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Third Workshop for the Conservation Management Plan for the Central America Humpback Whales

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REPORT

THIRD WORKSHOP FOR THE CONSERVATION MANAGEMENT PLAN FOR THE CENTRAL AMERICA HUMPBACK WHALES

INTERNATIONAL WHALING COMMISSION

La Paz, BCS, México, 28-29 October 2022

J. Urbán R., L. Rojas-Bracho, L. Trejos, L. Viloria-Gómora and M. Iñiguez

1. Welcome

The workshop was opened by Jorge Urbán, who welcomed everyone. A list of participants is given in Annex A. He noted that this is the third workshop to update all the information available for the Central America Humpback whale. This information will help to finalize the CMP proposal.

Urbán thanks Pamela Martínez-Loustalot, Lorena Viloria-Gomora and Lorenzo Rojas-Bracho for co-organizing this workshop. He also thanks the National Oceanographic and Atmospheric Administration (NOAA), the Universidad Autónoma de Baja California Sur (UABCS), Cascadia Research, Animal Welfare Institute (AWI) and the International Whaling Commission (IWC) for sponsoring this workshop.

2. Appointment of Election of the President and Rapporteurs of the Workshop

Lorenzo Rojas-Bracho was appointed president. Alexandra Curtis, Nicola Ransome, Lissette Trejos, Joëlle De Weerdt and Karen Martien were appointed as rapporteurs

3. Review and approve the agenda.

The agenda was adopted.

4. Presentation of participants

Each participant gave a brief presentation of themself.

5. Review of documents

Supporting documents were used for this workshop.

6. Objectives of the CMP and the third workshop

The main objective of the CMP is to conserve the CAHW population and its habitat through collaborative regional actions to reduce anthropogenic threats. The CMP aims to provide the range states with the scientific evidence and management tools to implement actions for conserving the Humpback whales of the population unit of Central America-Mexico-USA. This workshop focused on scientific aspects. It is expected to develop a diagnosis of the biological knowledge of the population of the CAHW, such as abundance, distribution, movements, migration, and genetics.

7. Introduction

Urbán mentioned that the IWC 68a Scientific Committee recommended the Central America Humpback whale population be treated as a "priority population" for CMP development (IWC, 2019). In March 2020, the first workshop was organized by the government of Panama and conducted in Panama City, Panama, to discuss the development of this CMP, including biological and ecological aspects, threats, mitigation, and monitoring. The workshop was attended by 21 participants from eight countries (Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, and US) (Urbán *et al*., 2020). After the presentation of the report of the Workshop on the Central America Humpback Whales population at Panama City, Panama, the Committee reiterated the recommendation that the Central American humpback whale population be treated as a 'priority population' for the CMP development process. The Committee recommended the continuation and increased collaboration of the Range States. Mexico organized a second workshop with representation from eight countries (USA, Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama). The workshop was hosted by Mexico´s National Commission of Natural Protected Areas (CONANP) and was held virtually on 6-7 April 2021. The workshop's objective was to prepare the IWC Template nomination for the endangered Central America humpback whale (CAHW) population. The participating range states developed and presented the draft CMP for this population (Urbán *et al.*, 2021). There was broad support from the Committee for the comprehensive information included in this draft. Therefore, the Committee recommended its suitability for endorsement.

8. Preliminary results on SPLASH-2

Moore presented the project SPLASH-2 initiated in 2020, which objectives are: Update estimates of humpback whale abundance throughout the North Pacific; Update/improve our understanding of genetic structure and movements throughout the North Pacific; and address high-priority science and research objectives for different populations and integration with Distinct Population Segments. The activities to date include two workshops (December 2020 and 2021); memoranda of Understanding with various collaborators (for photo ID data sharing); mini-grant program (to support data collection or processing efforts); supported Central American and Mexican photo ID efforts; analysis efforts to Central American population estimates; and collaborative analysis efforts with Happywhale.
Calambokidis mentioned that the last coordinated coverage of Central America was during SPLASH-1 (2004-2006) so out of date (Calambokidis *et al*., 2008). Since that time, a large increase in humpback whale abundance and areas of use along the USA West Coast but it is unclear how that impacted wintering area abundance. He underlined the need for trend data off Central America and a better understanding of the role of South Mexico and the best geographic boundary between Central America and Mexico DPS.
The discussion mentioned that, unfortunately, the ability to continue SPLASH-2 effort is uncertain. Funding from NOAA is year to year, and the level of funding secured for SPLASH-2 years one and two were not renewed. Funding support for SPLASH-1 was broader, including a large investment from NOAA and several non-governmental organizations and considerable NOAA ship time. In contrast, SPLASH-2 is meant to build on existing efforts and fill some gaps in priority areas, such as Central America.

9. CentAm/SMex-CA/OR/WA unit.

Martien presented the CA/SMex-CA/OR/WA Demographically Independent Population (DIP) report (Martien *et al*., 2021), which the US National Marine Fisheries Service recently delineated. CA/SMex-CA/OR/WA DIP includes all animals part of the Central America/southern Mexico wintering population. A DIP represents a group for which the population dynamics of the group is more a consequence of births and deaths within the group (internal dynamics) rather than immigration

or emigration (external dynamics). In most cases, DIPs are designated as stocks under the US Marine Mammal Protection Act. For humpback whales, DIPs are represented by migratory herds, which are groups of whales sharing the same feeding and wintering grounds. Because animals learn their migratory destinations from their mothers and show strong fidelity to those migratory destinations, migratory herds are demographically independent.
In the discussion, the Chair asked whether the decision had already been taken to consider the DIP as a stock. Martien noted that the current U.S. policy in implementing the Marine Mammal Protection Act is that scientists delineate demographically independent units. At the same time, managers decide whether those will be treated as stocks. At this point in the stock determination process for Pacific humpback whales under the MMPA, the scientifically delineated Central American population has not yet been finalized as a stock. The MMPA stock that would be replaced is all humpback whales off the USA West Coast. The Central America and Mainland Mexico units spatially overlap on migration and at the distributional limits of their wintering areas. Addressing where the boundary lies will likely require a combination of photo-id and genetics, and there is probably no hard line. Whales from the north seem to encroach more or less into southern areas depending on environmental conditions, and the distribution and timing could also shift with population growth.

10. Update on abundance and trend.

Curtis presented her report on the abundance of humpback whales wintering in Central America and Southern Mexico (Curtis *et al*., 2022). It was estimated as **1,496 individuals (CV=0.171)** for the 2019 through 2021 seasons. This estimate is based on fitting a spatial mark-recapture model to annual (November to April) sightings, including those from the first year of SPLASH 2 effort, while allowing for uncertainty in the northern population limit and correcting for sex heterogeneity, births, deaths, and exclusion of first-year calves from the dataset. Sensitivity analyses to account for uncertainty in the extent to which animals from the north not belonging to the population encroach into the Central America and Southern Mexico wintering area resulted in estimates ranging from 1,313 (CV=0.167) to 1,601 (CV=0.166). The annual population growth rate calculated directly from the estimate for 2019-2021 of 1,496 individuals (CV=0.171) and that for 2004-2006 for Central America (Wade, 2021), which did not include animals of Southern Mexico, was 4.8% per year (SD=2.0%). The population growth rate calculated based on a more comparable estimate to that of Wade (2021), derived by resummarizing spatial densities from the 2019-2021 spatial model to exclude animals in Southern Mexico, was **1.6% per year (SD=2.0%)**. Efforts underway to update these estimates with sightings data from the 2022 winter season (including the second year of SPLASH 2 effort) thus far show similar results.

During discussions, it was noted that the estimate for the Central American population is approximately one-third of the abundance estimated off the USA West Coast by Calambokidis and Barlow (2020). Sex heterogeneity in sighting probability is a major concern in the wintering area because females are less likely to fluke. Bias due to sex heterogeneity was addressed in the abundance estimate as follows: first, sex heterogeneity was estimated from relative recapture probabilities in the wintering area of whales identified genetically as females versus males based on biopsies collected off the U.S. West Coast, then a correction factor was estimated based on the mean bias in abundance estimates for simulated populations sampled with that level of heterogeneity. Photos of dorsal fins are less subject to sex heterogeneity than flukes. 2021 is considered an anomalous year, with more Mainland Mexico animals occurring off Southern Mexico, so an assessment omitting 2021 may be informative. Linking sighting histories off the USA West Coast to those off Central America and Mainland Mexico in a model may provide further information or confirmation of abundance and trend, including in the form of a shift in the proportion of whales migrating to Central America versus Mainland Mexico over time. The ability to characterize density differences among subregions of the wintering area would be improved by adding an effort covariate, which is currently underway.

11. Genetics.

Baker presented a fine-scale analysis of the population structure of humpback whales feeding along the US West Coast and British Columbia using over thirty years of sampling effort. This is achieved by integrating two sources of individual identification for humpback whales, fluke photographs and DNA profiles, providing 5,107 encounter records with 729 individuals during feeding season (April – November). From this integration, we refine the previous understanding of the population structure of humpback whales occupying these coastal waters, showing differentiation of mtDNA haplotypes between Northern British Columbia, Southern British Columbia-Washington, Oregon, Northern California, and Central/South California.

Martien gave a brief presentation summarizing the movement and genetic data that supported the conclusion that the Central America/southern Mexico wintering population is a single demographically independent population (Martien *et al*., 2020). She explained that the published description of the DIP does not specify the northern limit of the wintering range of the DIP because of uncertainty over whether the waters off of Colima and Michoacán are inhabited primarily by mainland Mexico whales, Central America whales, or both.

Martínez-Loustalot presented a study on the genetic characterization of humpback whales that transit through the poorly studied area of the Mexican Southeast Pacific, especially the areas of Guerrero (GRO) and Oaxaca (OAX), called "SEMX," and Los Cabos area, Baja California Sur (LCS) (Martínez-Loustalot *et al*., 2020). Mitochondrial DNA was extracted and sequenced from 177 skin samples collected in 2018 and 2019 to establish the genetic variability of these populations**. In SEMX, most samples were only two haplotypes, E1 and F2**. Pairwise differences with SPLASH project, SEMX does not show a significant difference with Central America, Similar comparison was made with the whales from California, and there were no significant differences. This pairwise difference shows a close relationship between SEMX, Central America, and California, implying that they belong to the same Central American Population Unit.

During questions, Baker explained that the observed stability in the genetic makeup of animals off the U.S. West Coast is even more remarkable considering the dramatic population trends along the U.S. West Coast. Merging genetic data between Oregon State University and NOAA SWFSC will add considerable information. The F2 haplotype may be more usefully thought of as a “Southern California” haplotype rather than a “Central America” haplotype. Site fidelity to feeding areas is higher than to breeding areas. Humpback whales are occurring in areas that have not been documented in recent history. To what extent populations reoccupied historically used areas versus colonizing new areas is sometimes unclear.

Martínez-Loustalot further explained that lotting individual haplotypes in terms of spatial distribution along Central America and Southern Mexico might help show a cline or abrupt discontinuity. However, samples from Southern Mexico for this analysis were collected almost exclusively from Oaxaca, with another three collected from Guerrero. Thus, they would not provide information on clines versus discontinuities.

It was noticed that off of Mexico, there is great stability in the genetic composition of humpback whales over a very long period between SPLASH1 and recent years. No differences were found between Guerrero and Oaxaca compared to SPLASH1 Central America mDNA samples, and no difference was found between Cabos and Mexico data from SPLASH1.

Some participants were reminded that researchers for SPLASH 1 collected 6-8 samples from Southern Mexico. There was some uncertainty about whether some of these samples were lumped with Mainland Mexico in the SPLASH analysis, but the rest were not analyzed.

12. Movements.

Martínez-Loustalot presented a study on the movements of humpback whales along the Mexican and Central American coasts (Martínez-Loustalot *et al*., 2022). Humpback whale photo-identification images were compared from multiple locations in Mexico and Central America, including Baja California Sur, Sinaloa, Nayarit / Jalisco (Banderas Bay), Colima, Guerrero, Oaxaca and Nicaragua. The Interchange Index and the Movement Index estimated Whales' movements among regions. The results showed higher movements among the southern sampling areas, Nicaragua, Oaxaca, Guerrero and Colima, suggesting that whales from southern Mexico belong to the "Central American population unit". This population unit migrates north to the US West Coast feeding areas using a migratory corridor along mainland Mexico to the mouth of the Gulf of California along the Baja California Peninsula.
Martínez-Loustalot also presented information about the migratory destinations of the different sampling areas studied. Nicaragua, Oaxaca, Guerrero and Colima showed similar migratory destinations to the coasts of California, to a lesser degree, Oregon and Washington. In contrast, Banderas Bay, Sinaloa and Baja California Sur showed a more diverse range of feeding areas destinations from Russia to California.
In the discussion, it was pointed out that only data from Cabo San Lucas in Baja California Sur were used in these summaries. Migratory routes are based on the number of recaptures in each feeding area. They are not corrected for sighting effort in each feeding area, as was done in Paul Wade's analysis using a multistate model. Interestingly, very few whales match to SE Alaska (SEAK) even though many go further northwest, and SEAK researchers have reportedly found very few whales that match Mexico.
Baker indicated that the information on what females are doing compared to males, might be improved by linking genetic samples to photo-id, an effort that Oregon State University is now working on for their genetic samples, especially for South Eastern Alaska (SEAK).

13.1. Panama.

Pérez gave a presentation about their work in Panama (Rasmussen *et al., in press*). The Central America humpback whale Distinct Population Segment (DPS) migrates from feeding areas off California, Oregon, and Washington to a breeding area off Central America during the boreal winter. This DPS is currently considered endangered and does not appear to recover at the same rate as other populations using the same feeding areas. Panama is the known southern limit of the breeding area off Central America for this DPS. Dedicated surveys for the Central America DPS have been conducted in the Gulf of Chiriqui, Panama, in six different years: 2001-2003, 2018, and 2021-2022. All surveys were conducted in February or March. A total of 5,581km were surveyed. Ten sightings of 23 whales were made. Of these ten sightings, five contained a calf (50%). Single animals (n=3), an adult pair (n=1), and a competitive group (n=1) were also sighted. Song was detected in all years surveyed except 2003. Of the 561 hydrophone deployments, the song was detected 49 times (9%), and the song was detected on ten separate days (22% of days). Behaviors included slow travel, fast travel, stationary, milling, and competitive behavior. Twelve individuals were photo-identified in Chiriqui, and six were identified elsewhere in Panama outside our study area 18 identifications from Panama. Of these, 17 have also been seen in feeding areas off the USA's West Coast (94%). The Gulf of Chiriqui is also used by humpback whales migrating from Southern Hemisphere feeding areas during the austral winter. This population has been recovering at a much higher rate. While humpback whales of Central America occur at relatively low densities in Chiriqui, further study is warranted at this southern extreme of their distribution to help determine why this population is not recovering faster. During the discussion, the workshop recognized the importance of this information, although they have only a few records.

Pérez explained that there are more than 40 tour operators in Boca Chica. Local guides were trained to collect information for the project. It was mentioned that the possibility that the sighting rate is increasing because of more people watching and training. It was proposed to use acoustic detection to document the arrival and departure times of the whales.

13.2. Costa Rica.

Palacios gave a presentation about the results of historical monitoring at Osa Peninsula. The reported information comes from opportunistic surveys of whale-watching boat departures from the Uvita community and monitoring surveys (when funds were available) from 2009-2022. The total trips were 605 from December to April 1869 hours of survey effort. The humpback whales were sighted in 465 encounters. The group size ranged between 1 to 12 individuals. The average was 2. The arrival time to Osa was in November (2 seasons), December (6 seasons) and January (5 seasons). The departure times were in January (2 seasons), February (5 seasons), March (6 seasons), and April (1 season). The stays in Osa (first and last sighting) were different, the shortest stay was 24 days (2016), and the longest stay was 137 days (2022). The relative abundance (# sightings/hours) by season range from 0.02 to 0.28 whales per hour. The lowest rate was in seasons 2015 and 2016, and the higher rate was in the 2020 season. The lowest rates since are related to the Niño years and the Pacific Decadal Oscillation (positive phase). In the case of relative abundance by month, the higher rate is presented in January (0.20 whales/hour) followed by February with 0.14 (whales/hour). The humpback whales were distributed along the coast of Osa from Dominicalito to Sirena and Cano Island. Among the threats observed in the area are entanglement in fishing gear and the risk of collisions with small boats. Guanacaste: the observations are given under the Cascadia Research and SPLASH II project. The monitoring is carried out in the Gulf of Papagayo, inside and outside the Santa Rosa marine conservation area, a protected area and another of multiple use as sport fishing and tourism. The trips were in January to March, 3028,1 km of survey effort. The humpback whales were sighted in 279 encounters. The group size ranged between 1 to 5 individuals, the average was 1. The relative abundance was 0.09 whales per km. The humpback whales were distributed along the coast of Papagayo Gulf and Santa Rosa National Park. Among the threats observed in the area are entanglement in fishing gear and the risk of collisions with small boats and jet skis.

13.3. Nicaragua.

De Weerdt analyzed the relative abundance, behavior and population structure of humpback whales breeding along the Nicaraguan Pacific coast based on a four-year sampling effort (De Weerdt *et al*., 2022). This is achieved by integrating information on humpback whales including fluke photographs, distribution, and environmental information for 124 individuals. Little recaptures were observed between north, and south Nicaragua and the results of this research suggest that the two sites are observed in a different way by the Central American population unit. This information gives new insights on the habitat use patterns of humpback whales in Central America. The project started in 2016 photo-id and since 2018 acoustics have been incorporated to the sampling scheme. Groups with calves found in shallower water. The general behaviour of groups without calves feeding occurs mostly in Southern Nicaragua. In both north and south groups with calves are typically resting.

13.4. El Salvador.

Castaneda and Ransome presented the situation in El Salvador. Before their preliminary work in 2018 there were only 11 humpback whales identified in El Salvador, today there are 162. Between 2020 and 2022 we conducted 156 surveys representing 522 hours of navigation and some 3,000 kilometers. We sighted 405 individuals in 212 groups, identifying 124 unique whales. Groups with calves and

single whales are common, competitive groups less frequent. We have whales from December to March and recaptures are frequent. We found whales with fishing nets set and tourist activity is increasing. Most whales are found around the 100 and 200 meter depth and approximately 2.5 - 10 km offshore. Migratory connections are predominantly with southern and central California; however, we found the first DPS individuals from Central America in SEAK. In conclusion, we have a considerable number of groups with calves in El Salvador, however, humpback whale densities are low and there are potential anthropogenic threats in the study area at present.

13.5. Guatemala.

Quintana presented the results of their historical monitoring. The first studies were conducted in the late 1980s and continued for ten years with varying levels of effort and duration. The effort has been restarted in the last four years. She described the population characteristics of humpback whales in this study, focusing on distribution, relative abundance, and behavioral patterns. Three databases were used to collect data with and without field effort, resulting in over 200 sightings distributed along Guatemala's Pacific coast. More than 90% of the data is found in the southern part of the coast. This bias is due to a greater field effort along this stretch of coast. This bias is related to a greater field effort in this coastal area. Within the southern region, three priority areas were identified, some overlapping with singing areas. Within the breeding season, the first sightings of humpback whales in Guatemala have been recorded in October but are more common in December. Relative abundance (whales/km) peaked in February and the extent of the peak in other months varies depending on the year. Different types of groups have been observed; the range varied between one and six whales, with an average of 2 whales (standard error = 0.02). Groups with mothers and calves (3 ± 0.16 whales) were significantly larger than all groups ($p < 0.001$, 2 ± 0.08). Groups of mothers with calves constituted approximately 11% of the groups identified. Other types of groups included groups with mothers and calves (21%), singers (23%), competitive groups (1%), and others (45%). Focused monitoring allowed us to quantify the surface activities of the whales. Travel has been the predominant activity (>90%; $X2 = 1329.03$, $P < 0.001$). The whales in Guatemala have also been observed in every country in Central America and in different parts of Mexico, along the east coast of the United States, including Alaska and Canada. The study shows that humpback whales are frequently sighted in Guatemala; therefore, it is essential to establish comprehensive measures for their protection.

13.6. Oaxaca.

Villegas presented the results of his studies at Oaxaca. The whales arrive in October, and the last whales returning appear in April. The peaks of abundance occur in January, February, and March, and the lowest occur in October and April. The group types are primarily solitary, followed by pairs, trios and quartets. For groups with calves, mother-calf is a priority, followed by mother-calf-escort and mother-calf-two escorts. The mother-calf groups are recorded from December, increasing as the season progresses, with the highest frequency in March. Whales were recorded at 0.2km to 9,6km with a higher frequency at 2,5km; most sightings are between 1 and 3 kilometers from the coast. The most representative behavior is traveling, and new behavior is registered in the area (persecution).

13.7. Guerrero.

Audley gave a presentation about their historical results, and she pointed out that the data on humpback whales were collected by Whales of Guerrero and community members between 2014-

2022. A total of 2191 hours of effort were conducted during that period on 1026 humpback whale sightings. An analysis of a 2014-2020 data (containing 1836 effort hours; 736 humpback whale sightings) subset supports that Guerrero is both a humpback whale reproductive ground and migratory corridor. Guerrero exhibits a lower relative abundance of humpback whales compared to Banderas Bay and Baja California Sur. An average of .77 whales/effort hour were sighted. There was less competitive breeding behavior and singing observed in Guerrero than in Banderas Bay. The average competitive group size was 3.98 whales per group, and the overall group size in Guerrero is 1.8. Competitive group numbers increased during years when whale counts were higher. Singing was detected 23% of the time in Guerrero. There was a higher rate of mom/calf pairs in Guerrero than in other areas of coastal Mexico. (Mean 13% and some years as high as 21%) Newborns, nursing behavior, inter and intra-annual sightings, including up to 27 days between sightings of mom/calf pairs for some intra-annual sightings. The forthcoming dorsal catalog, analysis of drone footage and 3-year 6-site whale/boat nursing and calving sanctuary study should reveal further insights. Whales travel south until early February and change direction to head north after that. Traveling whales showed a more well-defined temporal change in direction than mom/calf pairs and groups, which headed north later and in a less defined way. The mean peak abundance was day 42 of the Julian year. The competitive group peak abundance mean was day 32. Mom/calf peak abundance was day 44. There were fewer whales during strong El Niño events. There were more whales during strong La Niña events.

13.8. Colima.

Ortega-Ortiz gave a presentation about their investigation of the spatial ecology of the humpback whale in the Mexican Central Pacific (MCP) and its connections with other Mexican areas (Ortega-Ortiz *et al*., 2022). Surveys to search for humpback whales were conducted in winter-spring 2010–2019. The number of individuals, type of group, and activities were recorded, and flukes were photographed to differentiate individuals observed at Mexican areas. A total of 15,384.4 km were traveled in MCP waters, and 462 groups of humpback whales were sighted. The dominant groups were singles and pairs, observed mainly in front of the south of Jalisco coast. Their principal activity was traveling, and the least frequent activity was likely-feeding. A total of 420 individuals were photo-identified, and through their sighting history, it was possible to calculate that only 2.14% (1.67–12.5%) of them showed site fidelity; this indicates that the MCP is a transit zone to other reproductive areas. A photographic catalog of 798 individuals from Socorro Island was also analyzed to compare with the MCP catalog, but there were no photo-recaptures between the two areas. The comparison with catalogs of 302 individuals from the Guerrero coast and 1,459 individuals from Banderas Bay resulted in interchange indices of 1.02E_06 and 2.93E_07, respectively. The MCP is part of the breeding ground of humpback whales. However, it seems to be a transit area that does not offer optimum conditions for permanence and sustained habitat use, possibly due to regional anthropogenic activities. Ship traffic has caused the mortality of two humpback whale calves in 2013 and 2022. Moreover, most individuals show displacements to northern (Banderas Bay) and southern (Guerrero) but not to Socorro Island. This movement pattern was also observed to analyze only mothers and calves, which are more frequent at the end of each season (February and March). The acoustic activity also has been described, and during 2015 songs were null in recordings, which probably was associated with environmental anomalies, and in consequence, calves were null in 2016. Also, the song structure of males suffered a shift after 2016. One interaction with another aggregation/population was registered when a mother and calf was observed during the summer of 2010, which was biopsied. The isotopic (C and N) rates suggest that the mother was feeding in Southern regions such as the Antarctic. About genetics, using 275 biopsies, he have described 26 haplotypes. Three are newly discovered, and others have not been registered in some breeding

grounds. The nucleotide diversity from whales of MCP is similar to Banderas Bay, but it is different to Socorro Island, Baja California, Guerrero/Oaxaca and Central America. The isotopic niche (C and N) of these 275 biopsies will be determined to analyze seasons, sex, environmental conditions, and haplotypes. Also, contaminants will be described and quantified in the blubber of these samples. Our large data set will provide essential information for proximal conservation measurements of potential groups of whales using this region.

In discussion, Baker commented that he also found a new haplotype and the possibility of finding some individuals from the southern hemisphere population.

13.9. Jalisco/Nayarit.

Frisch gave a presentation about their latest season. Surveys started in the 2019-2020 season to study the distribution, arrival, and departure times of humpback whales in Banderas Bay. While adult humpback whales can be located all around the bay. However, the distribution of mothers and calves is primarily restricted to the northern part of the bay and, mostly, in the whale-watching area. The first consistent sightings of humpback whales start mid-November and the last ones the last week of April. The maximum number of whales per season peaked between January and February, with an evident decline beginning in March.

Ransome presented information about their field areas and research. The mainland Mexico area stretches from Banderas Bay (Nayarit/Jalisco), along the Nayarit coast and islands, through Sinaloa and up to Mazatlán. The area is undergoing dramatic coastal modification due to tourism and port developments. In 2018 and 2019, during the peak of the humpback whale breeding season (the start of January) aerial surveys were undertaken following a systematic design of 20 parallel transect lines running perpendicular to the coast (covering approximately 45,00km^2), using distance sampling methodology. There were 117 observations of different whale groups in 2018 and 2019. The density surface models were developed using generalized additive models (GAMS) and five different environmental covariates. The models revealed two areas of high humpback whale densities: Banderas Bay and an even higher area between San Blas and Mazatlán. Additionally, site fidelity, seasonal residency, and social groups of humpback whales in mainland Mexico were investigated using some of the region's oldest photo-id catalogs of males and females only sighted in mainland Mexico (Mexico whales). Males and females are seen in mainland Mexico but have also been sighted in the Central America DPS region (Central America whales). Central American whales were found to have sighting lengths of up to 29 years and spanning four decades in mainland Mexico. Central American males were seen on average in five seasons. Central American females were seen in significantly fewer seasons and, on average, only two seasons. Central American males and females were most commonly seen in breeding groups, and Central American females were sighted with three neonate calves in mainland Mexico. There were 60 cases where Central American whales had extended residencies in mainland Mexico (seen up to nine times a season and of up to 30 days), and in each case, they were not documented on Happwhale in the region of the Central America DPS that season.

13.10. USA, and overlapping of the CAHW with other population units in USA.

Calambokidis presented report multiple abundance estimates for humpback whales along the US West Coast-based both on regions, capture-recapture models, years, and datasets. He concluded that the best estimate was 4,973 (SE-239 and lower and upper 20th percentile values of 4,776 to 5,178) based on the Chao model for the years (2015-2018) for photo-IDs obtained from June to October and excluding Happywhale contributions. This estimate is somewhat in line with the just over 4,000

animals projected assuming the 7.5% annual growth rate (calculated previously) since the late 1980s and no pause in the early 2010s. The change from the late 1980s to the estimate we propose here would require an 8.2% annual growth rate, still well within plausible levels for the overall period if there had been no pause in growth (Calambokidis and Barlow, 2020).

The known migratory winter area destinations for humpback whales differed dramatically between Washington – S British Columbia and California - Oregon. Overall known migratory destinations for California-Oregon feeding areas consisted primarily of Central America and some of the Mexican wintering areas with only smaller numbers of whales documented going to the Mexican Revillagigedos and Hawaii. For Central America and S Mexico, over 70% of identified whales from those areas have been matched to California-Oregon; whales from Washington–S British Columbia including those identified in the Salish Sea show a more diverse mix of wintering areas.

While clear differences exist in winter migratory destinations among feeding areas, subtler differences also exist within feeding areas. Along the US West Coast, the proportion of whales going to Central America versus mainland Mexico and other winter destinations follows a gradient through the feeding area with whales feeding off S California more likely to go to Central America than those farther north along the coast. The opposite trend exists for mainland Mexico (Figure 1) (Calambokidis *et al*., 2017).

In discussion, the increasing entanglement in the US west coast was noted. Entanglements from the US west coast are found as far south as Mexico. Juveniles are far more vulnerable to entanglements. Central American whales are most heavily represented in Southern California, and that decreases as you travel up the West Coast. Mainland Mexico and Baja California whales have matched up the coast. Still, they do decrease slightly at the very north/Hawaii increases the number of matches from Oregon to the highest rate of matching in the very North of the Islands.

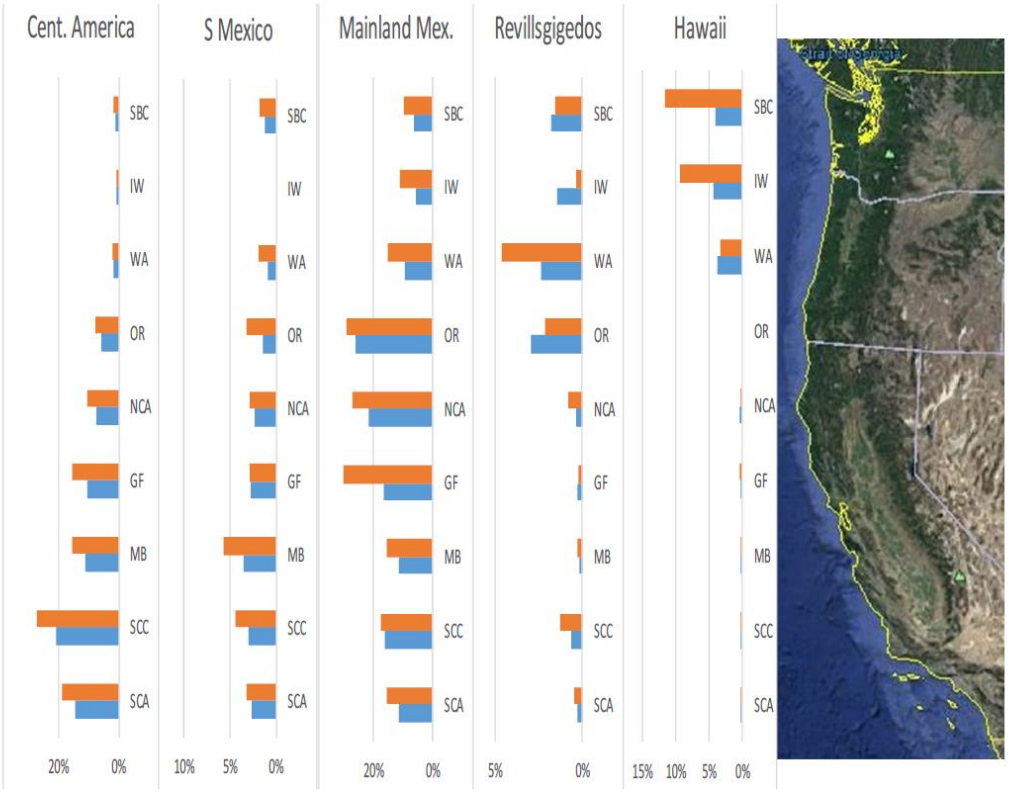

Figure 1. Proportions of humpback whales in different feeding areas that match different wintering areas. Blue bars show the percentage of unique individuals and red shows the percent of encounters in each area that matches each wintering area (Calambokidis *et al*., 2017).

14.1. Overlapping of the CAHW with other population units in México.

Urbán presented evidence of at least three population units distributed in the Mexican Pacific. Based on the results of Project SPLASH (Calambokidis *et al.,* 2008), two population units were distinguished, one coastal and one offshore, based on mixed stock analysis of the photo-identification recaptures with the feeding areas and the haplotype frequencies comparison among the Mexico Pacific and the North Pacific feeding areas. The Mexico coastal population has as its main feeding destination the coasts of California, Oregon and Washington; and the Mexico offshore population the waters from Russia, the Aleutians, the Gulf of Alaska and British Columbia (González-Peral 2011; Urbán *et al*. 2017). Recently, it was demonstrated that the humpback whales from southern Mexico, an area not analyzed during the project SPLASH, belong to the "Central America" population unit (Martínez-Loustalot *et al*. 2022) (See items 11 and 12). (Figure 2).

During the discussion, it was noticed that it took a lot of work to determine the border between the coastal and Central American populations. There were some recommendations for studies considering the changes in the movement of the whales during the winter season and different years. Some participants, including Urbán, noticed a disagreement with the designation of the "DPS Mexico," which includes several population units.

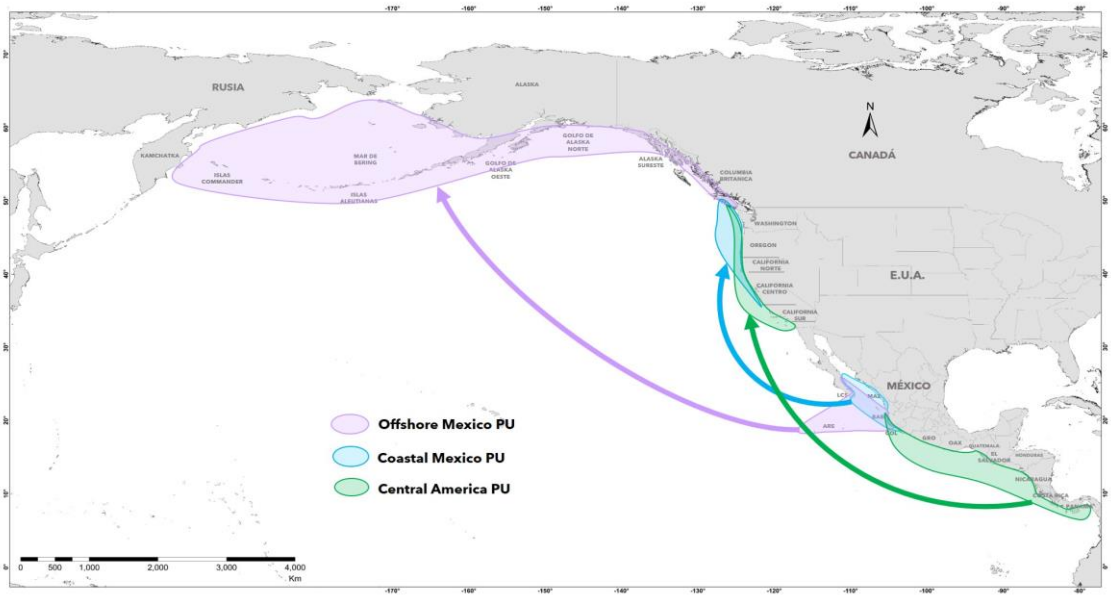

Figure 2. Humpback whale Population Units in Mexico. (Martínez-Loustalot, 2022)

15. Research priorities

Participants widely discussed research priorities for furthering the conservation and understanding of the Central America DPS of humpback whales. Based on currently available data, it is clear that the winter range of the DPS extends at least as far north as the Guerrero/Michoacán border and may include Michoacán, Colima, and Jalisco, at least in some years.

Priorities and recommendations are listed below, separated into research topics to be addressed and research methods to be pursued. Topics and methods are listed in random order (not prioritized). Additional details for many of the items are provided in the sections after the list.

Research topics

- Seasonal, annual, and spatial differences in feeding/wintering area use
  - Estimate migration durations
  - Examine the influence of oceanographic/environmental changes on migration destinations and timing
  - How do conditions on the feeding grounds alter migrations/movements to wintering areas?
- Quantify predation mortality and its links to migration routes/locations
- Identify key habitats for mothers with calves
- Further investigate instances of feeding on the wintering grounds, including determining prey types
- Examine body condition through use of UAS platforms

Research methods

- Contiguous survey of the entire coastline to identify possible new areas of whale concentration and better understand overall distributions
- Aerial survey over large geographic areas
  - Risk to personnel safety is a major concern
  - Will be more useful in some areas than others
- Use deep implanting satellite tags to increase knowledge of movements
  - Incorporate diversity of tag deployment dates and locations
  - Must consider the invasive nature of the tags and possible negative impacts on tagged individuals
- Develop dorsal fin ID catalogs and integrate them with existing fluke catalogs
- Increase the utility of genetic samples through:
  - Better coordination of sampling efforts
  - Better integration with other data types
  - Careful archiving of samples and data
- Better coordination and compilation of stranding/mortality data
- Standardize data collection methods and metrics among researchers, including:
  - Behavioral categories and definitions
  - Survey methods, vessel speed, and consistency of survey areas
  - Calculating of crude birth rate
- Coordinated outreach/interaction with local mariners (fishers, guides, etc.) to facilitate opportunistic data collection. This could include education, training, and provision of data collection resources (e.g., cameras)
- Encourage collaboration and data sharing.

Contiguous coastwide surveys: The participants discussed methods for achieving contiguous surveys of the entire Mexico/Central America coastline. Aerial surveys have been used successfully in north/central mainland Mexico. However, they likely would not be efficient in Central America due to the longer dive times and lower animal densities in that area. They are impossible in some areas due to high winds. There are also serious concerns regarding flying in small, single-engine planes. In Michoacán, where land-based work is too dangerous, aerial surveys may be a good option. Boat-based surveys may also provide a safe option for surveying Michoacán. A combination of aerial and boat surveys may be the best approach for a contiguous coastwide survey.

Implant tagging: Suction tags and dart tags do not last long enough to provide a complete picture of movements across the season. Implant tags could be useful to provide a complete picture of migration patterns and routes, though there are concerns regarding their invasive nature. Given an average duration of approximately 48 days, implant tags deployed early in the migration could last the entire winter season. Full-season data could also be collected by deploying implant tags at different times in different locations, for example, late summer on the US west coast and progressively further south as the winter season progresses. That would produce data across the entire season, though from different individuals.

Dorsal fin photos: The recent development of a humpback dorsal fin matching algorithm within Happywhale can greatly expand our understanding of humpback whales in this region. Many workshop participants noted that certain whales, notable mothers with calves and singing males, rarely fluke and are much less likely to be photographically captured. Participants noted the challenge and importance of correctly associating dorsal fin photographs with fluke photographs. Ideally, all contributors should agree to a protocol for consistently and reliably matching the different photograph types.

Genetics: Research and conservation would benefit from better coordination of genetic sampling through SPLASH II and greater utilization of genetic samples and data from SPLASH. The participants discussed efforts to integrate genetic data into Happywhale and agreed that specifying in Happywhale whether a biopsy (or biopsies) exists for an individual and where that biopsy is stored would be of great value. There was a brief discussion of the value of environmental DNA (eDNA) sampling, particularly for evaluating the presence/absence of humpback whales in the wintering areas very early in the winter season, before they are first sighted. CSB and KKM explained that eDNA would not be useful for such early detection because a sample has to be taken in close physical and temporal proximity to an animal in order to detect it.

Coordination/communication/standardization: Research and conservation would benefit from more communication and coordination among researchers. Real-time reports of sightings of whales early in the season in northern areas can alert researchers in more southern areas that whales may arrive soon. Developing standardized methods for collecting and reporting data would facilitate collaboration and data sharing. Prompt and consistent reporting of mortalities and associated data would be valuable.

There was some discussion of the value of starting research in the wintering areas in October rather than November. Whales are consistently seen in many areas in October, though in very low numbers. Consequently, expanding the field season into October would represent a substantial expense that would produce very few data. Some participants felt that the effort would be worthwhile, while others disagreed. It was noted that wintering ground effort earlier in the season would be more valuable if paired with feeding ground effort late in the feeding season.

16. Collaboration

Conservation and management of Central America DPS humpback whales depend on the cooperation and collaboration of researchers from multiple countries and institutions. Workshop participants emphasized the importance of sharing data while ensuring that all researchers receive proper recognition for their work. Many papers on regional movement patterns have recently been published or are near publication. These regional papers are of tremendous value and allow researchers to

publish their regional data independently. However, participants agreed that the current focus on research in Mexico and Central America presents an opportunity to publish broad-scale papers that combine data across research groups.

The emergence of the Happywhale platform and its automated matching algorithm has enabled collaboration and data sharing on a scale that was not previously possible. However, the workshop expressed concern about how data should be shared through Happywhale. Some groups have made their entire photographic collections publicly available on Happywhale with the intent of encouraging collaboration but have been disappointed to see their data used in projects they were not invited to collaborate on, or even made aware of in advance. As a result, some have chosen to keep subsequent Happywhale submissions private so that the data cannot be used without their knowledge and permission.

Workshop participants discuss the need to resolve issues surrounding data use and co-authorship. There was a general desire to be as inclusive as possible with co-authorship. However, that was tempered by the fact that inclusivity could result in having 50+ co-authors on all papers, which is not practical. Participants also acknowledged the fact that some journals require that all co-authors agree with the conclusions of a paper, which may not be possible when a large and diverse set of data contributors are included as co-authors.

There was a brief discussion of thresholds for determining co-authorship. Though in some cases it may be appropriate to set quantitative thresholds (for example, researchers who contribute more than X% of the data for the analysis receive co-authorship), in other cases the value and difficulty of collecting data should be considered. Sightings from low-density areas may be particularly important for analysis, and often require much more work to collect, and may warrant co-authorship even if the quantity of data contributed is low relative to other co-authors. Co-authorship can also be disproportionately important to early-career researchers and those working in under-represented areas.

Participants discussed specific collaborative papers that could be written to further our understanding of migratory movements and the population structure of the Central America DPS. Three papers were discussed, all of which would require the agreement of many Happywhale contributors. The papers were not discussed in detail, nor was there any attempt to secure data-sharing agreements. The papers are described briefly below. Though the descriptions only address sighting match data, these papers could also incorporate genetic data. Some participants felt that combining movement and genetic data would be best to make papers more comprehensive. In contrast, others thought it would be best to publish movement and genetic data in separate papers, both to prevent papers from becoming too long and to enable more researchers to serve as first authors.

Paper #1: Examine the movements of humpback whales, based on photographic matches, within and between Mexico and Central America to further our understanding of the ranges of each population unit.

Goal: This paper is envisioned as an update of the Martinez-Loustalot *et al*. 2022 paper. The update would include photographic catalogs and sighting data from all Central America countries and all Mexico states for which there are sighting data

Sighting data needed: All sighting data and photographic catalogs from Mexico and all Central American countries

Lead author: Martínez-Loustalot

Paper #2: Assessing the migratory destinations of whales that feed along the U.S. west coast

Goal: To examine latitudinal gradients in the proportional representation of different DPSs along the US west coast. The precise migratory destinations of animals within wintering grounds will not be included. Rather, winter migratory destinations will be reported as being Central America, Mexico, or Hawai'i DPS.

Sighting data needed: All sighting data from Central America countries, Mexico, US west coast, and Hawai'i.

Lead author: John Calambokidis

Paper #3: Migratory destinations of humpback whales from the "Central America" population.

Goal: To develop a two-way movement model for Central American humpback whales. The model will estimate the proportion of Central American whales that migrate to each feeding ground, and the proportion of animals from each feeding ground that migrate to Central America. Sightings of Central American animals within the range of Mexico will also be analyzed to gain insight into the migratory route and timing for Central American animals.

Sighting data needed: All sighting data from within the known range of the "Central America" population (all Central America countries, southern Mexico, the US west coast, Canada, and southeast Alaska)

Lead author: Ester Quintana

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ANNEX A. List of participants

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ANNEX B. Agenda

1. Welcome
2. Election of the President and Rapporteurs of the Workshop
3. Review and approve the agenda
4. Presentation of participants
5. Review of documents
6. Objectives of the CMP and the 3rd WS [Urbán, Rojas]
7. Introduction [Urbán]
8. Preliminary results on SPLASH-2 [Calambokidis, Moore]
9. The CentAm/SMex-CA/OR/WA unit (Demographically Independent Population) [Martien]
10. Update on Abundance and trend [Curtis]
11. Genetics [Baker, Martien, Martínez]
12. Movements and migratory destinations based on photo-id [Martínez]
13. Local information: Arriving and departing times, relative abundance, pick of abundance, group types, traveling direction, distribution:
    - 13.1. Panama [Pérez, Rassmusen]
    - 13.2. Costa Rica [Palacios, Garita]
    - 13.3. Nicaragua [De Weerdt]
    - 13.4. El Salvador [Ransome, Castaneda]
    - 13.5. Guatemala [Quintana]
    - 13.6. Oaxaca [Villegas]
    - 13.7. Guerrero [Audley]
    - 13.8. Colima [Ortega]
    - 13.9. Jalisco/Nayarit [Frisch, Ransome]
    - 13.10. USA [Calambokidis]
14. Overlapping with other humpback whale population units

14.1. Mexico [Urbán]

14.2. USA [Calambokidis]

15. Research priorities
16. Collaboration