American Cetacean Society

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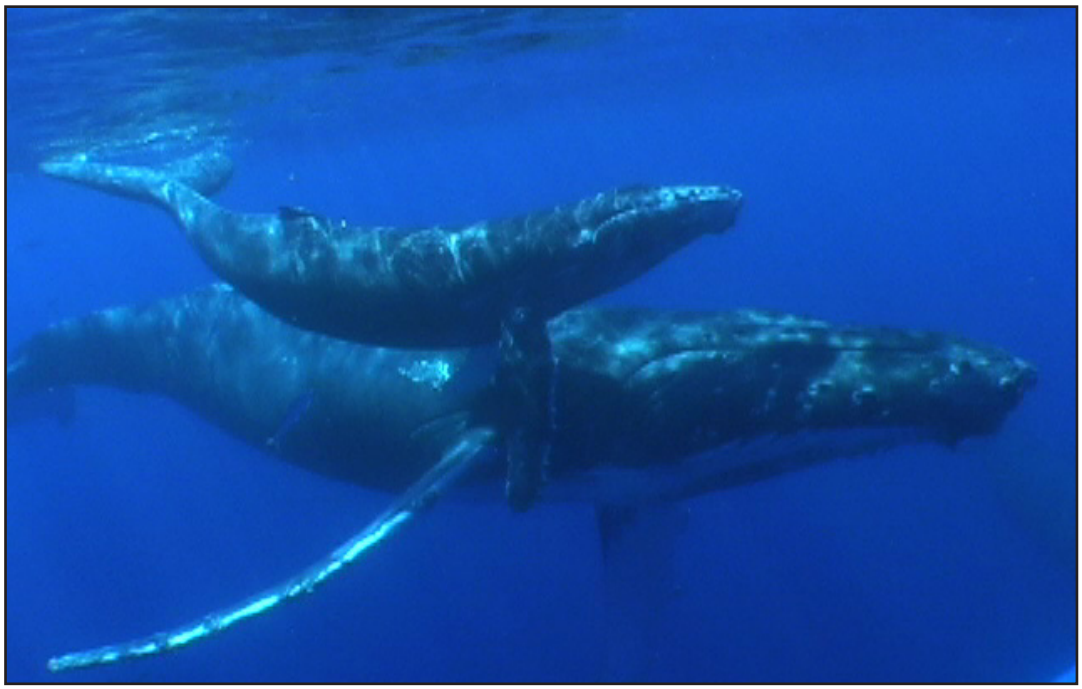
View Into Vocalizations:

Hawaiian Humpback Whales



Young calves often swim close to their mothers in their first year of life, spending time learning various behaviors and vocalizations.

by Maren Anderson and Ann Zoidis, Cetos Research Organization

Photos taken under NOAA Permit #14353

Cetos Research Organization has, for the past 12 years, worked towards a better understanding of cetacean species in the wild, and towards how to provide data to better inform government organizations of species' behaviors and their natural activities in order to aid in the preservation of these marine mammal species, many of which have been endangered for decades. Prior to the formation of Cetos as a non-profit, all of our senior researchers had been working in the marine mammal field, and many of them in Hawaiian waters, for years. Cetos was born out of a desire to collaborate with lifelong marine mammal colleagues and peers, to focus on underexplored research areas in certain species, including Hawaiian humpback whales, and to create an avenue for marine mammal scientists to be able to raise funds for work with marine species which they have wanted to pursue studying. One such example of this is the work of Dr. Thomas Jefferson on the critically endangered Vaquita. Cetos scientists began working in Hawaii during the early days when issues related to sonar and marine mammals (the subject of the recent book "*War of the Whales*") were first discerned. Our participation in these studies and subsequent scientific inquiries throughout the '90s and beyond became a basis for our passion for gathering ecological findings that can reduce impacts.

Humpbacks, cont.

Many of the acoustic and behavioral studies we work on are for the betterment of our understanding of the anthropogenic impacts on cetaceans. Much of our research is focused in the waters of Hawaii, though we also work in the Gulf of Maine, Alaska, Washington, and in the waters off of Mexico, the latter specifically related to the critically endangered Vaquita. Our longest running multi-faceted project and the focus of this article is on the behavioral ecology of the humpback whales that winter in the nearshore waters of the Hawaiian Islands.

Between the months of January and May, humpback whales are seen traveling, milling, resting, breeding, calving, and performing astonishing surface displays throughout the Hawaiian Island chain. These wintering humpbacks travel between their high-latitude feeding grounds and the warmer waters of the Hawaiian Islands for breeding and calving (Baker and Herman, 1981; Darling and Jurasz, 1983). The largest number of humpback whales occur off the coasts of what is known as the four island area of Kaho'olawe, Molok'ai, Lana'i, and Maui (Mobley et al., 1994, 1999) where we conduct studies on Hawaiian whales with a focus on mother and calf behaviors. We have studied Hawaiian humpbacks in the waters off Kauai and the Big Island also, but the four island area offers an ideal combination of calmer waters and excellent underwater visibility which we have found to be most beneficial for maximizing our data collection. It has for a long time, been a wonder what these animals do while underwater, and why they do it. The development, or ontogeny, of behavior of humpback calves is thought to reflect their preparation for adulthood, including migration, predator avoidance, feeding, and later reproductive activities. Between adult humpback whale males and females, reproductive strategies differ greatly. Males compete aggressively with other males for females, and females focus their energy on care and protection of their newborn calves. In addition to discerning the role of calf gender in certain behaviors, we set out to investigate the role of seasonal period and of environmental conditions (sea state, cloud cover, wave height, etc.) on the calves' behavior and behavioral development. We use underwater video, a hydrophone array for underwater recordings, and surface photographs to document surface and subsurface behaviors. We are most interested in what is going on both at depth, and just below the water surface. Our methods also allow us to investigate their vocalizations in an attempt to understand these sounds in relation to whale behaviors.

A Cetos staff scientist snorkels with our hydrophone and video array to document sounds and movements of a young humpback whale.

One category of vocalization is of particular interest to us. These are known as 'social sounds.' Humpback whales produce a variety of sounds including song, non-song social vocalizations, and nonvocal, surface-generated percussive sounds (e.g. sounds produced by breaches, fluke slaps, and pectoral fin slaps). In the Hawaiian wintering grounds, most of the vocalizations that have been recorded and studied are the beautiful and mellifluous 'song' of the males that may determine territory and likely has a courtship function (Payne and McVay, 1971; Darling and Jurasz, 1983; Payne, 1983, Helweg et al., 1992; Au et al. 2000, 2001, 2005, 2006). Songs are characterized by continuous, repetitive, and highly structured phrases that contain harmonious portions that range in frequency. However, the non-song sounds made by the mother or calf during the first months of a calf's life have seldom been studied. Very few scientific papers can be found on this topic for Hawaiian humpbacks in the wintering grounds. There is more literature on social calls in the waters of Alaska where these animals go in the summer to feed, but we have been interested in the calls and behaviors from when the calves are born and in their first few months of life. The more we are able to record these sounds during their first year of life, the more data we have to compare to social sounds recorded in their feeding grounds, and attempt to understand how these types of vocalizations are learned, change, or show up over their first year of life.

Social sounds are sounds which are non-song vocalizations emitted irregularly, and do not contain the rhythmic, consistent and continuous patterns of a song (Zoidis et al., 2008). Some adult humpback whale group compositions (large competitive groups, adult groups of three or more) have been documented emitting these non-song vocalizations (Silber 1986). Most of the social calls of these groups are louder and more dynamic than the calls we have found between mother and calf. We now know from our Cetos study that the

mother-calf social sounds attenuate very quickly and are relatively quiet. The literature had previously stated that mother-calf humpback pairs do not call to each other or utilize social sounds until our 2008 study. Scientists had been unable to verify calf social sounds or to determine whether social sounds recorded were coming from calves, mothers, or escorts (i.e. specific sounds could not be triangulated to a specific individual). By the use of an omnidirectional dual hydrophone array coupled with underwater video analyses, we were able to verify that calves are making social sounds. While in-water, our divers hold the hydrophone array parallel to the water's surface, and when a vocalizing individual animal crossed through the center of the video frame and bisected the two hydrophones, sounds from a particular individual could be verified. With the use of this type of hydrophone and video array, it became possible to determine that particular social sounds could be traced back to specific individuals, and for the first time, it was determined that male and female calves do, in fact, make social sounds while at the surface in their wintering grounds.

In our earlier field seasons, much of our analysis focused on these social sounds and their context. Because our methodologies were refined for the specific purpose of attempting to capture calf sounds, we were able to determine that of the 170 groups (with calves) that we recorded between the years of 2001 and 2006, 110 groups produced non-song vocalizations or social sounds. The reality was that we were aware of these vocalizations because of our years of in-water work, and when our divers were in the water with the mother-calf groups there were several instances where the calves approached the divers and grunted audibly. However, proving the grunt came from the animal we were observing and not an animal behind, below, or nearby was a different task and one that had to pass peer review muster. Fortunately, with the help of Dr. Adam Frankel, we were able to reconfigure our equipment exactly the way it was needed in order to combine video and sound recordings and show it was in fact the calf in our focal study group making social sounds (for more details, please review Zoidis et al. 2008).

These sounds do not yet have a known function, but we speculate that they are likely to have varying biological significance. We theorize that social sounds and their associated behaviors may play a large role in keeping contact between mother/calf pairs. While mothers rest at depth calves, who have a reduced physiological capacity to dive, surface often to breath and therefore spend much of their time at or near (just below) the surface. They are separated for intervals from their mother, especially during rest periods. This surface interlude is when we have recorded some social sounds. Some types of vocalizations known as 'alarm calls' could elicit a mother's approach. Certain sounds such as these grunts, in correlation with bubble streams or jaw claps, may function as such an 'alarm ' call to the mother, something commonly seen among other mammal species between a mother and her young. On three occasions during field seasons,when a calf emitted repeated grunts with increasing incidence and amplitude, sometimes with an accompanying jaw clap, the mother surfaced quickly and seemingly herded the calf away quickly and forcefully. We also found that as the number of escorts within the group increased, calf social sounds decreased. The reasons for this are not clear, but we theorize it has to do with escort and mother dynamics. The majority of our groups we analyzed that emitted non-song vocalizations were lone mother-calf pairs (87% of total calf pods).

In addition to our work on social sounds, a great deal of our current research is geared towards understanding the development of calf behavior in their first year of life. Recently, one of our research goals in elucidating calf behavioral development was to determine whether or not mother and calf spatial relationships developed or changed over the course of the winter months. This had not been examined in humpback whales, though it has been in right whales which are also baleen whales (Taber and Thomas 1982; Thomas and Taber 1984). We also set out to examine if there was a presence or absence of particular calf behaviors during changes of sea state or other environmental conditions (e.g. swell, wind); and whether there was a clear change in behaviors, including in vocalization patterns or vocalization interactions between mothers and their calves, based on the sex of the calf. Over the course of eight field seasons (between 2001-2010), first-year humpback calf behavior and vocalizations were recorded in between the surface and 5m of depth and analyzed. This dataset was predominantly from work conducted in near-shore waters of northwestern Maui, with one field season off of the coast of Kauai. Using random search patterns, groups were located and group composition was determined. Calf morphology photographs were taken for later confirmation and identification of sex. Upon assessment of groups with calves, snorkelers were deployed with digital video cameras using two recording systems: one equipped with a single omni-directional hydrophone and the other a two-element hydrophone array. As in all our studies, all efforts were made to minimize disturbance of diver presence on the whales, with particular instances in which calves or mothers interacted with divers at the surface noted as a distinct behavior set. Video footage was then analyzed for each of the factors we were studying. Using linear mixed effect models, we analyzed footage of 199 groups in which a calf was present, specifically documenting when calves were (1) at the surface without their mothers, (2) in physical contact with or in close proximity to (within 5m) of their mothers (3) playing, (4) milling, (5) interacting with divers, or (6) vocalizing (social sound). The duration of the study was broken down into five periods of development for each field season, two-week periods of time that would ensure an adequate sample size. These seasonal period were categorized as follows: Period 1 = January 1-15; Period 2 = January 16-31; Period 3 = February 1-14; Period 4 = February 15-28; and Period 5 = March 1-15.

Humpbacks, cont.

Patterns that researchers have recognized in calf behavior development are a result of genetic (known as innate behaviors) and environmental factors (considered 'learned' behaviors). How many of these patterns humpback whales are born with and how many they perfect or learn in their first few years of life is of particular interest to us. Our findings demonstrated that aspects of behavior of the calves are influenced by the sex of the calf and the seasonal period (Zoidis et al. 2014). While we found no significant changes in calf and mother behavior during sea state changes or as a result of other environmental conditions (although trends were present and will continue to be examined in further studies since it may be that the trends could be teased out with a larger sample size), we did find difference by sex and by timeline. We found that males spent a large portion of the time being surface active and at play, significantly more often than females. Males exhibited play behavior 0.10 ± 0.15 of the time, whereas females played only 0.05 ± 0.10 of the time. Sexual differences in play behavior are present in many other species that, like humpbacks, have differing reproductive strategies as adults (Spinka et al., 2001; Maestripieri & Ross, 2004). Adult male humpbacks have different mating strategies (some of which require a higher level of fitness for competition for females later in life) whereas adult females utilize most of their energy in preparing for mating and calving seasons and raising young. Males are known to exhibit both aggressive and passive displays during their time in their wintering grounds. Aggressive displays include bubble blasts, head lunges, physical bumping and pushing, and charges and strikes, whereas passive displays include singing and escorting. As competition over females continues throughout the breeding season, these passive displays can quickly turn into aggressive displays, which is very energetically costly to the male humpbacks. Our research finding show that male humpback calves spend significantly more time playing at the surface and expending energy being active which may contribute to future fitness or adult mating behavior. It suggests that this behavioral gender difference could possibly be attributed to future adult roles, and may be critical to the development of social and motor skills that prepare male calves for future breeding displays (and hopefully winning mates). Despite females spending less of the time being surface active and playing, they too are developing behaviors that are thought to aid in their development of social and motor skills that mimic techniques used to, for example, escape from predators, capture prey, and in developing social or mothering skills. While it is important to our research to minimize interactions between whales and divers, we took note of how often calves engaged with divers at the surface. When comparing behaviors by sex, trends indicated that male calves were at the surface without their mothers and interacted with divers more often than females, showing a developing independence and boldness in these male calves.

Humpback whale fin slapping at the surface, off of the coast of Maui, Hawaii.

Regardless of their sex, young humpback calves benefit from a closeness to their mothers, who offer protection. It is known that most newborn mammals including whales and dolphins spend a majority of their time within a body length or two of their mothers when first born. This distance typically increases over the course of their first year of life as newborn mammals get older and more mature. We found in our study that over the course of the first season winter months, calves were at the surface with their mothers initially, then without their mothers more often later in January and into February, as compared again to later and prior to migration e.g. in the March study periods. At this time (at the end of their wintering period and just prior to migrating back up north) calves returned to remaining in proximity to their mothers. In other words, they were closest to each other both early and late, during Periods 1 and 5, with a gap in the middle when they were further apart. Interestingly, this was seen in the right whale calves too but has not been noted in odontocetes species (dolphins, and other toothed whales) or other baleen whales. This finding shows that spatial proximity to the mother can vary throughout the calving season, and the behaviors of the calves in relation to their mothers changes as they mature in their first year of life. Increased mother/calf separation mid-season may allow for calves to develop motor skills, independence, and fitness in preparation for migration to the Pacific Northwest of the US, Alaska, and British Columbian waters. During the "away" periods, we speculated that increasing time of separation and increasing distance between mother and calf functions to accustom the calf to practice separations and independence while still having the 'safety net' of their mother close by. We also speculated, as did Cartwright and Sullivan (2009) that increased time spent away increases the calf's fitness, and may aid in developing motor skill. In the weeks prior to migration, calves once again return to swimming in close proximity to their mothers, possibly preparing for the rigors they are going to be faced with during the average of 3,000

miles migration between Hawaii and the Pacific Northwest of the United States. Reducing distance between a calf and its mother at this time could also possibly be an energy saving technique, saving their energy stores for their very strenuous first migration to the feeding grounds. The role of the five periods of development examined in this behavior study also will benefit from continued data collection; we are interested in increasing our knowledge of the behavioral development of calves. Patterns that we noted in our 2014 published study could be a prerequisite for humpback whale migration, which requires calves to adjust to changing habitats as they cross different oceanographic regions. This adaptability will also help them survive in new and hazardous environments.

We will continue to examine social sounds and their function. Further investigations of calf-attributed vocalizations are needed in order to determine how these social sounds change or are used depending on social structure, environmental cues, ontogeny, and behavior. Some of the social sounds between calves and mothers that may occur as a result of alarm or concern may be potential indicators of stress. The more we understand about reactions to sources of disturbance, the more this information could be used for future management of this endangered species, especially in the Hawaiian wintering grounds where calves are particularly susceptible to strikes by boats and ships (since they essentially "hover" just under the water surface and are often not visible to boaters).

In the coming 2015 breeding and calving season, as the North Pacific humpback population migrates towards the Hawaiian Islands, Cetos will be gearing up to continue its research into the role of social sounds in wintering humpbacks and the ontogeny of calf behavior. In collaboration with the bioacoustics scientists at BioWaves, Inc. and scientists from Scripps, Cetos will also work to integrate new acoustic, tagging, and tracking technologies into our research efforts. As technology progresses, the ability to reach different levels of understanding of humpback whale behavior increases. Using non-invasive tags, (suction-cup tags), we have the ability to record real-time behaviors above and below the surface of the water while at the same time recording vocalizations. There have been some successful tag placements on mother and calf pairs in Hawaiian humpback whales (Stimpert et al. 2012) and it is a growing field of study. Successful tagging of these pairs and obtaining these types of data will bring Cetos to the next level of analysis for truly beginning to understand how social sounds are used between calf and mother, as well as in larger social groups including mothers, calves, and escorts. In addition to further clarification of these vocalizations, we can complete our underwater ethogram, an analysis tool that can be used to quantify behaviors of individuals underwater. There are a variety of ways in which this type of tool can be utilized in both further research development and species management.

Quantifying underwater behaviors through an ethogram or through underwater studies, and learning more about calf and mother pairs can help us support successful recommendations that may decrease the potential negative interactions between humans and whales. Disturbances which may result in impacts to humpback whales from human-uses of nearshore waters can be better assessed when more is known about whale behavior. We know that increasing ship traffic (e.g. from ferries, recreational vessels, and larger ships) is a source of whale ship strikes in Hawaiian waters during the humpback whale wintering months. If we can elucidate more about calves hovering just below the surface of the water where they are hard to spot, maybe ship strikes to calves can be reduced. Cetos hopes to broaden the scope of our studies to compare this population to other populations of humpback whales in other geographic areas (such as in the Caribbean, Mexico, and elsewhere), or even to humpbacks from the main islands to humpbacks found in the northwestern Hawaiian Island chain to determine what, if any, differences exist. Gaining knowledge that covers different populations of these whales will help illustrate how they may use their environment and reducing impacts to young humpback whales can protect future generations of this species, so that precarious population levels from our recent past are not experienced again.

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Cetos Research Organization

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There is a Paypal button on the homepage.

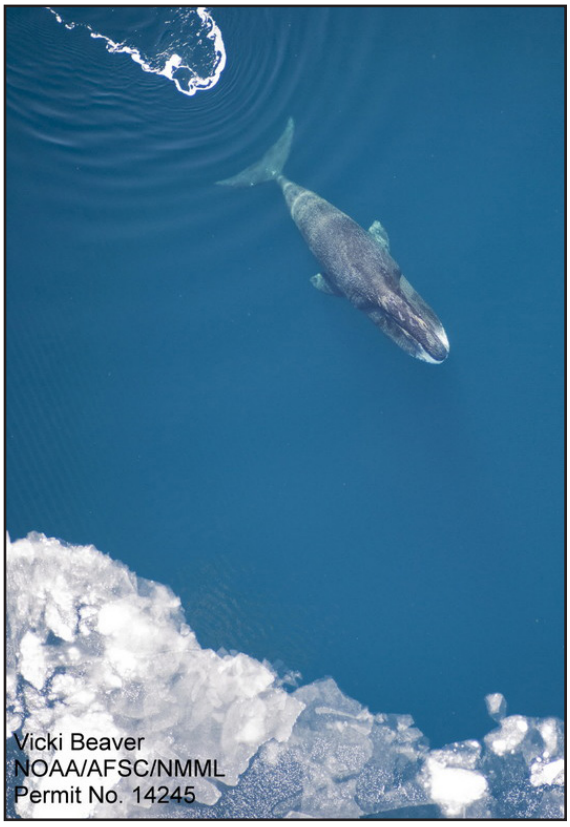
Maren Anderson began her love of Marine Science in high school when she was certified to SCUBA dive in Belize. Since then, her passion has continued in her studies and work. She received a Bachelor of Arts degree from University of Colorado at Boulder in Ecology and Evolutionary Biology with a focus in Tropical Marine Ecology in 2007. During her studies, she performed health assessments of coral reefs in the Caribbean Sea, Gulf of Mexico, and Pacific Oceans. Upon graduation, she worked with coral and marine ecosystem conservation at Disney World's Living Seas exhibit as an education specialist, diver and marine mammal research assistant. She assisted in cognitive research of Atlantic bottlenose dolphin as well as the rehabilitation of West Indian manatees. Maren joined Cetos Research in 2012 as a research assistant for the Humpback Behavior Project focusing on the interactions between mother and calf pairs. Maren has participated in vessel and land-based visual and acoustic towed array surveys, and assessing the abundance, density and distribution of marine mammals. These included locations such as Hawaii, the Mariana Islands, and the California coast, where she has studied pilot whales, spinner and bottlenose dolphins, Risso's dolphins, beaked whales, harbor porpoise, California sea lions and harbor seals. She has served as visual observer and assistant acoustics team member on these surveys. On land, Maren serves as a research assistant and consultant for various government agencies in managing marine resources, specifically in marine mammals and coral. She also works as a high school teacher in San Francisco, teaching Genetics, Evolution, and Marine Biology; and is the Director of Experiential Education programs for her school.

Ann Zoidis is Director and Founder of Cetos Research Organization, Ann has almost 30 years' experience as a field researcher and wildlife biologist. She has worked with birds (raptor and seabird studies) and general wildlife, but mostly in her career has focused on marine mammals. Ann has spent most of the last 25 years researching marine mammals in many parts of the world. In addition to these research studies, she has also managed numerous large environmental projects for various federal, state or private agencies assessing impacts to marine mammals. Recently she managed a large baseline study surveying for coral, sea turtles, and marine mammal species in the Marianas. She has managed or been Principle Investigator on many marine mammal studies or participated as a research associate on field research projects for various agencies or institutions (including at Cetos) all over the country in the Atlantic and Pacific, in Maine, Florida, Alaska, Hawaii, and the western Pacific. In addition to her academic and research pursuits, Ann is a Research Associate of the College of the Atlantic in Bar Harbor, Maine where for many years she was a senior scientist at the Edward McCormick Blair Mount Desert Rock Marine Research Station with the research group Allied Whale. She has published on several papers including a precedent setting paper on humpback whale calf sounds. As a research biologist, she does biological monitoring, surveys, and research, with much of her work focusing on cetacean behavior, acoustic and vocalization studies, or assessing effects of disturbance on marine wildlife behavior. Ann has conducted numerous species monitoring surveys and studies from vessel, shore, and aerial platforms. She has been successful with research at Cetos and has contributed to the field of whale science; Cetos has been giving presentations at most of the ACS or SMM conferences since 2003. She enjoys working with long-time colleagues and also appreciates the opportunities she has often had through her work to give younger scientists their start in the field.

Seismic Operations: Do They Scare Bowhead Whales Away or Make Them More Difficult to Count?

by Frances C. Robertson

I never imagined that I would one day be in the most northern parts of the United States—Prudhoe Bay and Barrow, Alaska—to investigate how bowhead whales (*Balaena mysticetus)* respond to seismic survey operations. As part of my Ph.D. research, I wanted to know whether bowhead whales were avoiding large areas around seismic survey operations, as has been previously suggested, or whether the manner in which they reacted to seismic sounds simply made them more difficult to count and gave the false impression that fewer whales were present.



A sub-adult bowhead whale swims just beneath the surface along the ice edge.

Bowhead whale bones and the frame of an umiak (whaling boat) stand on the edge of Barrow, Alaska, looking out over the Chukchi Sea. Photo by Frances Robertson.

The bowhead whale is one of three cetacean species endemic to the Arctic, and the only baleen whale that has evolved to live year round in Arctic and subarctic waters. It is an incredible species that can break through ice as much as 2 ft. thick, sing songs with a repertoire to rival that of a songbird, and lives more than 150 years. It is also a species that is coming in to contact with an increasing array of human activities, in one of the most remote, inhospitable parts of the world.

The global demand for energy has led to renewed interest in the Arctic for oil and gas exploration. This industry commonly employs seismic (acoustic) surveys to discover potential hydrocarbon (oil) deposits. This involves releasing high energy, low-frequency sound into the ocean at regular 8-10 second intervals that can be detected tens to hundreds of miles away.

Bowhead whales are low-frequency specialists and therefore, may be sensitive to industrial seismic activities. As a result, it is important to understand how exposure to seismic sound influences bowhead whale behavior, distribution and abundance in ensonified areas. Such knowledge can help to develop wildlife management plans to mitigate the impact of oil and gas exploration on the whales, and on the cultural subsistence practices of local Iñupiat people. One means of understanding the effects of disturbance, including human

75 Crew from TIkigaq (Point Hope) Alaska, returns to the ice edge after an unsuccessful whaling attempt. The whalers understand the behavior of the whales –the whales follow a breathing pattern before going for a deep dive. Photo by Othniel Anaqulutuq Oomittuk Jr, a member of 75 Crew whose captain is Othniel's Uncle, Jacob Lane Jr.

activities, on animals is by observing their behaviors. Another is by examining their distribution relative to human activities. This is because animals' behavioral decisions are often reflected in their distribution (e.g. whether or not an animal stays in, or avoids an area). Distribution assessments are an important component of wildlife management plans, particularly when attempting to assess impacts.

One of the key ways that scientists and resource managers quantify and limit the exposure of whales to industrial activities is by counting the number of individuals in the affected area. This can be achieved with aerial surveys that allow large areas of the ocean to be covered in relatively short periods of time. Such surveys are often used to count bowhead whales in the Arctic. However, counting whales is no easy task. Whales are often hard to spot because they are spread over very large areas and only come to the surface for short periods to breathe.

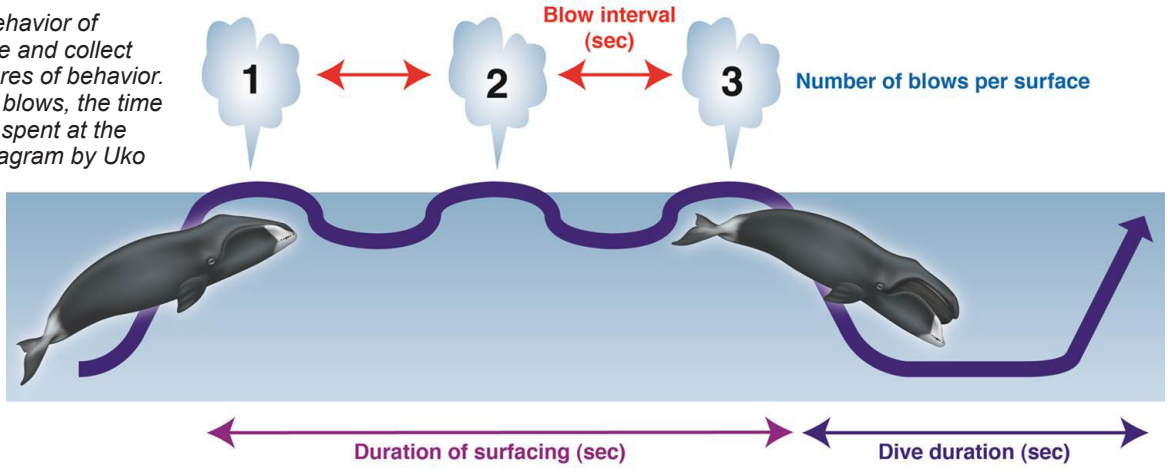
Aerial surveys for bowhead whales are also flown over areas where there are industrial activities. A minimum of two observers constantly scan the sea's surface on either side of the plane noting the number, activity, heading, and location for each whale sighted. These sightings are used to estimate the numbers of whales that are present.

I know from past experience that it is impossible to spot every whale from the air because whales spend most of their lives beneath the surface and out of our view. However, counts can be corrected for submerged whales by knowing something about the surfacing and diving behavior of the whales. The surfacing and diving behavior of whales can be studied by measuring how much time a whale spends at the surface, how many times a whale exhales air (blows) while at the surface, and how long a whale dives (Fig. 1 below). Traditionally these data have been

Aerial observers watching for whales. Photo by Frances Robertson.

Figure 1:

Biologists can observe the behavior of bowhead whales from a plane and collect four main quantifiable measures of behavior. These include the number of blows, the time between each blow, the time spent at the surface and the dive time. Diagram by Uko Gorter.



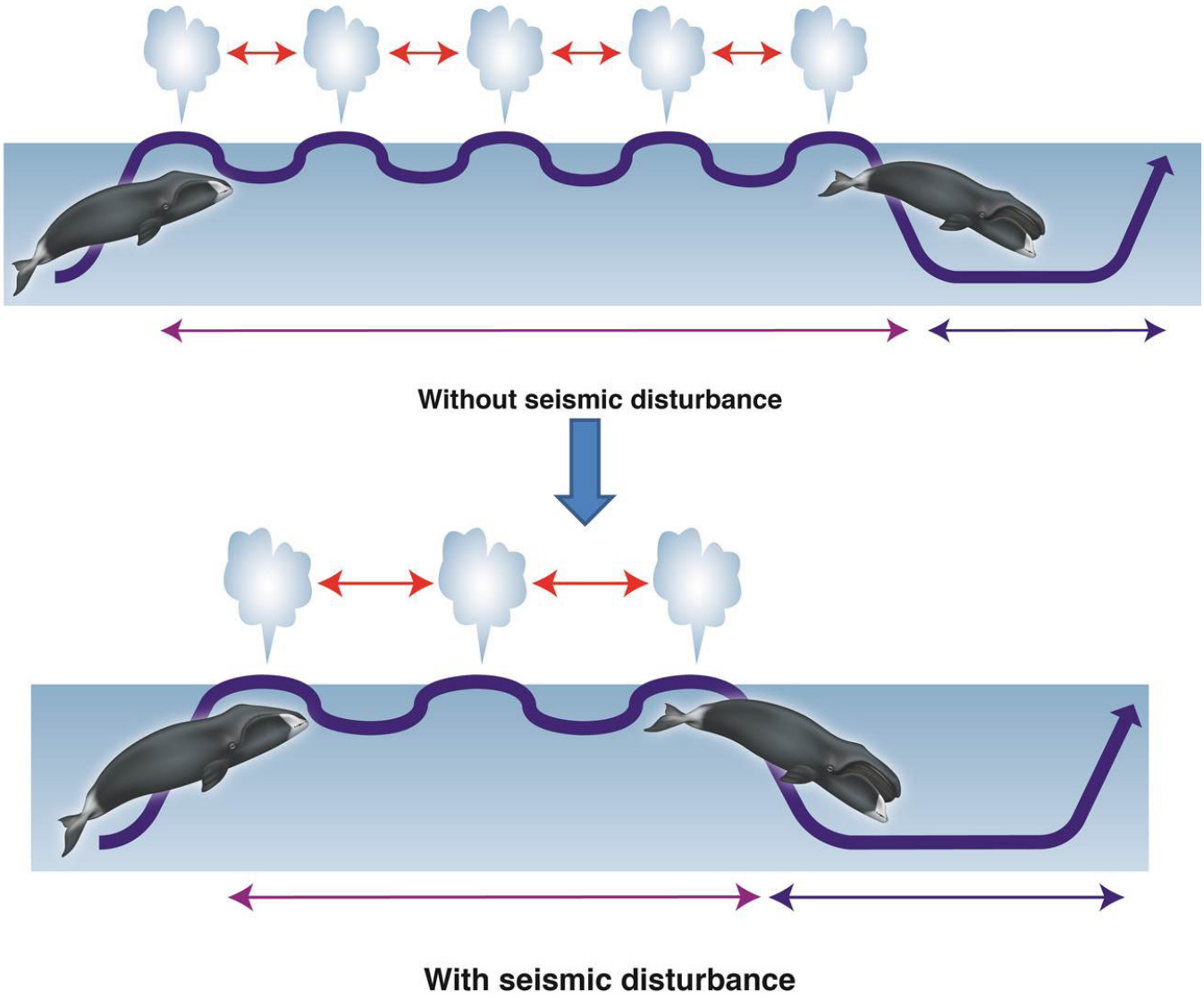
Bowheads, cont.

collected by watching whales over a period of time, either from land, a vessel or from the air. Aircraft provide an ideal platform to observe whales from a distance and collect fine-scale surfacing and diving behavior data without influencing the whales' behavior, which sometimes happens when observers attempt to collect these data from a vessel.

Behavior data collected from aerial platforms also allow whales to be observed under different conditions, including both in the presence and absence of seismic survey operations, allowing biologists to study how these activities may influence the whales' behavior. By comparing the behavior of presumably undisturbed whales with the behavior of whales exposed to seismic survey operations, it was possible to quantify how whales' surface time, dive time and number of exhalations varied when whales were in the presence of seismic survey operations.

Figure 2:

Bowhead whales change their surfacing and diving behavior in the presence of seismic survey operations, so that, in general they spend less time at the surface. The top diagram depicts a typical surface and dive cycle for an undisturbed whale, while the bottom diagram depicts a typical surface and dive cycle for a bowhead whale exposed to seismic survey activities. Diagram by Uko Gorter.



Bowhead whales are known to vary their surfacing and diving behavior when exposed to seismic survey operations, although it was unknown whether these changes in behavior differed by season, reproductive status and activity (feeding, socializing and travelling). By incorporating these variables into my analyses, I was able to determine that changes in behavior of whales exposed to seismic operations were context dependent (i.e., they were contingent on the whale's circumstance and activity).

During my Ph.D., I discovered that the surface and dive behavior of undisturbed whales and whales exposed to seismic survey operations were different (Figure 2). Whales varied their behavior in such a way that they were, in fact, less likely to be seen by observers during aerial surveys. This means that an animal that this is already difficult to count because it spends such a brief time at the surface is now even more difficult to count, resulting in observers missing more whales because they are submerged out of sight below the surface of the ocean. This was particularly the case for whales exposed to seismic operations in the autumn, and for travelling whales.

The behavioral reactions of the bowhead whales to seismic survey operations are similar to the changes in behavior that might be expected when whales perceive an unknown threat such as the presence of predators. Similar changes in surface and dive behavior have been observed in other air-breathing marine animals (e.g. marine mammals and sea birds) faced with a threat, including dugongs facing the threat of predation from sharks. When air-breathing marine animals, like whales, are at the surface, they are faced with fewer avenues of escape, so it makes sense for animals that perceive a threat to try and spend shorter amounts of time at the surface.

When whales change the time that they spend at the surface, they inevitably influence an observers' ability to spot and count them as the observer plane flies overhead. Because submerged whales cannot be seen, they are missed by observers, and if these missed whales are not somehow accounted for, then subsequent density estimates for a study region will be biased.

Density estimates for bowhead whales in regions exposed to seismic sound do not currently account for any variations in behavior that result from exposure to seismic operations. However, I was able to quantify the whales' behavioral reactions to seismic survey operations by estimating the bias in whale counts and establishing correction factors for bowhead whales exposed to seismic survey operations.

I calculated these correction factors by combining bowhead whale behavior with the time that a patch of water was within view of the observer in the plane. This patch of water depends on

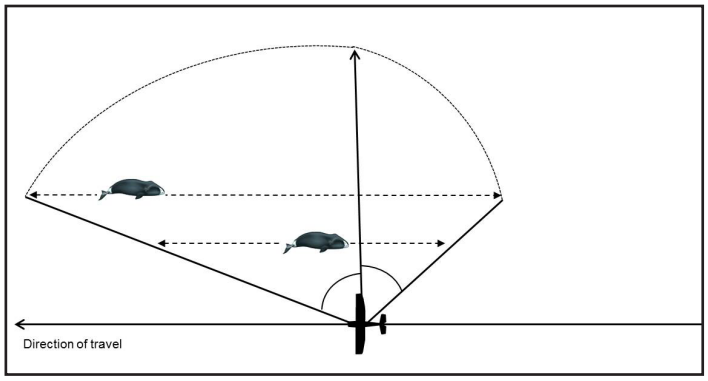


Figure 3:

A diagram of the patch of sea surface where a whale might be seen when it is at the surface. This area is shaped like a slice of pie and its size can be estimated through standard trigonometry.

the speed and altitude of the survey plane, as well as on the plane itself - for example, does the plane have special bubble windows or flat windows. All of these factors result in a specific-sized patch of sea surface within which the observer will have the opportunity to spot a whale should it be at the sea surface. The size of the patch of sea surface can be estimated using standard trigonometry (Figure 3). I found that, in general, bowhead whales were less likely to be seen and counted by observers when the whales were exposed to seismic survey operations. However, the probability of whales being at the surface and available to be

The bubble window of a plane outfitted for marine mammal surveys. This special window allows observers to see the sea surface ahead of the plane as well as directly below the plane. Photo by Frances Robertson.

Bowheads, cont.

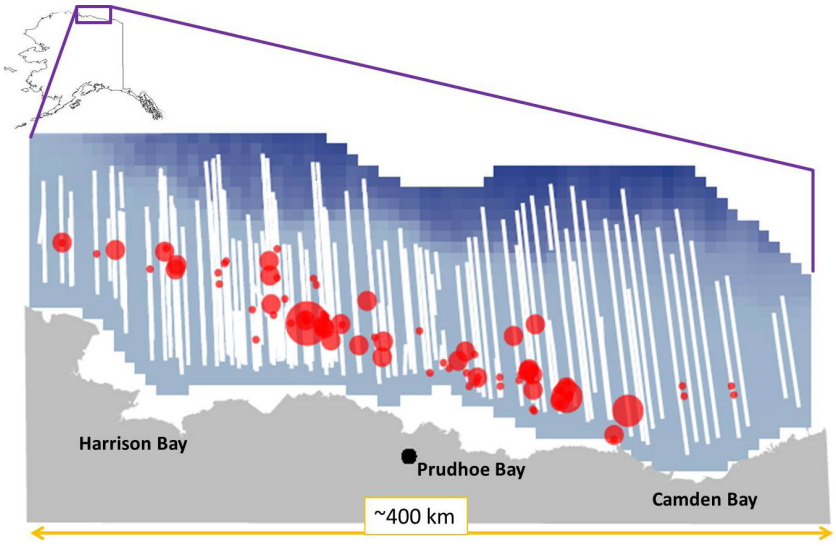


Figure 4:

Aerial surveys were flown over the southern Alaskan Beaufort Sea in the autumn of 2008 in area where seismic survey operations were occurring. This map shows both the transect lines (in white) and bowhead whale sightings (red circles –where the size of the circle corresponds to the group sizes of the whales). Mostly single whales were seen but sometimes groups of up to 4 whales were seen. Depth within the study area is also shown on a gradient scale (0-2500 m); the majority of the study area is on the continental shelf—shown in lighter blue while the continental slope is shown by the darker blue.

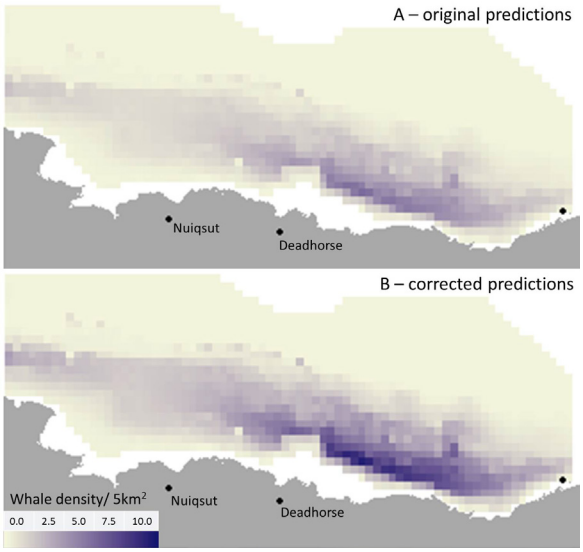


Figure 5:

Predicted densities for bowhead whales in the southern Alaskan Beaufort Sea in the autumn of 2008. The density predictions shown in plot A corrected for the availability bias for undisturbed whales, while the density predictions shown in plot B below, corrected for the availability bias of bowhead whales exposed to seismic survey operations.

counted depended on what the whale was doing, whether it had a calf, and what season it was. For example, bowhead whales were less likely to be counted when traveling and particularly in autumn (regardless of activity, travelling or otherwise).

There were two main areas where seismic survey operations took place in the Alaskan Beaufort Sea during the autumn of 2008, providing an excellent sample dataset with which to test my sightings correction factors (Figure 4). I used my sightings corrections for bowhead whales to create new whale density and distribution estimates for the southern Alaskan Sea during autumn 2008. I then compared these new estimates that accounted for the whales' behavioral reactions to seismic operations with those that did not. I found that density assessments that did not account for behavioral changes (i.e., those that did not use the availability correction factor for whales exposed to seismic operations) underestimated the numbers of whales in the study area. In fact, it appears that previous calculations of the numbers of whales in areas exposed to seismic operations may have been underestimated by 25% to 64%. I also found that bowhead whales were not deflected offshore in 2008 from areas with active seismic operations, but appeared to be lingering in some areas to feed despite the presence of seismic sounds (Figure 5). So my research suggests that bowhead whales are not actually avoiding areas with seismic sounds to the extent that was previously thought but rather their subtle behavioral changes make them harder for us to count. (Figure 5)

There is still much work to be done on this subject; and it will be important to consider factors such as ice presence and prey availability in future analyses of bowhead whale density and use of areas affected by seismic surveys. Both ice presence and prey availability influence bowhead whale distribution in the southern Beaufort Sea, and prey also appears to influence how long whales linger in an area to feed. It also will be important to consider how sound levels from seismic operations vary within the whale's habitat as whales may be avoiding areas where sound levels are particularly high - something that was not possible to quantify with the scale of my analyses because actual sound levels near the whales could not be estimated. However, the ground paved by my research means that the accuracy of future estimates of numbers of whales exposed to, and potentially disturbed by seismic operations, can be greatly improved. This will provide scientists and wildlife managers with a more accurate means of quantifying and controlling the impact of industrial activities on bowhead whales.

Frances is a wildlife biologist based in Vancouver, BC. Frances' research has focused on the impacts of human activities on cetaceans. She has 12 years of marine mammal research experience studying the impacts of coastal and offshore industries on cetacean populations. Her research has taken her from the Alaskan Arctic to the remote islands of British Columbia, the quiet islands of Orkney and to the busy tourist islands of the San Juans in Washington State. She has spent months on seismic survey ships watching out for marine mammals and has flown the coast of northern Alaska monitoring for effects of offshore oil and gas activities on bowhead and beluga whales, ice seals, polar bear and walrus. Frances is also a co-investigator with the Northeast Pacific minke whale project where she is interested in minke whale foraging ecology and habitat selection. She completed her Ph.D. with the Marine Mammal Research Unit, at the University of British Columbia, investigating the effects of seismic survey operation on bowhead whales in the Beaufort Sea. Her doctoral research centered on understanding the behavioral ecology of cetaceans and particularly how animals' behavioral reactions to human activities are context specific.

More information on this research can be found at http://www.distantfin.net/phd-research.html

Notes From the President...

ACS thanks Diane Glim for her service and dedication to ACS.

It has been an honor and a privilege to serve as president of the American Cetacean Society for the past two years, and I'll be passing the torch to the capable hands of Diane Alps in January 2015.

Many thanks to the ACS National Board of Directors that served with me. They were tireless in their support during a time of transition, and all rose to the challenges of operating a successful all-volunteer, non-profit organization that benefits the beloved cetaceans that share our world.

Thank you, Diane Alps, Debra Ternullo, Barbara Bennett, Uko Gorter, Joy Primrose, Lynette Koftinow, Richard Ternullo, Jerry Loomis, Mike Makofske, Sandy Rosenberg, Diane Cullins, Sabena Siddiqui, our Scientific Advisory Council, and Kaye Reznick, our publications editor, for your passion and commitment to ACS.

Thank you to ACS members, benefactors and friends for your continued support of the American Cetacean Society. We could not survive without you.

For the whales,

Diane Glim

Chapters in Action

Lynette Koftinow, San Francisco Bay

Fall is always our busy season and this year more than ever! It has been filled with our monthly presentation series, great whale watching trips, educational outreach events, and our new naturalist training program.

Our Coastal Cleanup Day Sept. 20th was fantastic! People participated in cleanups all around the bay area from inland water ways to coastal regions. Afterwards all volunteers met at the Bay Model Visitor Center in Sausalito for a yummy Thank you BBQ put on by the Lions club, Whole Foods donated the food, raffles and music. The day was gorgeous and such a feeling of accomplishment and celebration.

We had a wonderful time talking with and introducing attendees to SF Bay ACS chapter at the Wildlife Conservation Network Expo on October 11 in San Francisco. We hope that the Vaquita will be the new chosen species to be included in 2015 WCN Expo presentation series.

SF Bay ACS joined in the "Sharktoberfest" event at the Farallones Sanctuary Office at Crissy Field October 18. It was a festive day filled with families, friends, music, face painting, and a "marine costume parade!" All of the participating organizations educated the visitors about their organizations. I was interviewed by a Danish group of professors and their interns from Lillebaelt

Academy of Professional Higher Education, who were in the bay area working on two projects. We will post the interview on our website when it is received.

We have had an incredible first Naturalist Training Program. We limited the class to twenty students with a waitlist ready to begin a new class! Congratulations to our awesome class! We will continue our class with field trips and various other events. A huge Thank you to Lisa Gentile who developed the course and to all of those that helped in its creation, including Melanie Smith.

On September 30 Mary Jane Schramm gave a very educational presentation on the Farallones Marine Sanctuary. Our October 28

we enjoyed a presentation by Sarah Allen on "New Science on California Orcas" that was fascinating to all.

Discovery Days at AT&T Park is always one of our favorite events. The event brought the fun and excitement of science to a huge crowd (30,000). In conjunction with local science outreach groups they had hundreds of hands on activities, numerous performances, interactive demonstrations and family oriented science entertainment.

Be sure to join us for a special November 13 presentation. Our Vice President, Melanie Smith, was chosen as the ACS National

representative to the International Whaling Commission this year. Her presentation will be "Behind the scenes at the IWC."

We offer YEAR-ROUND DISCOUNTS for our SF Bay ACS Members WHALE WATCHING WITH OCEANIC SOCIETY! In the past we have partnered with Oceanic Society for our annual whale watching trips in which they have been so gracious in giving our members a discount. NOW they are going to have ongoing member discounts for both their Farallon Island and Half Moon Bay trips! To receive your discount call the office, letting them know you are a SF Bay ACS member. They will be setting up an ACS discount code on their website in the future. Farallon Island trips (May – Nov.) that are normally $125 per person are $105 for our SF Bay ACS Members. Half Moon Bay trips (late Dec. – mid-May) normally $54 per person are $49. Call or e-mail: Donna Redstone; 415-256-9604 or redstone@oceanicsociety.org Join SF Bay ACS Chapter and Oceanic Society on Research Programs this winter in Mexico!

We are very excited to partner with Oceanic Society on future research trips around the world. Our members will receive a 10% discount on these trips and your money goes toward the important research projects! Our first trips this winter will be Barra de Potosi Humpback Whale Monitoring Research Program February 26-March 5, 2015 and Biodiversity of Southwest Mexico by Land and Sea March 6-14, 2015. You can go on these trips individually or together. Complete information: http://whalesinmexico.com/media/Humpback-Research-Expedition.pdf and http://whalesinmexico.com/media/Biodiversity-SW-Mexico-Tour.pdf

If you are a teacher or student that would like to partner with us on educational projects or creating a SF Bay ACS Ocean Club please notify us. We would love to work with you!

Our Harbor Porpoise Research Project, conducted in collaboration with San Francisco State University and Golden Gate Cetacean Research organization, is going well. We are looking for additional volunteers to participate with us on this project. It is a very exciting project and a fabulous opportunity to work with us and the scientists. For further information please contact: Lynette Koftinow: acs.sfbay@gmail.com.

We are putting a call out for board members, volunteers, and interns to join our active chapter! You have an opportunity to become a board member, volunteer, or intern with us. We have a variety of positions available that require as little as two hours of your time a month. To find out more about becoming a board member or volunteering, please contact Lynette R. Koftinow @ acs.sfbay@gmail.com. Look forward to working with you! For our inspiring monthly presentations, events, SF Bay ACS Student Chapters and school projects, and updates on issues please visit our website: www.acs-sfbay.org and be sure to follow us on Facebook at facebook.com/sfacs.

Joy Primrose, Oregon

Fall has arrived and with it our speaker series meetings have resumed. Our October 11, 2014 program, Current Concerns for Cetaceans, featured two guest speakers. Sage DeLuna of the Surfrider Foundation gave a wonderful presentation on marine debris. She dispelled common myths about marine debris and provided practical suggestions. Lindsay Nelson presented an update on the forage fish campaign and the drift gillnets fishery issues that are currently before the Pacific Fishery Management Council. On November 22 we will meet at the Newport Public Library at 10 AM to have holiday treats and highlights from the 14th International American Cetacean Society Conference. Oregon Chapter members who attended the conference November 7-9 will share information. The December 13 presentation is "Do you speak Whale?" It is about the sounds that different species of marine mammals use to communicate, navigate, forage, and how scientists use them for ecological and conservation purposes, given by Slene Fregosi and Niki Diogou of the CIMRS Bioacoustics Lab at OSU Hatfield Marine Science Center. The meeting will be held at 10 AM in the Newport Public Library meeting room.

Sabena Siddiqui, Student Coalition

The American Cetacean Society Student Coalition (ACSSC) is going strong in Indiana and Hawaii while new groups are forming!

The ACSSC - University of Hawaii has had another great semester. Their campaign was focused on beach cleanups in the local beaches of Hawai'i where many students helped in the effort to maintain a healthy ocean through picking up debris from the shoreline. Guest speakers from NOAA and other marine programs, for example, Dolphin Smart, came to speak to their members about marine mammal research, conservation and internship opportunities. Two officers, Brijonnay Madrigal (President) and Kara Rockstad (Treasurer) attended the ACS conference this November to represent Hawai'i.

The ACSSC- Indiana University kicked off the year with a scavenger hunt, and hosted a dine and donate fundraiser event at a local frozen yogurt shop. In light of the cetaceans in captivity campaign, the group screened "Free Willy." Officer Erin Wilde presented on the J, K and L south resident orca pods. After looking at the whales during the presentation, the group decided to adopt one! Their members got together for dinner and chose Calypso, from L pod. The group plans to continue with the ongoing campaigns when Spring comes around.

Chapters, cont.

One of about 50 sperm whales sighted off Orange County raises its distinctive head in this photo by ACS-OC Naturalist Carla Mitroff, taken October 6 on a trip with Dana Wharf Whale Watching.

Mike Makofske, Orange County

The third quarter was an exciting one for ACS-OC as we built toward the 14th International ACS Conference, held right in our backyard in Newport Beach! A full report will be in the January 2015 Spyhopper.

August saw our best-attended meeting of the year, as a packed room viewed the *Blackfish* documentary, followed by a Q&A with Dean Gomersall, Animal Care Supervisor at the Pacific Marine Mammal Center (PMMC) in Laguna Beach. Dean is one of the former SeaWorld employees featured in the film, and we appreciate him visiting our meeting and sharing his insights.

Our thanks also go out to another PMMC figure, Robb Mead. Robb was our September speaker and he led a lively discussion of the continuing efforts to protect the harbor seal rookery in La Jolla, along with other topics of concern closer to home in Orange County. Robb is an activist with many groups and definitely one the "good guys." We look forward to our continued association with him and PMMC.

This has been a crazy good summer and fall for cetacean sightings off Orange County, highlighted by the October 6 encounter with as many as 50 sperm whales, sighted by boats out of both Newport Beach and Dana Point. It was a magical day, and no one who was there will ever forget it.

Coming up in December: graduation of another terrific group of ACS-OC Naturalists! The graduation meeting is Thursday, December 4, 7:30 pm, at the Costa Mesa Community Center, 1845 Park Avenue in Costa Mesa. All our meetings are free and everyone is welcome, so come meet the new grads!

Diane Alps, Los Angeles

The Los Angeles Chapter of the American Cetacean Society has enjoyed quality speakers, incredible whale sightings and amazing volunteers this year! The Monthly Speaker Series has had record attendance with fascinating speakers, including the most recent:

- Marine Mammal Rescue; and the Impacts of "Blackfish" by Dean Gommersall from the Pacific Marine Mammal Care Center Dean started his career working as an animal trainer at Sea World of Florida and Universal Studios Florida. He is currently the Animal Care Supervisor and Facility Manager at the Pacific Marine Mammal Center and a member of the Orange County Large Whale Disentanglement Team. Dean played a critical role in the documentary, "Blackfish," openly speaking about his experiences working with captive cetaceans. He answered questions about his experiences working with captive animals, his decision to work in rescue and rehabilitation, and the progress that has been made since the release of "Blackfish."

- Marine Mammal Genetics: Recent insights into the taxonomy of fin whales by Eric Archer from Southwest Fisheries Science Center. Eric is a population geneticist in the Marine Mammal Genetics Group. He is using genetics to study to take a close look at the Northern hemisphere fin whales. Eric discussed how the discrete distribution in the North Pacific and North Atlantic has raised the question of whether a single Northern Hemisphere subspecies is valid.

- California Marine Mammal Network by Justin Viesbicke from National Marine Fisheries Service, Protected Resources Division. Justin isthe California Stranding Network Coordinator for NMFS in Long Beach. He is responsible for coordinating marine mammal rescue and rehabilitation with network partners, volunteers and other government agencies. He discussed how the stranding network responds to animals in need of assistance and what causes a majority of these animals to strand.

Whale sightings in Southern California continued to be off the charts throughout summer! Late-running gray whales wandered along the coast, while fin whales, blue whales, humpback whales and minke whales were seen quite regularly. Our "off-season" Whalewatch Naturalists continued to work with Marina del Rey Whale Watch during the summer, and our "off-season" Census volunteers often

reported amazing whale sightings from the shores of the Palos Verdes Peninsula. Whale watching in California, including Los Angeles, offers year-round excitement, and is no longer restricted to the gray whale migration in the winter.

Whalewatch Naturalist program has kicked off in a big way! We have welcomed 60 new volunteers into the program, in addition to the 50+ returning veterans. We look forward to our inaugural whale watch trip on December 26th to kick off the gray whale watch season and give the volunteers their first on-the-water experience.

Want to share in the excitement!? Our Gray Whale Census and Behavior Project is always looking for new whale watchers to help spot whales from the bluffs of Point Vicente..Visit our website for daily sighting reports, last year's report and information on how to sign up. Our Facebook page is the place to go for local whale reports! Find out about local sightings and updates from our Census by following our Chapter's page: acs.lachapter. Our Chapter is very excited to see what 2015 has in store and we hope you'll join in the fun with us! Yea whales!

Uko Gorter, Puget Sound

Since our return to ACS chapter duties in September, after a nice warm Seattle summer break, ACS-PS has been going full force. Our usual monthly meetings, held every third Wednesday of the month, were well attended. Below is a summary of our meetings in the past three months:

September 17: "U.S. Navy Sonar and Marine Mammals: Potential Measures to Mitigate Harmful Effects", presented by Meegan Corcoran. As an ex-US Navy sonar technician, Meegan has a unique insiders perspective on this issue. As such, she discussed additional measures that would increase protection to marine mammals while supporting national security.

October 15: "Too much is never enough: The cautionary tale of Soviet whaling", presented by Yulia Ivashchenko. Yulia told the incredible story of how Soviet whaling was illegally conducted during a 30-year campaign. It is a cautionary tale that has lessons for modern conservation efforts around the globe.

November 19: "Cetacean Celebration: The diversity of Whales, Dolphins, and Porpoises." A slide show of over 90 jaw-dropping photos of all Cetacean species, highlighting the wondrous diversity of the order of Cetacea. The photos are part of the upcoming "Marine Mammals of the World: A comprehensive Guide to their Identification" (Jefferson et al., 2015, Academic Press).

Apart from our monthly meetings, ACS-PS participated in the Southern Resident Orca C.A.L.F. Workshop at the Whale Museum in Friday Harbor (San Juan Island) on October 25. ACS-PS president Uko Gorter served as a co-facilitator of the Education break-out group. The event was very successful, and recently repeated in Vancouver, BC, where our Canadian counterparts were able to participate.

Lastly, Uko Gorter, gave a presentation of the "Marine Mammals of the Salish Sea" at the Islander Middle School, Mercer Island on November 21. The marine biology class headed by Jessica Warnick was quite knowledgeable and appreciative.

Follow us on our ACS Facebook page, and our website: www.acspugetsound.org. We love to welcome new members and attendees!

Richard Ternullo, Monterey Bay

Over 100 people attended Dr. Fred Sharp's presentation about Humpback Whales and Bubble Feeding at the September meeting at Hopkins Marine Station in Pacific Grove. Dr. Sharp, from the Alaska Whale Foundation, provided excellent photos and fielded many questions from the interested audience.

On Halloween night, Skylar Thomas, a shark researcher and filmmaker, showed his White Shark video and discussed the views and controversy surrounding the white shark cull in Western Australia.

A celebration of Alan Baldridge's exemplary life was held in early October at the site of his professional career - Stanford University's Hopkins Marine Station. Alan's legacy of scientific inquiry into the lives of cetaceans was an inspiration to many. The ACS 14th Biennial Conference was dedicated to Alan Baldridge in his honor.

A Legacy of Conservation

The legacy of ACS will be the pivotal role it has played for over 40 years in protecting the world's "ambassadors of the seas." Part of your legacy can be in the support you provide toward this cause. You don't need to be wealthy to make a gift that will have an impact on the future of whales, dolphins, and porpoises and their habitats. A charitable bequest to ACS in your will or living trust will serve as a powerful testimony to your conviction that this work is important to the health and biodiversity of our marine ecosystem.

I hope you'll join me in including ACS in your estate planning. I can't think of a better gift for our children and grandchildren.

Diane Glim

All information about charitable bequests is held in the strictest confidence.

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Thank you for supporting ACS and our mission.

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AMERICAN CETACEAN SOCIETY

On Behalf of Whales, Dolphins, and Porpoises...

ACS Board of Directors:

Read more about our chapters and Board members at www.acsonline.org

Membership in ACS Puts You in Good Company

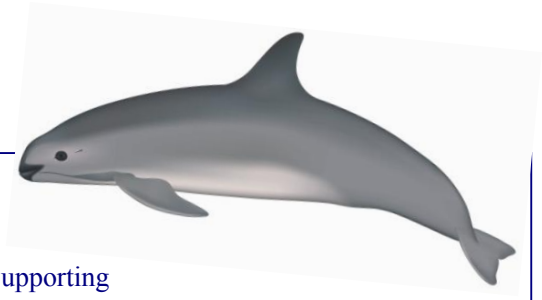
Photo ©Michael Ho, http://MichaelDanielHo.com

The American Cetacean Society (ACS) protects whales, dolphins, porpoises, and their habitats through public education, research grants, and conservation actions. Founded in 1967, ACS was the first whale conservation organization in the world.

ACS is a 501(c)(3) non-profit organization with national headquarters based in San Pedro, California. We have active chapters in Los Angeles, San Diego, Orange County, Monterey, San Francisco, Puget Sound, and Oregon, and a Student Coalition based in Bloomington, IN. We also have new chapters forming in New England and Florida. Members live throughout the United States and in more than a dozen countries.

Join us in our mission, and help us spread the word! You will find many opportunities for education and involvement as an ACS member. **You can join/renew or make a donation** by using the form below, or go to www.acsonline.org and enroll or donate using PayPal. We hope to see you on the active rolls, and would love to have you share in our upcoming *Whalewatcher* journals and online *Spyhopper* newsletters.

Thank you,
Your friends at ACS



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Do you have particular areas of interest in cetacean education, research, and conservation?_____

If you have questions, please call our national office at 310-548-6279 or e-mail acsoffice@acsonline.org

AMERICAN CETACEAN SOCIETY

ACS Annual Appeal

We Can't Do it Without You!

The American Cetacean Society continues to grow and make an increasingly meaningful impact on awareness, education, and protection of whales, dolphins, and porpoises and their habitats. This is due in large part to your support, personal dedication, and willingness to carry our message out to your own contacts and communities.

We hope that you will consider making a donation during this important fundraiser for ACS - our Annual Appeal to members and supporters. Thank you so much for your dedication to the American Cetacean Society - together, we can make a difference!

Diane Glim
ACS Board President

Help ACS protect whales, dolphins, porpoises and their habitats through public education, research grants, and conservation actions.

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☐ **I would like to make a tax-deductible donation to the American Cetacean Society in the amount of: _____$25 _____$50 _____$100 _____Other**

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