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California sea lions are capable of travelling long distances (~2000 km) and show different levels of dispersion along their range. A defined migration pattern, however, is not known and therefore the population structure is difficult to determine. Recently, Rice (1998) divided the eastern North Pacific sea lions into two species, *Zalophus californianus* (the California sea lion) and *Z. wolfebaeki* (the Galapagos sea lion). The present study seeks to determine the genetic structure of sea lions within the eastern North Pacific and to re-examine the divergence between *Z. californianus* and *Z. wolfebaeki*. 197 skin samples from pups were collected at 11 rookeries along the Baja California peninsula and 2 rookeries on the Channel Islands, off the coast of California. An additional 34 skin samples were collected from animals at the Galapagos islands. A 315 base pair fragment from the hypervariable region I of the control region of the mitochondrial DNA was sequenced. We found: (1) two distinct clades, corresponding to *Z. californianus* and *Z. wolfebaeki*, (2) a strong phylogeographic signal within *Z. californianus*, with one portion of a minimum spanning tree comprised predominantly of Gulf of CA haplotypes and the other portion of the tree comprised predominantly of Pacific coast haplotypes (with a few haplotypes from the central and southern Gulf of California), (3) that haplotypes from the Galapagos are connected to haplotypes from the California sea lion through haplotypes found in the upper Gulf of California, and (4) a number of haplotypes were found only in the upper Gulf of California, each separated by a few base pairs. These data support the separation of *Z. californianus* and *Z. wolfebaeki* as distinct species and indicate the existence of population structure within *Z. californianus*, with a higher degree of isolation and higher number of ancient lineages in the upper Gulf of California.

**Effects of the Lunar Cycle on Dive Patterns of Different Age Groups of Galapagos Fur Seals**Schreer, Jason F.<sup>1</sup>; Mercer, Michael D.<sup>1</sup>; Horning, Markus<sup>2</sup>

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Recent work on the ontogeny of diving behavior of Galapagos fur seals (*Arctocephalus galapagoensis*) has shown that lunar cycles in diel prey migrations exert a stronger effect on diving frequency of juveniles than adults. This study uses the same data to expand on that research, investigating the influence of lunar light intensity on the frequency, depth, and duration of different dive shapes (which may have different behavioral functions) for pups (<1 yr), juveniles (1-2 yr), and adult females. Similar to the previous work, dive frequency of juveniles is more negatively influenced by increasing lunar light levels than adults and pups. This indicates that the more limited diving capacity of younger, foraging animals reduces their ability to compensate for changes in prey depth during the lunar cycle. However, by comparing patterns across dive shapes it appears that adult females are also influenced by lunar patterns. While greater diving capacity allows females to forage over more of the lunar month, higher light levels around the full moon may cause females to shift from more efficient square dives to less efficient deep V dives. This shift in diving patterns may be necessary to support dependent pups and juveniles during periods when they cannot forage. Given the relatively small body mass of Galapagos fur seals (the smallest pinniped) and associated limited diving capacity, and the relatively high mortality rates of young, these animals are living near the threshold of their behavioral and physiological limits. Consequently, the effects of lunar phase on this species is very strong and impacts, in different ways, each age class of Galapagos fur seal.

**Harbor Seals, *Phoca vitulina*, in Rhode Island, USA Waters**Schroeder, Cheryl<sup>1,2</sup>; Kenney, Robert<sup>1</sup>(1) Graduate School of Oceanography, URI, Narragansett, 02282 USA  
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The population of western Atlantic harbor seals, *Phoca vitulina concolor*, has increased in Maine and Massachusetts, USA since the end of bounty hunting in the 1960s and the advent of the federal Marine Mammal Protection Act in 1972. Little is known, however, about the migrant population of harbor seals that occur in southern New England. Until recently, only one long-duration census survey and irregularly occurring counts have recorded the numbers of harbor seals in Rhode Island waters. Since 1993, random regular counts of the locations where harbor seals haul

out semidiurnally have provided the first reliable, synoptic descriptions of harbor seal abundance and distribution in the Rhode Island region of southern New England. Harbor seals seasonally move into Narragansett Bay, Block Island Sound, and Rhode Island Sound. The seals begin arriving in late September and remain for 75% of the year until mid-May. The increase in the number of seals is not linear throughout the sighting season as might be expected from migration trends observed in southeastern Canada. The typical seasonal distribution of harbor seals is unimodal with a peak from late January to April. The number of seals precipitously declines from mid-April to early May; few seals remain in Rhode Island waters by mid-May. The spatial distribution of harbor seals has changed markedly since 1987. The number of locations where seals haul out has more than tripled, though some traditional haulout sites have apparently been abandoned. Twenty-seven haulouts were observed throughout Narragansett Bay and around the offshore island of Block Island. The number of harbor seals in Rhode Island waters between 1973 and 1999 increased significantly ( $p < 0.001$ ) by 12.1%. In 1999, the maximum count was 349 seals, yielding an abundance estimate of 825-1,047 harbor seals.

**Evolution of Pinniped Maternal Strategies: A Phylogenetic Analysis**Schulz, Tyler<sup>1</sup>; Bowen, Don<sup>2</sup>

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Life-history traits often have been considered adaptive if inter-specific comparisons were significantly correlated. However, such analyses are invalid because they fail to recognize that more closely related species are more likely to be phenotypically similar. We used Felsenstein's independent contrasts and Pagel's discrete phylogenetic methods to test 17 adaptive hypotheses concerning the evolution of pinniped maternal strategies. We used 13 life history traits from 9 to 33 species depending on the traits. After removing both the influence of common ancestry and/or maternal mass, relationships between average foraging trip duration and maternal mass ( $r = -0.204$ ,  $p = 0.338$ ) or between trip duration and lactation length ( $r = 0.148$ ,  $p = 0.500$ ) were no longer significant. Only when the walrus was excluded, was there a significant negative relationship between lactation length and maternal mass ( $r = -0.379$ ,  $p = 0.032$ ). Lactation length was negatively correlated with daily milk energy output per metabolic mass ( $r = -0.834$ ,  $p < 0.001$ ) and positively correlated with total milk energy output per metabolic mass ( $r = 0.760$ ;  $p = 0.003$ ). The evolution of abbreviated lactation was not correlated with breeding on unstable substrates within the pinnipeds ( $p = 0.36$ ). Our results show that the lactation length of extant pinnipeds is influenced primarily by phylogeny and secondarily by maternal mass and the energetic cost of milk production. Although quantitative analyses are not possible, predation likely led to the short lactation of phocids. Breeding on unstable pack-ice further abbreviated lactation in phocine species. High pup growth rates, high-fat milk, and high rates of daily milk energy output are adaptations that ensure the rapid transfer of energy during an abbreviated lactation. While foraging trip duration is largely determined by phylogeny, limited fat stores constrain small phocid species to a foraging strategy despite the fasting behaviour of their close relatives.

**Proximate Mechanisms Involved in Pinniped Vocal Communication**Schusterman, Ronald<sup>1</sup>; Reichmuth Kastak, Colleen<sup>1</sup>; Southall, Brandon<sup>1</sup>; Kastak, David<sup>1</sup>; Spillman, Shannon<sup>1</sup>

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Sea lions and fur seals vocalize most in air, seals underwater, and walrus in both media. Sea lion females leave their pups to forage and then reunite with their pups after exchanging signature vocalizations at long range. Calls attracting females to their pups and visa versa are diverse, but are marked by sharp onsets and are frequency and amplitude modulated. Like sea lions, seals that breed on land in crowded rookeries also vocalize more in air. However, with the exception of elephant seals, there is no evidence of mutual vocal recognition between mother and pup in seals. Threats and alarm calls are structurally similar across sexes and species. Pinniped males have individually recognizable calls that they produce in the context of aggressive exchanges. They are repetitive, broadband pulses with rapid onset. A variety of experimental approaches show that although pinniped

vocal behavior is likely under strong hormonal control, the calls also have some degree of plasticity. For example, we have repeatedly found in the laboratory that male California sea lions, male harbor seals, and a female elephant seal are highly vocal during the breeding season and relatively quiet at other times of the year. Despite these strong annual cycles, it is relatively easy to condition the vocalizations of these and other captive pinnipeds. We conclude that the vocal behavior of pinnipeds can be controlled by a variety of environmental conditions including social situations and experimental contexts.

### Polychlorinated Biphenyl Concentrations from Bottlenose Dolphins along the Southeast U.S. Coast and a Probabilistic Assessment of Adverse Health Effects

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Unusual mortality events involving bottlenose dolphins along the southeast U.S. coast and the prospect of an association with persistent organochlorine contaminants (POCs) prompted the National Oceanic and Atmospheric Administration to initiate a collaborative program to evaluate the health status of key populations. The program built upon the model established by the Chicago Zoological Society's ongoing program in Sarasota Bay, Florida and involves live capture and release of dolphins to collect health information and to determine contaminant tissue concentrations via blubber biopsies. The blubber is analyzed for a suite of POCs, including 30 individual polychlorinated biphenyl (PCB) congeners. PCB levels are of particular concern given the body of experimental and epidemiological evidence linking PCB exposure to deleterious effects on reproduction and immune function. Populations have been sampled from specific regions of the southeast coast, including those where anomalous mortality episodes have occurred. In addition to Sarasota Bay, these regions include Matagorda Bay, Texas, Beaufort, North Carolina and Charleston, South Carolina. Approximately 30-40 dolphins have been sampled from each location. Measured total PCB tissue residues for juveniles and adult males were similar and ranged from 9 to 245 ppm. Measured residues for adult females were much lower (1 to 20 ppm), supporting the theory of contaminant offloading from mothers to their young. From the measured PCB concentrations, we derived distributions of exposure for each of the sampled populations. The resultant distributions were compared with a reported threshold concentration for adverse health effects to determine probabilities of the effect level occurring within each population. For all sampled populations, over 90% of juveniles and males had PCB tissue residues exceeding the defined threshold for adverse effects. The results indicate a high probability that the health of dolphins, particularly juveniles and males, from the sampled populations is being adversely impacted by exposure to PCBs.

### Sightings of Blue Whale (*B. musculus*) Calves and Calving Intervals for Known Females in the Sea of Cortez from 1984-2001 and Subsequent Observations off California

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A photo-identification catalogue of 255 individual blue whales (*Balaenoptera musculus*) was compiled from 1984 to 2001 in the Sea of Cortez, of which 45 were determined to be females either through molecular analysis of sloughed skin samples or because they were accompanied by a calf. A total of 42 calves, estimated at between 35-45ft in length, was observed, which suggests that they were one to three months old. Four of these calves were seen again in the Sea of Cortez and photographed in subsequent years indicating some site fidelity. Two other calves first observed in the Sea of Cortez, but not re-sighted there, were later observed off California - one just four months after its initial March sighting off Loreto. Although very little is known about calving in blue whales, a minimum calving interval of two years is generally accepted, with gestation taking 10 to 11 months and nursing lasting approximately 7 months. In this study four females were observed with a second calf, with calving intervals ranging from 2 to 7 years. Matching of photographs

revealed that a significant proportion of the known females (28) observed in the Sea of Cortez had been photo-identified off California (11). Nine of the 11 seen off California were known to have had calves. The high sighting rate of females and calves in the area, as well as the repetition of sightings suggests that the Sea of Cortez is regularly used as a nursery for blue whales. The relative high number of calves observed (16.1%) could be indicative of a recovering population with high recruitment rate, or that a higher proportion of reproducing animals move into the Sea of Cortez during winter months. A crude birth rate from the Sea of Cortez sightings ranges between 0,063 and 0,167 with an average of 0,1.

### The Conservation Status of the Franciscana Dolphin: Evidences of Decline

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The franciscana dolphin, *Pontoporia blainvillei*, is endemic to coastal waters of the western South Atlantic. It is perhaps the most impacted small cetacean in this region mainly because of high levels of by-catch in gillnet fisheries during at least the last four decades. Until very recently, the effects of the by-catch could not be evaluated due to the lack of studies on stock characterisation and abundance and lack of accurate estimates of by-catch. It is the intention of this study to present evidences of decline for a stock inhabiting southern Brazil and Uruguay following a stepwise approach. In this approach we first identify the stock according to a phylogeographic concept. Once the stock has been identified, its size and level of by-catch were estimated. Finally, by modeling the population dynamic of the stock under different scenarios it is suggested that its intrinsic potential rate of increase could not sustain the current levels of by-catch. Population viability analysis also suggests that even halving the current level of by-catch, the stock still presents high risk of decline. Uncertainty about the parameters was modeled and did not change the overall conclusion that there is a high risk of population decline under current levels of by-catch in coastal gillnetting. Therefore, prompt management action is required. Regulation of the gillnet fishing effort and changes on fishing grounds might be the only suitable immediate actions to increase the chances of long-term survival of the franciscana.

### What Can the Phylogenetic and Population-Genetic Relationships of Right-Whale Cyamids Tell Us about the History and Behavior of Right Whales?

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In the North and South Atlantic oceans, *Eubalena glacialis* and *E. australis* carry three species of whale lice (*Cyamus erraticus*, *C. gracilis* and *C. ovalis*). Cyamids are obligate ectoparasites, so they should speciate when their hosts do. Individual whales amount to discrete habitat islands, so the genetic structures of cyamid populations should reflect patterns of migration and of social interaction among conspecific whales. And cyamid molecular clocks are expected to run faster than those of right whales, so cyamid DNA sequences should contain much informative inter- and intra-specific variation. We sequenced portions of the mitochondrial COI genes of cyamids collected in the western North Atlantic and the western and eastern South Atlantic oceans, and we sequenced complete COI and cyt b genes of right whales representing these same three populations. Northern and southern populations of the three cyamid species show substantial synonymous divergences (Ks = 0.3-0.4). A COI synonymous clock rate of 0.05 substitutions/site/MYr was recently estimated for pairs of snapping shrimp isolated by the rise of the Isthmus of Panama; this is similar to calibrations for terrestrial arthropods. Each cyamid "species" is therefore actually a pair of sister species whose last common ancestor is inferred to have lived 6-8 MYr ago. This finding corroborates other evidence suggesting that northern and southern right whales have been isolated for at