FINAL REPORT

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GRANT TITLE: Buoyancy Regulation and the Energetics of Diving in Dolphins, Seals, Sea Lions and Sea Otters

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OBJECTIVE: A comparative assessment of the role of buoyancy regulation in diving mammals.

APPROACH: The swimming and diving characteristics of northern elephant seals and New Zealand sea lions in nature were examined. Swim speed, ascent and descent rates were measured using data loggers attached to the animals in order to compare differences in diving behavior. Differences in diving behavior were compared to the predictions of buoyancy regulation models. These models make predictions whether an animal should use hydrostatic or hydrodynamic buoyancy regulation based on their body size and swimming speed. In a separate study we experimentally examined the relationship between buoyancy and diving behavior in juvenile northern elephant seals. The seals were divided into three treatments: seals that would be made more buoyant (B+), seals that were to be made less buoyant (B-), and control seals (Bc). Their buoyancy was modified through the addition of noncompressible syntactic foam discs (B+) or lead weights (B-) placed inside PVC tubes. Time-depth recorders and the PVC buoyancy tubes were attached to the seals, and they were released in Monterey Bay. The seals returned to Año Nuevo after several days, and the instruments were recovered and the diving data analyzed.

ACCOMPLISHMENTS: The swimming patterns of elephant seals and sea lions fit the predictions of buoyancy models. Given their size and swim speed elephant seals rely primarily on hydrostatic buoyancy, whereas due to the smaller size and faster swimming speeds, sea lions benefit from hydrodynamic buoyancy regulation. We found that the density and therefore buoyancy of adult female elephant seals varies over their long migration trips to sea. Modifications of buoyancy in
juvenile elephant seals only effect descent rate. Seals
descended more rapidly when they were less buoyant.

SIGNIFICANCE: This study demonstrated that buoyancy plays a
significant role in shaping the diving behavior of seals and
sea lions. We found that marine mammals either use either
hydrostatic or hydrodynamic buoyancy regulation depending
upon their swimming speed and diving strategy. True seals
rely more on hydrostatic buoyancy regulation, while sea
lions, fur seals and cetaceans rely more on hydrodynamic
buoyancy regulation.

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## Buoyancy Regulation and the Energetics of Diving in Dolphins, Seals, Sea Lions and Sea Otters.

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### Abstract

We examined swim speed and ascent descent rates in sea lions and elephant seals in order to make comparisons in their diving strategies and how these may be effected by different strategies of buoyancy regulation. We experimentally examined the relationship between buoyancy and diving behavior in Juvenile northern elephant seals. This study demonstrated that buoyancy plays a significant role in shaping the diving behavior of seals and sea lions. We found that marine mammals either use either hydrostatic or hydrodynamic buoyancy regulation depending upon their swimming speed and diving strategy. True seals rely more on hydrostatic buoyancy regulation, while sea lions, fur seals and cetaceans rely more on hydrodynamic buoyancy regulation.