Knowledge of population abundance and trend is crucial for effective management and conservation. Animal abundance is monitored to identify species of concern, to evaluate the success of conservation actions, and to calculate allowable capture of individuals. Because it is rarely possible to count all of the individuals within a population, statistical methods for estimating population size have been developed. Traditionally, these methods rely on visual observations of the species of interest. For cryptic or visually inaccessible taxa, visual surveys often produce imprecise estimates of animal abundance. However, many hard-to-see species produce sounds that are comparatively easy to hear. These sounds can be used as proxies for the animals themselves. Recent advances in recording technology, detection and classification algorithms, and statistical methods have led to the development and rapid growth of passive acoustic monitoring (PAM) and, in particular, passive acoustic density and abundance estimation. For many species, there is enormous potential to use passive acoustic methods to increase the precision of abundance estimates, thereby improving our ability to monitor and detect change in populations over time.

Here, we focus on cetaceans, which are particularly difficult to monitor using visual methods. Given current budgets, it is not possible to detect biologically significant declines for most cetacean populations using traditional visual survey methods and associated statistical techniques. High natural variability in cetacean distributions combined with the high variability in visual surveys (due to cost, conditions, and observer error) lead to low precision in visual abundance estimates. In the U.S., given the current frequency and extent of cetacean surveys, 50\% declines over a 15-year period would be undetectable in 72\% of baleen whale populations, 90\% of beaked whale populations, and 78\% of dolphin and porpoise populations. Even when all available visual survey data are pooled across regions and species groups, declines less severe than 50\% over a 15 year period are only detectable in about half of cetacean families in the Atlantic and Pacific Oceans \citep{Taylor:2006uy}. Without the ability to detect changes in the abundance of these populations, it is nearly impossible to implement effective management actions.

PAM is an excellent alternative to visual surveys for these species, as cetaceans produce echolocation clicks, whistles, and other vocalizations that can propagate long distances underwater. Fixed PAM networks in particular are a relatively inexpensive monitoring technology and can be deployed for months at a time. Compared to aerial surveys, the long deployments of PAM sensors provide data with lower variance, which increases the precision of the resulting abundance estimates and therefore statistical power to detect trends. PAM networks have been used to estimate the abundance of Blainville’s beaked whales \texitit{(Mesoplodon densirostris)} and sperm whales \textit{(Physeter macrocephalus)} in the Bahamas, and to estimate the abundance of the critically endangered Baltic Sea harbor porpoise and North Pacific right whale \textit{(Eubalaena japonica)}, and to document the decline of the critically endangered vaquita \textit{(Phocoena sinus)} in the Gulf of California.

Designing PAM schemes for long-term monitoring of cetacean populations is now feasible through advances in affordable underwater instrumentation, improvements in cetacean vocalization detection algorithms, and development of statistical methods for estimating animal abundance using passive acoustic data. However, there is no framework for optimizing PAM surveys to maximize precision. To date, most studies attempting to estimate cetacean abundance using passive acoustic data have either used existing acoustic datasets or relied on general design principles from the visual survey literature to guide data collection. There is a growing need in science, management, and industry for quantitative design criteria to optimize the implementation of passive acoustic monitoring networks for cetaceans.

We use the Monterey Bay population of harbor porpoise as a case study for evaluating the statistical power of potential passive acoustic network designs to detect trends in abundance. This population occupies a nearshore area approximately 2,500 km$^2$ and consists of approximately 3,700 individuals \citep{Forney:2014vi}. This population is distinct from other harbor porpoise populations along the U.S. West Coast \citep{Calambokidis:1991vj, Chivers:2002tt}. While fishery mortality is currently insignificant for this population \citep{Carretta:2015gz} the population is likely still recovering from take in a set gillnet fishery for halibut that operated in the mid-20th century \citep{Jefferson:1994uf, Forney:2014vi}. There has also been some mortality over the past decade due to bottlenose dolphin \textit{(Tursiops truncatus)} attacks on harbor porpoise in this region \citep{Cotter:2012bf, Jacobson:2014bo, Wilkin:2012dr}. The Monterey Bay population of harbor porpoise has been studied using line-transect aerial surveys since the late 1980s \citep{Forney:1991ul}. Additionally, since XXXX, line-transect aerial surveys for leatherback sea turtles have been conducted in the region using the same survey methodology.

**- Describe approach and objectives**

Cetacean-habitat models have been developed to predict cetacean occurrence using environmental covariates \citep[e.g.,][]{Forney:2012gc, Becker:2014bl, Gilles:2016ep, Becker:2017hz}.