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The Major Histocompatibility Complex (MHC) comprises a multigene family encoding glycoproteins involved in adaptive immune responses in vertebrates through presentation of pathogen-derived peptides to T-cells. The high level of polymorphism observed in MHC loci is often explained in terms of its susceptibility to infectious diseases and its protective function against pathogens. Bottlenose dolphin (*Tursiops truncatus*) is the most widely distributed odontocete in coastal ecosystems, and has been used as sensitive indicators of toxic compounds and pathogenic microorganisms in their habitats. In this study, we quantified the adaptive polymorphism level at *DQ*β exon-2 (MHC-II) of 61 individuals from six coastal locations along the Gulf of Mexico & Caribbean Sea. Twenty-eight *Tutr-DQB** allele sequences were detected using the bayesian algorithm PHASE v2.1.1 for haplotype reconstruction in heterozygous individuals, and most were confirmed by TA cloning. These 172bp sequences showed high levels of nucleotide diversity (π=7%) and expected heterozygosity (*He*=0.86) for all locations. All sequences but one presented uninterrupted reading frames consistent with functional loci found in related mammals. This is the first report of an apparently nonfunctional *DQB* sequence for suborder Odontoceti. Significantly higher nonsynonimous divergence at peptide binding region (PBRd_N=28.5%, $p< 0.05$) and a high ratio of non-synonymous to synonymous substitutions (d_N/d_S=6.4) suggests that this locus is subject to balancing (positive Darwinian) selection over long evolutionary time. This evidence was supported by a pattern of trans-specific allele sharing within the suborder Odontoceti, which suggest that closely related species have been expose to same pathogens, and some of them have co-evolved with their hosts. In conclusion, the high level of adaptive polymorphism observed in these coastal dolphins, in congruence with previous high neutral polymorphism data (mtDNA and microsatellites), could be explained by additive variability detected as rare MHC alleles, and trigger a broader range of immune responses against local pathogens (bioindicators).

Modeling recreational boating off the coast of Northeast Florida and its implications for the North Atlantic right whale

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With more than one million registered boaters, Florida is the number one destination for marine recreation in the United States. The number and diversity of recreational boating activities that take place in Florida's waterways and near-shore environments has led to impacts on coastal ecosystems and wildlife. Consequently, there is a need for science-based information that can support efforts to manage the use and protection of Florida's resources. This project is determining the behaviors and spatial patterns of recreational boaters in Northeastern Florida as input to management and education strategies that can reduce impacts to North Atlantic right whales (Eubalaena glacialis), which use the area as calving grounds during the winter months. Map-based surveys of recreational boaters will be compared with oceanographic variables (e.g., sea surface temperature, bathymetry, and distance to shore) to (1) estimate and map the spatial overlap between right whales and recreational boating activities, and (2) to characterize recreational boaters' experience, knowledge and attitudes toward the North Atlantic right whale and other marine life. Boaters observed transiting area inlets over a one-year period will be asked to characterize their activities and draw the routes and water-based destinations associated with their recreational boating trips. Aerial surveys funded by NOAA in the North Atlantic right whale calving ground will complement the map-based boater survey by providing observed point locations for both whales and boats. Spatial analysis will be used to map risk levels of boat/whale interactions as input to targeted education and outreach initiatives aimed at maintaining a high-quality boating environment that is safe for both boaters and right whales.

Live CT imaging of sound reception anatomy and hearing measurements in the pygmy killer whale, *Feresa attenuata*

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In June 2008, two pygmy killer whales (*Feresa attenuata*) were stranded alive near Boca Grande, FL, USA, and were taken into rehabilitation. We used this opportunity to learn about the peripheral anatomy of the auditory system and hearing sensitivity of these rare toothed whales. Three-dimensional (3-D) reconstructions of head structures from X-ray computed tomography (CT) images revealed mandibles that were hollow, lacked a bony lamina medial to the pan bone and contained mandibular fat bodies that extended caudally and abutted the tympanoperiotic complex. Using auditory evoked potential (AEP) procedures, the modulation rate transfer function was determined. Maximum evoked potential responses occurred at modulation frequencies of 500 and 1000 Hz. The AEP-derived audiograms were U-shaped. The lowest hearing thresholds occurred between 20 and 60 kHz, with the best hearing sensitivity at 40 kHz. The auditory brainstem response (ABR) was composed of seven waves and resembled the ABR of the bottlenose and common dolphins. By changing electrode locations, creating 3-D reconstructions of the brain from CT images and measuring the amplitude of the ABR waves, we provided evidence that the neuroanatomical sources of ABR waves I, IV and VI were the auditory nerve, inferior colliculus and the medial geniculate body, respectively. The combination of AEP testing and CT imaging provided a new synthesis of methods for studying the auditory system of cetaceans.

Hearing pathways of the finless porpoise: Form and function in an 'unrepresentative' species

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There are clear variations in the jaw and head morphologies of odontocetes suggesting subtle variation in sound reception. While prior studies have shown mandibular regions are important to odontocete hearing, sound transmission pathway studies have been confined to a few 'representative' species. How an animal receives sound may influence how it uses or is impacted by sound. Here we address how a divergent species, the Yangtze finless porpoise (*Neophocaena phocaenoides asiaeorientalis*), receives sound. Noise impacts on this subspecies are a concern as they inhabit waters with many acoustic sources. Hearing was measured in two animals using auditory evoked potentials. Broadband clicks and low-, mid- and high-frequency (8, 54, 120 kHz) tone stimuli were presented at nine locations on the head and body using a jawphone transducer. Thresholds were compared to anatomical dissections, and computed tomography and magnetic resonance imaging of two finless porpoise. 'Acoustic fat' regions were confined to relatively small areas in the finless porpoise. Minimum thresholds and best hearing locations were from a cheek fat pad and distal to the porpoise bulla. However, mean thresholds were not substantially different at locations from the rostrum tip to the ear (11.6 dB). This is quite different from the bottlenose dolphin and beluga, in which 30-40 dB threshold differences were found across their heads. AEP response latencies were shortest from the cheek pad indicating a preferential sound pathway. Latencies were dependent on stimulus level suggesting hearing pathways which reduce transmission loss can result in both higher amplitude and faster auditory responses. The unique combination of anatomical and physiological data reinforces the importance of sound-conductive pathways. Finless porpoises have relatively less 'shading' of sounds and are potentially more susceptible to masking effects. The results show there are differences in how divergent odontocetes receive sound, supporting caution when applying auditory data across species.

Histological investigation of the "slip" in marine mammal tracheas

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In 1940 Scholander proposed that marine mammals have stiffened upper airways that would stay open and receive air from highly compressible alveoli during diving. However, this idealized alveoli-up system would tend to underestimate the importance of tracheal collapse or the role of the trachea at pressure. There are little data available on the structural and functional adaptations of the marine mammal respiratory system. Although biomechanical and pressure-associated changes have been measured, the aim of this research is to investigate the microscopic tracheal characteristics of five different species of diving mammals, specifically focusing on elastic fibers and distances of cartilage overlap. Our histological measurements have revealed the presence of "slip features" in both pinniped and cetacean tracheas. These "slip features" are characterized by partial or incomplete cartilaginous rings, which, at pressure, will overlap maintaining constricted airways. This finding lends evidence for pressure-induced collapse and re-inflation of the trachea. In some cases, more than one "slip feature" is present per tracheal ring, perhaps allowing for more rapid and effective compression. There is great variation in the anatomy of the "slip feature" between cetacean and pinniped, as some truly overlay one another and others are separated by elastic fibers, connective tissue and smooth muscle. There also seems to be a significant difference between the quantity of elastic fiber in pinniped species versus cetacean species, for example cetaceans tended to have more elastic fibers, perhaps correlating to deeper dive depths or higher ventilatory rates.

Bayesian state-space model of cetacean abundance trends from 1991-2008 time series of line-transect surveys in the California Current

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Estimating temporal trends in marine mammal abundance is central to their management and our understanding of their ecology. However, detecting trend estimates for marine mammals is challenging, particularly within a null hypothesis testing framework, because of variable detection rates across surveys (e.g. due to differences in observers or conditions) and low precision of individual abundance estimates. We demonstrate a Bayesian approach for estimating abundance and population trends, using a time series of line-transect data for cetaceans off the west coast of the United States. A hierarchical model is used to partition the state process of interest (i.e., population density modelled as a function of covariates and random process terms state and observation processes) from the observation process (i.e., observed counts modelled as a function of population density and detection probability using distance sampling theory). Using fin whales (*Balaenoptera physalus*) as an example, Bayesian posterior summaries for trend parameters provide strong evidence of increasing fin whale abundance in the California Current study area from 1991 to 2008, while individual abundance estimates during survey years were considerably more precise than previously reported estimates using the same data. Results for other species show a variety of population trends and are used to illustrate the broad utility of our methods. Our initial work indicates that Bayesian hierarchical modeling offers numerous benefits for analyzing marine mammal abundance trends. These include implicit handling of sampling covariance, flexibility to accommodate random effects and covariates, ability to compare trend models of different functional forms, and ability to partition sampling and process error to make predictions. Bayesian posterior distributions offer a probabilistic and intuitive means of inferring abundance trends that may be obscured by null hypothesis testing.

Got Milk? Aircraft Observations Provide Rare Glimpses into Whale Calf Nursing and Back Riding

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Nursing behavior by large cetaceans in situ is not well described. During ~30,000 km of aerial surveys off Southern California to monitor marine mammals in 2008-2011, nursing behaviors were documented for three species: Eastern Pacific gray whale (*Eschrichtius robustus*), fin whale (*Baleanoptera physalus*) and killer whale (*Orcinus orca*). Photographs, video, notes and audio recordings were used to analyze mother-calf interactions. Back riding occurred in gray and fin whales, as described for bowhead whale (*Balaena mysticetus*) mother-calf pairs by Würsig et al. (1999). During slow sub-surface travel, a fin whale calf swam alongside mother's peduncle area, touching her head-first for short (< 1 min) bouts at a 45° angle. During the sighting (~50 min) the calf switched from one side of the mother's peduncle to the other 12 times, usually by "riding" (n=8) the mother's back or swimming underneath her (n=4). Nursing was