GWLJ30

Ramakrishnan, U., LeDuc, R. G., Darling, J., Taylor, B. L., Gearin, P., Gosho, M., Calambokidis, J., Brownell Jr., R. L., Hyde, J., and Steeves, T. E. 2001. Are the southern feeding group of Eastern Pacific gray whales a maternal genetic isolate? Report of the International Whaling Commission SC53/SD8.

GWLJ31

Steeves, T. E., Darling, J. D., Rosel, P. E., Schaeff, C. M., and Fleischer, R. C. 2001. Preliminary analysis of mitochondrial DNA variation in a southern feeding group of eastern North Pacific gray whales. Conservation Genetics **2**: 379-384.

GWLJ32

Makah 2012. Comments on Draft 2012 Stock Assessment Report for the Eastern North Pacific Stock of Gray Whales (Revised 11/1/2011) - Submitted by the Makah Indian Tribe on January 17, 2012

GWLJ33

Makah 2011. Is the Pacific Coast Feeding Group of Gray Whales a "Population Stock" within the Meaning of the Marine Mammal Protection Act? A Preliminary Analysis by the Makah Indian Tribe, October 5, 2011. PCFG Stock Status Memo from Makah Indian Tribe 10-5-2011; PSRG-2011-B13.

GWLJ34

Scordino, J., Bickham, J., Brandon, J., and Ammajian, A. 2011. What is the PCFG? A review of available information. Paper SC/63/AWMP1 presented to IWC Scientific Committee.

GWLJ 35

Brandon, J. R., Scordino, J., Butterworth, D. S., Donovan, G. P., and Punt, A. E. 2012. Towards the Selection of a Final Set of Trials for the 2012 ENP Gray Whale Implementation Review. Paper SC/64/AWMP11 presented to IWC Scientific Committee.

GWLJ 36

Ford, J. K., Durban, J. W., Ellis, G. M., Towers, J. R., Pilkington, J. F., Barrett-Lennard, L. G., and Andrews, R. D. 2012. New insights into the northward migration route of gray whales between Vancouver Island, British Columbia, and southeastern Alaska. Marine Mammal Science. doi: 10.1111/j.1748-7692.2012.00572.x

GWLJ37

Gosho, M., Gearin, P., Jenkinson, R., Laake, J., Mazzuca, L., Kubiak, D., Calambokidis, J., Megill, W., Gisborne, B., Goley, D., Tombach, C., Darling, J., and Deecke, V. 2011. Movements and diet of gray whales (*Eschrichtius robustus*) off Kodiak Island, Alaska, 2002-2005. Paper SC/M11/AWMP2 presented to IWC Scientific Committee.

GWLJ38

Mate, B., Bradford, A., Tsidulko, G., Vertyankin, V., and Ilyashenko, V. 2011. Late-Feeding Season Movements of a Western North Pacific Gray Whale off Sakhalin Island, Russia and Subsequent Migration into the Eastern North Pacific. Paper SC/63/BRG23 presented to IWC Scientific Committee.

GWLJ39

Punt, A. E. 2012. Revised ENP Gray Whale Trials and Initial Conditioning Results. Paper SC/63/AWMP presented to IWC Scientific Committee.

GWLJ40

Baird, R. W., Stacey, P. J., Duffus, D. A., and Langelier, K. M. 2002. An evaluation of gray whale (*Eschrichtius robustus*) mortality incidental to fishing operations in British Columbia, Canada. Journal of Cetacean Research Management **4**: 289–296.

GWLJ41

Conner, L., Stelle, L. L., Najera-Hillman, E., Megill, W., Calambokidis, J., and Klimek, A. 2011. Using Photo ID to Examine Injuries in Eastern Pacific Gray Whales (*Eschrichtius robustus*). Poster presentation, 20th Biennial Conference on the Biology of Marine Mammals, Tampa, Florida.

GWLJ42

International Whaling Commission. 2011. Report of the 2011 AWMP Workshop with a focus on eastern gray whales. Paper SC/63/Report 2 presented to the IWC Scientific Committee.

GWLJ43

International Whaling Commission. 2012. Report of the AWMP Workshop focussing on the PCFG gray whale Implementation Review. Paper SC/64/Report 3 presented to the IWC Scientific Committee.

GWLJ44

International Whaling Commission. 2012. Report of the Scientific Committee, Panama City, Panama, 11-23 June 2012. Paper IWC/64/Report 1, Revision 1.

GWLJ45

International Whaling Commission. 2012. Annex E: Report of the Scientific Committee: International Whaling Commission, Panama City, 2012. Paper IWC/64/Report 1 Annex E.

GWLJ46

O'Corry-Crowe, G. M., Martien, K. K., and Taylor, B. L. 2003. The analysis of population genetic structure in Alaskan harbor seals, *Phoca vitulina*, as a framework for the identification of management stocks. Southwest Fisheries Science Center Administrative Report LJ-03-08.

GWLJ47

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GWLJ48

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