

Science

Sciences

ADVICE RELEVANT TO THE IDENTIFICATION OF CRITICAL HABITATS FOR NORTH PACIFIC HUMPBACK WHALES (MEGAPTERA NOVAEANGLIAE)

Context

Humpback Whales were listed in 2005 as 'threatened' under the Species at Risk Act (SARA), based on a re-assessment of species status by the Committee on the Status of Wildlife in Canada (COSEWIC) (Baird 2003). A recovery strategy for the North Pacific population is currently under development and was legally required by January 2009. Under SARA, a recovery strategy must identify a threatened species' Critical Habitat¹ to the extent possible. based on the best available information. In order to complete the draft Recovery Strategy for North Pacific Humpback Whales in Canada (DFO (Fisheries and Oceans Canada) 2009) an analysis of available information on important habitat(s) for humpbacks in British Columbia (B.C.) is required to assist formal identification of SARA Critical Habitat in the Recovery Strategy. Science advice was requested by DFO Resource Management to identify habitat that may be critical to the recovery of Humpback Whales in B.C. waters. As a result, a draft DFO Research Document was prepared (Nichol et al. 2009) and a Special Science Response (SSR) meeting was conducted to provide the necessary peer-reviewed information for consideration by the Recovery Team and in preparation for regional consultation on the Recovery Strategy. This report summarizes information presented in the draft Research Document in association with discussion points and conclusions from the review.

A national advisory meeting was held via conference call on September 30, 2009. Objectives were to: (1) review the draft working paper "Assessment of critical habitats of North Pacific Humpback Whales in British Columbia" L. Nichol, R. Abernethy, L. Flostrand, T. Lee, J. K. B. Ford; (2) generate Science advice regarding information relevant to the identification of Critical Habitat in support of the recovery goals and objectives as set out in the draft Humpback Whale Recovery Strategy; and (3) finalize a map of critical habitat to include in the recovery strategy. Discussion at the outset of the meeting focused on context and DFO Science's role in providing science advice regarding habitat(s) essential for the survival or recovery of a species versus identifying SARA Critical Habitat to Resource Management. As the Recovery Team is responsible for identifying Critical Habitat boundaries in the Recovery Strategy, the third objective was omitted from this SSR meeting.

¹ SARA states that Critical Habitat is "habitat that is necessary for the survival or recovery of a listed species and that is identified as the species' critical habitat in the recovery strategy or action plan for the species"



Background

A Recovery Potential Assessment (RPA) for North Pacific Humpback Whales was reviewed at the 2008 National Marine Mammal Peer Review meeting in Nanaimo, B.C. (Ford et al. 2009). The RPA did not assess critical habitats but described, in general, important areas which warranted further investigation as SARA Critical Habitat.

In January 2009, a meeting of experts in the field of Humpback Whale research was convened to critique information presented in the draft Recovery Strategy for North Pacific Humpback Whales (DFO 2009), such as species information and key threats, to ensure it incorporated all available knowledge and addressed priority research, management and other actions to promote recovery of North Pacific humpbacks in Canadian waters. Discussions included available data and important habitats in B.C. Based on weight of evidence from the data and information presented, participants felt it was clear that there are predictable, seasonal aggregations of Humpback Whales and four areas were identified for further analysis to support Critical Habitat identification (Fisheries and Oceans Canada Humpback Whale Recovery Planning Workshop, Nanaimo, B.C., January 12-14, 2009).

Analysis

Summary of Nichol et al. (2009)

Humpback Whales are a migratory species that spend winters at subtropical and tropical breeding grounds and spend spring through fall at higher latitude foraging grounds. Waters off the coast of B.C. represent part of these higher latitude feeding areas for North Pacific humpbacks, with whales feeding on dense patches of prey, such as zooplankton and small fish. Humpback Whales experience relatively low rates of predation thus are primarily limited by "bottom up" ecological processes such as prey limitation (Ford and Reeves 2008).

As such, analysis of Humpback Whale occurrence in B.C. should emphasize that habitat use is primarily for the purposes of foraging.

The most recent population estimate for the number of humpbacks in B.C. waters (in 2006) is 2,145 (1,970-2,331) and the number of humpbacks in B.C. is estimated to be increasing at 4.1% (95% confidence limits 3.9 - 5.1%) per year (Ford et al. 2009).

Initial identification of important areas for humpbacks in B.C. was made by examining the occurrence and distribution of Humpback Whales from photo-identification, visual survey data and incidental sightings collected over the past two decades. Although there is widespread occurrence of Humpback Whales on the B.C. coast, areas with relatively high concentrations of animals are apparent (Figure 1). Survey efforts have not been consistent throughout B.C. and the variability in survey efforts limits many types of broad scale analyses. Survey efforts have mostly been focussed in regions of known high occurrence. There are four areas where relatively high concentrations of animals have persisted over many years: (a) around Langara Island, (b) off the southeastern side of Moresby Island (and Kunghit Island), (c) mainland channels around Gil Island (and Gribbell Island), and (d) off southwest Vancouver Island (Figure 2). These four areas will hereafter be referred to as Langara Island, Southeast Moresby, Gil Island and Southwest Vancouver Island. B.C. whaling records also suggest that these and other

coastal areas may have been important feeding areas historically (CRP-DFO unpubl. data). Despite being incomplete, these records show that humpbacks were encountered in the four areas identified in Figure 2 at least as early as the 1920's and as late as the 1950s and '60s.

Once these areas were identified analyses of data were conducted to delineate these four important areas and to quantify Humpback Whale occurrence patterns within them. Data collection methods employed were photo identification, line transect and small vessel surveys and acoustic monitoring. Photo identification data were used to derive comparable abundance estimates for the four areas, to examine patterns of annual occurrence and to investigate site fidelity and movements among areas. As described in Ford et al (2009), the minimum number alive (MNA) is a conservative abundance estimate that accounts only for the number of individuals seen with an annual adjustment for survival. MNA abundance was calculated for each area based on photo-identified animals (1992 to 2006) and compared to the total MNA of 1,620 whales in 2006 for the B.C. coast (Ford et al. 2009). Line transect survey data from DFO ships in Southeast Moresby Island and Gil Island areas were used to compare sighting densities to all areas of the coast surveyed; however, there were insufficient data from Langara Island and Southwest Vancouver Island areas to make similar comparisons. Small vessel survey data were available and were used to compare seasonal sighting rates in the Gil Island area only. Acoustic monitoring data were only available for the Langara Island and Gil Island areas and were used to investigate seasonal patterns of occurrence.

Although it would be desirable to link observed concentrations of Humpback Whales to habitat features, that task is impossible with the current breadth and resolution of available data. The primary forcing mechanisms affecting the physical oceanographic environment of the four candidate areas are winds, tidal currents, buoyancy fluxes and effects from freshwater runoff, seasonal down-welling and upwelling processes and bathymetric features. In all four candidate areas, seasonal variations in biotic productivity are linked to fluxes in nutrients and daylight. In spring, when many marine invertebrate species spawn, total zooplankton numbers increase following increasing trends of phytoplankton abundance. The interactions of water movements (from tides, current and atmospheric weather) with local topographic features can increase the availability of plankton to species higher up in the food chain by bringing plankton closer to the surface, concentrating them at converging water masses or in eddies, or by attracting plankton to regions of higher productivity. Euphausiids, which are known to be important zooplankton prey in Humpback Whale diets, concentrate in coastal areas and in fjords in association with oceanographic processes (Simard and Mackas 1989).

Although no studies have yet been undertaken to document the degree of Humpback Whale foraging on small fishes in B.C., recent sightings of forage interactions with Pacific herring and Pacific sardine have been common (Cetacean Research Program (CRP)-DFO unpubl. data). Observations from all four candidate areas include observations of flick and lunge feeding on euphausiids (*Euphausia pacifica* and *Thysanoessa spinifera*) and in areas of Gil Island and Langara Island, foraging on fishes has been observed as cooperative bubble-net feeding, a behaviour associated with feeding on schooling fish (CRP-DFO unpubl. data). The absence of incidental observations of foraging on fish in the Southeast Moresby Island and Southwest Vancouver Island area should not be taken to imply that fish are not sought and preyed upon in these areas.

A summary of findings by area (as depicted in Figure 2) from the relevant analyses undertaken follows.

Langara Island

- A total of 629 individual whales have been identified in this area and Humpback Whales have been encountered in every year (1992 to 2007).
- Using MNA results (compiled up until 2006), 597 animals were identified in this area, which represents approximately 37% of the comparable B.C. coast-wide MNA.
- While sightings and photo-identification data indicated that Humpback Whales were present spring through summer, acoustic monitoring of the region from a shore-based hydrophone installation revealed that Humpback Whales continued to be present through the fall and winter with numbers dropping off dramatically in February (corresponding to the migration of animals to lower latitude breeding grounds).

Southeast Moresby Island

- A total of 531 individual whales have been identified in this area (1992 to 2007).
- Using MNA results (compiled up until 2006), 403 animals were identified in this area, which represents approximately 25% of the comparable B.C. coast-wide MNA.
- A comparison of individuals per 100 km of line transect survey effort indicated that whale densities were consistently higher in this area in spring (seven spring surveys) than over all areas surveyed on the coast; results were significant. Sighting rates during summer (six surveys) were still higher in the Southeast Moresby Island area than coast wide but not significantly so.

Gil Island

- A total of 172 individual whales have been identified in this area (1997 to 2008).
- Using MNA results (compiled up until 2006), 116 animals were identified in this area, which represents approximately 7% of the comparable B.C. coast-wide MNA.
- Sightings data from DFO ship-based line transect surveys from 2002 to 2008; indicated that the density of Humpback Whales was somewhat higher during four fall surveys in the Gil Island area although not significantly different from the sighting rate computed from all areas surveyed in fall.
- Using data from small vessel surveys in this area, the mean density of individuals increased significantly from spring to fall. The mean fall density was 11.26/100km, similar to the density from the DFO ship-based fall surveys in the area (14.23/100km).
- This area, and its usage by Humpback Whales, is distinctive as it is a fjord-like habitat and appears to be used predominantly in the late season.
- Williams and Thomas (2007) reported Humpback Whale sightings in this area but few or no sightings in other mainland inlets and channels they surveyed.

Southwest Vancouver Island

- A total of 247 individual whales have been identified in this area (1992 to 2007).
- Using MNA results (compiled up until 2006), 208 animals were identified in this area, which represents approximately 13% of the comparable B.C. coast-wide MNA.

 Recent genetic and photo-identification research provides evidence for two subpopulations of humpbacks in B.C. with one sub-population occupying southern B.C. waters including the Southwest Vancouver Island area (Urban et al. 2000, Calambokidis et al. 2008, Ford et al. 2009). Based on photo-identification matches, 87% of Humpback Whales that forage in areas of B.C. north of southwest Vancouver Island return to winter breeding grounds in Hawaii, whereas whales encountered off southwest Vancouver Island are equally likely to be destined for breeding grounds off Mexico and as they are to breeding grounds in Hawaii (Urban et al. 2000, Rambeau 2008). Differences in frequencies of mitochondrial DNA haplotypes between animals wintering in Hawaii and those wintering in Mexico support the photo-identification results (Baker et al. 1998). Further DNA analyses to better elucidate the genetic population structure in the North Pacific are in progress.

Photo identification data were analyzed to determine the rate of inter-matches (movement) between areas. Rates of inter-matches were low. The highest percentage of inter-matches was between Langara Island and Southeast Moresby Island areas; the lowest percentages were with Southwest Vancouver Island which is furthest from the other three candidate areas (Figure 2). The median distance between initial and subsequent year sightings of photo-identified humpbacks in B.C. is 75 km, which indicates very high site fidelity to feeding areas across years (Ford et al. 2009). Humpback Whales in other areas also show considerable site fidelity to feeding areas (Whitehead and Carscadden 1985, Piatt et al. 1989).

SARA protects the residences of threatened or endangered species from harm or damage. The concept of 'residence' as defined in *SARA*², does not apply to Humpback Whales as this species has no known dwelling-place in B.C., similar to a nest or den. Therefore no attempt was made to identify residences for humpbacks in B.C.

General Discussion

Reviewers sought clarification on the method by which the four areas were selected and the procedure used to delineate the polygon boundaries of each area, and suggested that these data be described fully. Modeling to analyze humpback occurrence and oceanographic processes and physical characteristics of habitat were initially suggested as an objective approach to identifying areas and delineating boundaries.

It was noted, that Humpback Whales feed on a variety of prey species, are highly adaptable in terms of diet, and are known to forage in a wide variety of habitat types (e.g. fjords, open ocean, nearshore). This makes determining linkages between prey and Humpback Whale presence challenging. Further discussion indicated that modeling or mapping of euphausiid (or other prey) distribution and abundance in relation to baleen whales has not yet proven an effective approach to identifying small scale areas of importance. Instead patterns in sightings of whales have generally proven a more accurate predictor of future occurrences when examined in other jurisdictions. With regard to modeling whale density, it was acknowledged that systematic coast wide whale survey data (line transect and photo-identification) was not available for analysis. It was also acknowledged that DFO's line transect effort (initiated in 2002) has focused on known areas of importance rather than systematic line transect coverage of all coastal areas; a well recognized and resource intensive survey method. It was acknowledged that the four areas

² a dwelling-place, such as a den, nest or other similar area or place that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding, or hibernating.

identified are known "hotspots". There may be other areas of importance to humpbacks but this does not diminish the importance of the four areas analyzed. Participants discussed data biases which resulted from unequal survey effort across the B.C. coast. Clarification of methods used to highlight and focus only on the four candidate areas chosen as well as uncertainties and data limitations were acknowledged and will be clarified in the Research Document. The limitations to obtaining full survey coverage of the B.C. coast were recognized. It was acknowledged that the data analyzed and presented was the best currently available and the approach used to identify the four areas was acceptable.

The boundaries of each area were drawn to capture the majority of sightings from DFO line transect and long-term photo-identification data as well as areas of high occurrences reported in published literature; an approach that statistical analysis would be unlikely to substantially improve upon. It was further noted that previous assessment of Resident Killer Whale Critical Habitat also utilized sightings data in this way to delineate boundaries (Ford 2006). Therefore, it was agreed that mapping of the four polygons including boundary lines (Figures 2 and 3) would be retained in the science advice. Reviewers discussed and acknowledged that it was not possible at this time to define the specific biological and physical characteristics of the habitat in the four areas that support prey, but that the review (provided in the Research Document) of existing information on oceanographic and biological processes in the vicinity of each area was useful.

The strength of the data in support of the Gil Island area compared to the other areas was discussed. The relatively low percentage of the B.C. population which has been encountered in the Gil Island area (7%), and lack of statistical difference in density of animals seen on DFO line transects in the area compared to that measured from all surveyed B.C. regions was discussed. Although the Gil Island area has not been occupied by a relatively large proportion of the population, the area appears to be somewhat unique as a late season feeding habitat.

Existence of sub-populations within the North Pacific humpback population was discussed with respect to the relative importance of the Southwest Vancouver Island area. Mitochondrial DNA haplotype patterns for humpbacks feeding along the Canadian and U.S. west coast indicate genetically distinct feeding stocks (Baker et al. 1998). Currently, there is insufficient information to delineate a specific geographic boundary between sub-populations. Preliminary data suggests a diffuse sub-population division may exist somewhere off northern Vancouver Island (Ford et al. 2009). At this time, Humpback Whales in Canada are recognized as a single population under SARA. This information does not affect COSEWIC's formally recognized single designatable unit (Baird 2003). However, it was acknowledged that information supporting distinct population subunits provides strong evidence in support of the Southwest Vancouver Island area as important or critical foraging habitat. It was noted by the reviewers that there is potential for changes in U.S. stock assessment approach and management of humpbacks with respect to distinct regional sub-populations. This was discussed as context, or weight of evidence, for the importance of these genetic data in the critical habitat assessment. The importance of the genetic information for consideration of critical habitat was acknowledged.

It was agreed that all four areas, including the boundaries as presented, should be included in the science advice for consideration as Critical Habitat under *SARA*.

Conclusions

The meeting participants endorsed the conclusions of the draft Research Document and agreed that the information presented on the four candidate areas was the best available at this time for Humpback Whales in B.C. Furthermore, there was consensus among participants that all four areas should be presented in the science advice on critical habitat. Several revisions to the Research Document were recommended, including three main points; adding more information to clarify the manner in which the areas were identified (and others rejected), describing the variability, bias and limitations of each of the data sets used and how this limits some analytical approaches, and adding more information about threats to habitat.

The following main conclusions presented in the draft Research Document were generally endorsed by the meeting participants.

- 1. It is expected that the areas outlined in this document comprise a portion of important habitats for the population while in B.C., and in future additional regions of important habitat may be identified both within Canada and in international waters as data gaps are addressed. Humpback Whale habitat use in B.C. is primarily for the purpose of foraging. Habitat features of foraging grounds include oceanographic processes which support high annual primary productivity, including tidal mixing, eddies, upwelling, wind- and wave-driven currents, and complex coastal areas (bathymetry). These processes vary among the candidate areas, but likely support secondary productivity within each area. A direct linkage between these processes and the annual presence of humpbacks within each of the four areas has yet to be clarified, and is likely to take many years. Therefore, at this time there is insufficient information to further specify physical or biological habitat features which may contribute to local humpback occurrences within the four areas analyzed.
- 2. Over half of all whales photo-identified in B.C. have been encountered in the Langara and Southeast Moresby candidate areas. Sighting rates from DFO line transect surveys indicated that Southeast Moresby had a significantly higher sighting rate than all areas of the coast surveyed in spring. While a lower proportion of the photo-identified animals have been encountered in the southwest Vancouver Island area, this area appears to meet requirements for Critical Habitat designation due to growing evidence of distinct local sub-populations of humpbacks. This recent information increases the relative importance of this candidate area as it represents the only candidate area for Humpback Whales that occupy southern B.C. and northern Washington waters. Humpback Whales appear to use the Gil Island area predominantly in the late summer and fall. This area is also quite distinctive as the only fjord-like candidate area which may be used more than other mainland inlets and may have been important historically as well, based on whaling records.
- 3. In general, Humpback Whales show considerable site fidelity to feeding grounds. Almost three-quarters of the Humpback Whales photo-identified in B.C. have been encountered in these four areas. Low rates of inter-matches among the candidate areas suggests that each area supports different parts of the population, indicating that collectively these candidate critical habitats may support a substantial portion of B.C.'s Humpback Whale population at this time. Thus factors influencing the habitat of these areas would have the potential to affect a large proportion of the Canadian Pacific humpback population.
- 4. Considering that the precautionary approach is required to address recovery of threatened species, and that analysis of the four areas utilized the best available information at this time, it appears that all four areas presented meet the definition of Critical Habitat under

Canada's *Species at Risk Act.* The Recovery Team should consider all four areas analyzed in this report (Figures 2 and 3) in its proposal of *SARA* Critical Habitat in the draft Recovery Strategy for North Pacific Humpback Whales.

5. Anthropogenic activities that would affect prey occurrence and abundance, disrupt habitat use (shown here to be predominantly for foraging), or displace whales are threats to Humpback Whale habitat in B.C. Examples of threats include, but are not limited to, oil spills, fishing, seismic surveys, sonar or other alterations of acoustic environment that impact communication or foraging. The draft Recovery Strategy also notes disturbance and/or displacement due to underwater noise, vessel strikes and entanglement as threats to humpbacks (DFO 2009).

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Figures

Figure 1. Locations of 6401 humpback photo-identifications in B.C. collected during 1984-2007 (Ford et al. 2009).



Figure 2. Locations of the four candidate critical habitat areas identified as, a. Langara Island, b. Southeast Moresby Island, c. Gil Island, d. Southwest Vancouver Island.



Figure 3. Each of the four areas showing distribution of sightings from line transect surveys and photoidentifications in relation to area boundaries.

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