Presentation Abstracts
Module 1: Tuesday, August 25th | 9:00 am – 1:00 pm

West Coast Entanglement Science Workshop, August – September 2020
https://www.opc.ca.gov/west-coast-entanglement-science-workshop/

Session: Forecasting and monitoring marine species dynamics | Part 1: Ecology and monitoring

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Insights into entanglements from whale population monitoring

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Monitoring of populations of humpback, blue, and gray whales (especially the Pacific Coast Feeding Group or PCFG) along the US West Coast has been conducted using a variety of approaches including long-term photo-identification since the 1980s by Cascadia Research and other collaborating groups. This research has served as the basis for abundance estimates of these populations as well as insights into their status, trends, and stock structure. This information has also been important in understanding some of the causes and the impacts of entanglements on these populations.

We examine several aspects of whale population monitoring along the US West Coast and the insights they provide into the entanglement issue. This includes:

1. Updated population estimates and trends of humpback, blue, and gray whales along the US West Coast and how these interact with entanglement risk
2. Studies of entanglement scars on humpback whales along the US West Coast and how scaring rates compare to known areas of documented entanglements
3. Insights into the population units of whales in different region and DPS status (for humpback whales) and insight into the risk of entanglements
4. Role of research in documenting entanglements and proposed study to integrate population monitoring, information on whale fishery overlap, documentation of entanglements, and disentanglement response into future surveys
5. Whale diving and feeding behavior from observations and tag deployments and insights into dynamics of entanglement

Genetic population assignment of humpback whales in the eastern North Pacific to Distinct Population Segments

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Humpback whales migrate annually from spatially and genetically differentiated winter breeding grounds, or Distinct Population Segments (DPS), to shared summer feeding grounds (Baker et al. 2013). Recent increases in the entanglement of humpback whales on feeding grounds off the US West Coast have led to conservation concerns for individuals thought to belong to the Mexico DPS, considered threatened under the US ESA, and the Central America DPS, considered endangered under the US ESA (Bettridge et al. 2015, NOAA 2019). An accurate understanding of feeding ground use by each DPS is important for geographic assessment of entanglement risk and allocation of individual mortality events from areas of mixing. To this end, standardized DNA profiling (microsatellite genotypes, mtDNA haplotypes and sex) was conducted for 765 biopsy samples representing 666 individuals collected off the West Coast of North America representing fifteen years of sampling effort (2002-2019). These DNA profiles were compared to a large reference database including DNA profiles from the breeding grounds of the four recognized North Pacific DPS during the SPLASH study in Bayesian assignment testing (Baker et al. 2013).

Spatial assessment of the population assignments produced showed latitudinal trends of decreasing assignment probability to Central America with increasing latitude and increasing assignment probability to the Hawaii with increasing latitude. Individuals with assignment to Mexico were found across a wide range of latitudes along the US West Coast. Beta regression Generalized Additive Models (GAMs) assessed the relationships between each sample's proportional assignment to the four North Pacific DPS relative to latitude/longitude, sea surface temperature, year, and month. GAMs had high deviance explained and latitude was a highly significant predictor variable in all DPS models. Further analyses are underway to improve the spatial population assignment models and the assignment accuracy to the Mexico DPS.

Analytical development of whale satellite tagging data to inform critical knowledge gaps off the US West Coast

Daniel M. Palacios, Oregon State University

For the last three decades, Oregon State University (OSU) has been deploying Argos-monitored satellite tags on baleen whales off the US West Coast to collect data on movement and habitat use for these species in this important feeding ground. As the technology has matured, its potential use as an operational tool for effective monitoring of whale populations is coming to fruition, as exemplified by recent projects that OSU has conducted on behalf of the US Navy since 2014 as part of their regulatory compliance with Letters of Authorization issued by the National Marine Fisheries Service (NMFS). A retrospective analysis of OSU's cumulative datasets has the potential to generate critical baseline knowledge about whale distribution and movement, important areas of aggregation, and habitat

preferences off the West Coast at spatial and temporal scales not possible with other survey methodologies. Currently, OSU holds satellite tracking datasets for these four species of baleen whale – gray whales: years 2005 (n=17), 2009 (n=18), 2012 (n=9), and 2013 (n=6); humpback whales: years 2004-2005 (n=14) and 2016-2019 (n=67); blue whales: years 1994-2008 (n=104) and 2014-2017 (n=90); and fin whales: years 2004-2006 (n=2) and 2014-2018 (n=31). In addition to acquiring tracking data to inform whale distribution and movement, since 2016 OSU has been using advanced tags that also report dive depth, duration, and feeding activity. Thus, with our more recent datasets we also have the ability to characterize diving behavior and its variability at diel, weekly, and monthly timescales.

The answer to the question of how West Coast fisheries can reduce entanglement risk is evidently by reducing spatial and temporal overlap between whales and fishing activity. This is not a simple task, however, considering the high variability in oceanographic conditions, forage resource abundance, and whale behavior from year to year. Ultimately, a dynamic ocean management approach is well-suited for this task, although the implementation of such an approach is data-intensive and follows three development phases: 1) conduct basic science to fill critical data/information gaps (i.e., quantitative characterization of the cumulative tracking data to derive parameters such as timing, movement rates, home range, and vertical use of the water column); 2) use these results to develop intermediate data products (i.e., predictive habitat models to forecast whale distribution and density from oceanographic conditions); and 3) conduct risk assessment modeling using the intermediate data products as input, to develop decision support tools to be used by managers. Additionally, strategic acquisition of additional tagging data in the future would allow for continued monitoring and for iterative improvement of the data products developed in phases 1-3. Finally, given the presence of three NMFS-identified Distinct Population Segments (DPS) of humpback whales off the West Coast, the implementation of these phases ideally should be done at the DPS level for this species to the extent possible.

Identifying co-occurrence between whales and fishing effort in Oregon to reduce entanglement risk

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Increased whale entanglements along the US West Coast in Dungeness crab fishing gear are causing significant concern among managers, researchers, fishermen, and the environmental community in Oregon; entanglements threaten both whale populations and the stability of the crab fishery and coastal communities. First convened in 2017, the Oregon Whale Entanglement Working Group developed recommendations to reduce entanglement risk, including the high priority of supporting future research to better document whale distribution in Oregon waters. In progress since early 2019, this research project aims to fill this data gap and link an improved understanding of whale distribution patterns in Oregon with fishing effort to develop maps of entanglement risk, which managers can use to spatially manage fishing effort more effectively. Data on whale presence/absence in Oregon waters is collected using standardized distance sampling methods during four monthly surveys aboard USCG helicopters along set tracklines in four different coastal regions of Oregon. The goal is to conduct these four survey tracklines monthly for two full years, beginning February 2019. To-date we have conducted 51 surveys and recorded 206 sightings of 10 different cetacean species. Additionally, when humpback whale

aggregations are observed, boat-based field operations occur to collect photo-ID and biopsy data to improve individual and population assignment to Distinct Population Segments (DPS).

Species distribution models (SDM) will be generated using this presence/absence data in relationship to oceanographic and topographic data. Other complementary datasets on baleen whale occurrence in Oregon waters will contribute to this SDM calibration and validation process including vessel-based survey data and opportunistic sightings reported by citizen scientists. We have also developed an extensive outreach program to engage various ocean-users (e.g., commercial and recreational fishermen, USCG personnel, tugboat captains, tour operators) to collect opportunistic whale sightings using the mobile app Whale Alert. Predictive maps of whale distribution patterns in Oregon derived from the SDMs will be spatially overlaid with layers of crab gear fishing effort generated by the Oregon Department of Fish and Wildlife (ODFW) to identify areas of elevated risk of whale entanglement. This project will improve our knowledge of whale space-use patterns in Oregon and develop maps of co-occurrence with fishing effort. Understanding when and where whales overlap with the fishery would allow discrete and targeted management actions, potentially including spatio-temporal fishery closures, to maximize effectiveness and minimize burden to fishermen. Furthermore, our network of project collaborators is strong, transparent, and broad including engaged fishermen and ODFW managers. Already we have communicated effectively between groups: fishermen often inform scientists on the locations of whale aggregations, and scientists have in-turn informed managers on locations and behavior of whales who then advise the fishery on recommended, voluntary gear placement to reduce entanglement risk.

Monitoring leatherback turtles in nearshore US west coast waters

Scott Benson, NOAA Fisheries, Southwest Fisheries Science Center

Endangered leatherback turtles (*Dermochelys coriacea*) that originate from nesting beaches in the western Pacific occur seasonally (June-November) in US west coast shelf waters for foraging. We have used genetics, telemetry, aerial surveys, and habitat sampling to inform key questions about population structure, movements, abundance, trends, and foraging habitat. Multi-year telemetry studies have identified key foraging areas in shelf waters off central California and shelf/slope waters off Oregon/Washington. A steep, longterm declining trend has been documented at the largest nesting beaches in western Pacific (Papua Barat, Indonesia) and a similar declining trend in abundance is evident at a vital central California foraging area. As a consequence of its endangered status, leatherback turtle critical habitat was designated off central California and Oregon/Washington in 2012.

Unlike large whale species, leatherbacks are cryptic, therefore, monitoring presence and distribution is a significant challenge. Telemetry studies and aerial surveys have been useful for monitoring presence and movement within nearshore central California foraging areas to inform potential management actions and mitigate entanglement risk. Biological indicators recorded during our surveys can also be useful proxies for presence of leatherbacks. For example, leatherbacks primarily consume brown sea nettles (*Chrysaora fuscescens*) in neritic central California waters and surface aggregations of brown sea nettles can be observed during aerial surveys.