

profiles, plankton and micronekton sampling were used to track the 3D movements of water masses, zooplankton and forage fish. Strong tidal upwelling occurs over the shallow sill of the fjord during flood, pushing dense cold waters over the sill, which block the Saguenay outflow and subduct into the fjord with their fish and zooplankton content. This complex 3D circulation generates frontal structures and convergence zones where biomass appears to concentrate until current reversal occurs during ebb. During flood, beluga spatial distribution concentrates around the intense subduction front, where the biomass appeared to accumulate, before being dispersed downstream in the St. Lawrence during ebb with the Saguenay plume. The beluga density tends to decrease then. These results strengthen the hypothesis that beluga whales frequent the Saguenay entrance to feed on tidal aggregations of forage fish generated by fjord sill dynamics.

Habituation of an orienting response to auditory stimuli in California sea lions (*Zalophus californianus*) exhibiting symptoms of domoic acid toxicosis

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Domoic acid (DA) -- a neuroexcitatory algal byproduct differentially targeting the hippocampus -- is increasingly common off the coast of California and worldwide, and is implicated in mass stranding events in California sea lions. DA clears the body within days, so diagnosis of exposure generally requires prohibitively expensive brain imaging or histology. In a first effort to develop a reliable behavioral assay for DA exposure, and to better understand the effect of DA exposure on behavior, 12 sea lions diagnosed with DA toxicosis and 26 controls with no apparent neurological symptoms, all housed at The Marine Mammal Center in Sausalito, CA, were exposed to auditory stimuli in four sequential test phases. Each phase comprised multiple 1-second, ~90 dB sounds presented successively with an inter-trial delay of 5-15 seconds. Each phase was defined by one of two sounds, A and B, presented from one of two diametrically opposite locations, 1 and 2. In phase 1, Sound A was presented from location 1. In phase 2, sound A was presented from location 2. In phase 3, sound A was presented from location 2 following a 15-minute delay. In phase 4, sound B was presented from location 2. A subject's transitioning from one phase to the next was predicated on habituation within a sound phase, defined as no behavioral response to 3 consecutive stimuli. Difference in responsivity between DA subjects and controls across all test phases was highly significant, with DA-exposed sea lions habituating more slowly -- these results are consistent with evidence suggesting humans with hippocampal damage demonstrate delayed habituation to relatively quiet auditory stimuli. Due to consistently high variability, this assay is of limited diagnostic value; however, encouraged by the highly significant responsivity difference between subject groups, we are developing a suite of new behavioral assays we believe will have higher diagnostic resolution.

Correlations between oceanographic variables and *Kogia* strandings in Florida

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Because whales of the genus *Kogia* strand frequently, 18 per year in the state of Florida, it is possible to examine potential correlates with *Kogia* strandings statistically. In contrast, many other whales strand so infrequently that it is difficult to discern meaningful environmental correlates with their strandings. Investigators have demonstrated that certain environmental fluctuations correlate with cetacean strandings in many parts of the world. Florida was divided into four regions and strandings were segregated by region with 70% of the strandings occurring on the east coast of Florida. We attempted to correlate three environmental variables (upwelling coefficient, temperature, and chlorophyll a concentration)

with *Kogia* strandings in Florida from 1977-2007. Square regions (16 km x 16 km) of ocean adjacent to each stranding were examined for the last two weeks prior to the stranding. Each region was divided into 16 sub-regions (4 km x 4 km). For each increment of time the data were averaged over all 16 sub-regions. Temperature data were obtained by the AVHRR Pathfinder satellite; chlorophyll a data were obtained by the MODIS Aqua satellite; and upwelling data were gathered by the NOAA Fisheries Southwest Fisheries Science Center Environmental Research Division. Data were downloaded from NOAA websites and the ERD Live Access Server. Significant changes in upwelling index values were defined as a change of absolute value greater than or equal to 200 m³/s/100 m of coastline. Approximately 47% of the strandings from 2003-2007 showed a correlation with significant changes in upwelling index value within two weeks before the strandings. Approximately 64% of the strandings from 2004-2007 showed the same correlation. There does not appear to be a correlation between strandings and temperature or chlorophyll concentration. The upwelling index analysis from 2004-2007 suggests that nearshore upwelling contributes to *Kogia* strandings in Florida, as found in other studies.

Long-term patterns in the use of harbour seal Haul-Out sites and foraging areas

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Scottish harbour seal populations have suffered recent declines. Protected areas provide one tool to improve their conservation status, but there is limited information on long-term patterns in site-use. This 20 year study investigated changes in the use of haul-out sites and foraging areas within two adjacent estuaries in NE Scotland. Haul-out counts were collected during the pupping season using both land-based and aerial surveys, while the spring and summer foraging areas of adult females were identified using VHF and GPS-GSM telemetry. In 1988, >99% of seals and all mother-pup pairs were located within an estuary that was subsequently designated as a protected area for harbour seals under the EU Habitats Directive. However, by 2008, 30% of seals and 37% of mother-pup pairs were located within an adjacent estuary. It was hypothesised that changes in prey distribution may have resulted in the use of this alternative haul-out site if it reduced travel costs to more off-shore foraging areas. However, although sample sizes were small and individual variability high, foraging adult females were located in broadly similar areas in 1989-1991 and in 2009. Structural changes in sandbanks, shooting of seals or other anthropogenic disturbance remain alternative explanations for why these changes in distribution have occurred. Despite significant declines in adult counts within the protected area, maximum pup counts from the two estuaries combined showed little change during the study. This suggests that the gradual increase in pup counts within the adjacent estuary has sustained reproductive levels in this region. These data highlight the importance of long-term monitoring for understanding the effectiveness of protection of harbour seal breeding sites, and provide insights into the design of marine protected areas that incorporate foraging areas for these populations.

PAGEBREAK

Characteristics of blubber distribution of beluga whales (*Delphinapterus leucas*) in Bristol Bay, Alaska in 2008.

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Blubber stores are an indicator of body condition in marine mammals, and these stores may be expected to vary across seasons, sex and age classes, particularly in species with temporally variable prey resources. Bristol Bay beluga whales feed heavily on rainbow smelt and salmon that are abundant in spring and summer, and may fast or have greatly reduced feeding