Comprehensive Seabird Baseline Monitoring in the MLPA North Coast Study Region

Revised Plan of Work,
January 23, 2014

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To develop a baseline understanding of seabirds in the NCSR that includes environmental variability, we have proposed three independent yet complimentary elements that will use a combination of long-term monitoring and before-after control-impact designs to characterize seabird abundance, reproduction, diet, and distribution in the NCSR.

OUTCOMES AND DELIVERABLES

Element 1 –Trends in Abundance: We will conduct a region-wide baseline census of seabird breeding populations for focal species (Common Murre, Brandt's Cormorant, Double-crested Cormorant, Pelagic Cormorant, and Western Gull) using standardized aerial photographic surveys of all NCSR colonies during 2014. Additionally, we will analyze regional trends in abundance over a 19-year period (1996-2014) using annual counts of breeding focal species at one colony in the north of the NCSR, Castle Rock National Wildlife Refuge (Castle Rock), and one Colony complex in the south of the NCSR, Vizcaino Rock and Rockport Rocks Complex.

Seabird colony sizes within the NCSR have been extensively monitored by a collaborative effort between HSU, CDFW, USFWS, and UCSC since 1996 using aerial photographic surveys (Capitolo et al. 2006). The colonies photographed cover the entire NCSR and almost all MPAs within it. However, many of these aerial photographs have not been quantified (i.e. the birds in them have not been counted and compiled into a single dataset, particularly since 2004). We will complete the 1996-2014 time series for two focal seabird colonies in the proposed monitoring project.

Counting of archived photographic surveys (1996-2013): We will count currently unprocessed aerial colony survey data for Castle Rock and the Vizcaino Rock and Rockport Rocks Complex following standardized established methods previously described in detail (e.g. Capitolo et al. 2006, Thibault et al. 2010), and develop a database of the two colonies from 1996-2013. Photographs from 1997, 1999, 2001, and 2003-2004 were previously counted (Capitolo et al. 2006) by 'dotting' individual birds in photographs that cover the extent of each colony. Photos from 1996, 1998, 2000, 2002, and 2005-2013 will be counted. This element will yield a nearly unparalleled 18-year dataset on five seabird species identified as indicative of multiple ecosystem features within the North Coast Study Region (see Appendix 1, original proposal).

Baseline surveys (2014): To bring the counts at Castle Rock and Vizcaino Rock and Rockport Rocks Complex up to date, and establish a baseline across the region, we will conduct an aerial photographic mission across the entire region and quantitatively translate those photos into a spatially-referenced dataset of breeding seabird colony sizes during 2014 (Capitolo et al. 2006). This will provide a baseline of current abundance of colony breeding seabirds in the NCSR. Further, at the request of the Monitoring Enterprise (ME), we will collaborate with Gary Falxa, U.S. Fish and Wildlife Service, to provide existing data on Marbled Murrelets during 2014 by the USFWS as part of a project unrelated to the NCSR MPA monitoring program. These data will be graphically provided as part of the reporting associated with Element 1.

Trend Analysis: We will use the long-term data (1996-2014) developed from Castle Rock in the north and Vizcaino Rock and Rockport Rocks Complex in the south in model-based analyses specifically designed to establish a baseline against which the effects of MLPA establishment on seabird colony sizes can be evaluated. Conceptually, the baseline provided by a long-term time series is characterized by two key elements: first, long-term trends in seabird abundance (both region-wide and at individual colonies), and second, the extent, type, and causes of temporal variation in colony sizes. Information on pre-existing trends and temporal variation provides an important means of determining whether changes following MPA establishment are due to changes in management practices or environmental variability. We will use log-linear Bayesian state-space models partitioned into process and observation components (e.g. Moore and Barlow 2011) to estimate the average annual percentage change in total population size, annual change in individual colony sizes, temporal process variance and temporal autocorrelation structure, and observation variance. We will use a Gibbs sampler (a Markov Chain Monte Carlo approach) to estimate the posterior probability distributions of model parameters, using minimally informative prior probability distributions. We propose a Bayesian approach because of the ease of interpretation provided by posterior probability distributions of estimated parameters, which are interpretable as the probability that a trend occurred at a particular rate (Wade 2000). Further, we will estimate statistical power to detect responses of 10, 25, and 50 percent over 2, 5, 10, and 20 year time scales following MPA establishment.

We will additionally use Bayesian generalized additive models (GAMs) to test whether seasonal sea surface temperature (publicly available source: NOAA Pathfinder Sea Surface Temperature dataset) and seasonal net primary productivity data (publicly available source: NASA SeaWIFS/MODIS NPP dataset) predict change in seabird colony population size over time, using a Deviance Information Criterion (DIC) model selection approach (Ward 2008). This approach will explicitly allow evaluation of the extent to which oceanographic variability may confound measurement of the effects of MPA establishment over the short- and long-term, by informing whether observed changes were caused by oceanographic conditions or response to management changes. Finally, we will use Bayesian change point analysis (e.g. Thomson et al. 2010) to identify specific time points at which trends in colony sizes changed, further providing a framework for future evaluation of the impacts of MPA establishment, including the effects of special closures, marine reserves, and marine conservation areas. Further, 7 of the 19 years in the analysis will overlap with colony-specific reproductive data (collected in Element 2).

Element 2 – Reproduction and Diet at Castle Rock: We will quantify nesting phenology, reproductive success, chick diet, and foraging effort of the most abundant seabird in the NCSR, Common Murre, over an eight-year period (2007-2014). At Castle Rock standardized colony-based surveys for murre reproduction and diet have occurred for the last seven years (2007-2013). We will continue these investigations in 2014. Efforts at Castle Rock in 2014 will focus on aspects of Common Murre reproduction and diet. Specifically, we will investigate nesting phenology, elements of reproductive success and prey composition. Most murre colonies in northern California, including Castle Rock, are on islands too distant to be observed from the mainland. The small size of islands along the coast in this region excludes the possibility of human presence at colonies without deleterious disturbance. Thus we will use a remote-controlled video monitoring system capable of viewing the majority of the island. We will use this system to determine hatching success, fledging success, nesting phenology, and the daily composition of prey fed to chicks. All data will be collected using standardized protocols established for murres and used at multiple colonies in the California Current (McChesney et al. 2009, Eigner 2009). Further, this system allows citizen viewing in real-time over the internet and the potential for citizen participation in observing the murres (while preserving the original data for scientific review, if necessary). We plan to include the assistance of volunteers in making observations. Hardware for observations is very complex and equipment failures can occur; accessing the rock to service the equipment after breeding has begun is not possible. If a failure were to occur very early in the process before detailed diet and reproduction data can be obtained, we would make a second attempt in the 2015 using the resources reserved for 2014.

Reproduction: Nesting phenology and success will be determined by monitoring all nests initiated within a 14m^2 area surrounding the cameras (following methods used by the Common Murre Restoration Project 1996-2013; Eigner et al. 2012). This area generally includes about 100 nesting individuals and has been selected to ensure visibility of all nesting attempts. Surveys will begin just prior to the initiation of any nests in the monitored area and occur every other day until all nests had either successfully fledged chicks or failed. During each survey, an observer uses the cameras to determine the status of the nest-sites (i.e., presence of an egg, chick, or nothing). When using volunteer observers the video will be recorded to be verified by a trained technician when necessary.

Diet: For murres, foraging effort is often inferred by quantifying time allocation of breeding pairs during the chick-rearing period because the energy demands on breeding pairs are maximal and, relative to the incubation period, the resulting attendance patterns are more reflective of the conditions of the marine environment (Harding et al. 2007); when food is abundant, breeding pairs will spend up to half of their day together (co-attendance) at the colony and, as food becomes increasingly scarce, the duration of co-attendance is reduced to maintain feeding rates required by young (Burger and Piatt 1990, Zador and Piatt 1999, Harding et al. 2007). In times of extreme food shortage, both members of a breeding pair will leave their chick unattended at the colony while they search for prey (Ashbrook et al. 2008). To quantify time allocation, a subset of chick-rearing pairs (about 15 to 20 per year) will be monitored from dawn until dusk every seven days, beginning when chicks are present at 66% of breeding sites and continuing for a three week period. The daily composition of prey delivered to the colony will be assessed by conducting surveys to observe prey delivery events each day beginning when chicks are present at 10% of breeding sites and ending when 90% of chicks have departed the colony (following Miller and Sydeman 2004). During diet surveys, the camera will be controlled by an observer to detect murres delivering prey to the colony. Each prey item will be identified to the most specific level possible from the video.

Element 3 – Coastal Habitat Use: Many seabird species concentrate in coastal habitats during the breeding season or year-round for nesting, roosting, and foraging. We will apply methods developed by Point Blue Conservation Science for monitoring foraging rates and distributions, breeding population sizes and distributions, productivity, and disturbance rates of seabird focal species within coastal habitats of the South Coast and North Central Coast Study Regions to the NCSR. Potential study sites we will evaluate for inclusion in the monitoring program early in 2014 are, from south to north, MacKerricher SMCA, Ten Mile Beach SMCA and SMR, South Cape Mendocino SMR, and Pyramid Point SMCA. Sites initially proposed and currently excluded, that we will still consider as alternative sites, are Samoa SMCA and Reading Rock SMCA. These sites and matched references should allow for data collection on foraging rates and distributions, and transects, while MacKerricher SMCA, South Cape Mendocino SMR, and Pyramid Point SMCA provide the best potential sites for nest and roost monitoring.

Foraging rates and distributions: For each rocky coast MPA identified above, we will monitor the abundance of foraging seabirds at one site inside the MPA and one control site several km away from the MPA. Our objectives will be to 1) define within-season foraging trends and 2) determine if seabirds and marine mammals forage more inside or outside MPAs. We will conduct surveys from April through July in 2014 and 2015. We will survey each site once a week during one of the following time periods: 0600-0900, 0900-1200, 1200-1500, or 1500-1800, rotating sites among the four time periods per week to develop a complete 12-hour assessment of foraging activity. We will make observations from a single observation point, using binoculars and a 20-60x spotting scope to record the numbers of foraging individuals for all species observed within a 1km radius (see Figure 3 contained in Appendix 1 for sampling scheme). We will record only those animals that are actively foraging. We will describe seasonal and spatial trends for individual species as well as for indices of species richness and diversity.

Transect monitoring: The goals of transect monitoring are three-fold: 1) to document the size and distribution of annual breeding and roosting populations for each focal species within the NCSR study area, 2) to identify nests that can be followed for estimating annual productivity, and 3) identify areas of dense breeding and roosting populations to monitor for disturbance. We define a transect as a length of coastline that can be surveyed within a four-hour period. We will divide each transect into manageable counting blocks based on easily recognizable geographic features. We will define observation points along each transect. During a given survey, observers will travel to each observation point and view the counting blocks assigned to that observation point. Figure 4 in Appendix 1 shows an example of a transect that we established in the South Coast Study Region. Beginning the week of April 1, we will conduct one transect survey per week at each of the areas identified above. Surveys will be conducted between the hours of 0600 and 1000 as this is the peak time for Pigeon Guillemot rafting activity and roosting activity by non-breeding birds. For each survey, we will begin at one end of the transect and visit each observation point. We will alternate starting points between the north and south ends of the transect on a weekly basis to minimize time bias on guillemot raft counts. From each observation point, we will scan the adjacent count blocks using binoculars and a spotting scope. We will record the number of nesting, roosting, and rafting (for guillemots only) birds observed within each counting block. We will do this for each of the focal species identified above. Additionally, we will use a detailed map of the study area to mark 1) individual rocks within a given counting block that have high abundances of breeding and/or roosting birds and 2) the specific location of Black Oystercatchers and 3) the specific location of Marbled Murrelets. These data will be used to identify rocks for disturbance monitoring, to estimate territories of breeding oystercatcher pairs, and to identify locations of Marbled Murrelet in the sampled nearshore environment.

Nest monitoring: The overarching goal of nest monitoring is to record annual nesting phenology and estimate annual colony productivity. Both phenology and productivity are good indicators of the underlying oceanographic conditions affecting annual population size. Recording phenology requires weekly checks on individual nests within a given colony. Productivity can be calculated as either 1) the number of fledglings produced per adult breeding pair or 2) the percentage of total eggs laid that hatched and successfully grew into fledglings. The first calculation requires only knowledge of the number of fledglings produced within a given nest. The second requires more detailed knowledge of how many eggs were laid, how many of those eggs hatched, and how many of those chicks fledged. For each focal area possible, we will follow 30 nests of each focal species. We will identify monitorable nests during our transect surveys of each focal area. A monitorable nest is one for which eggs, chicks, and fledglings can be clearly viewed and enumerated without disturbing the nesting adults. Once nests are identified, they will be monitored every 7 days. During each monitoring visit, we will record 1) nest condition, 2) number of adults attending the nest and whether one is in incubating posture, 3) number of eggs, 4) number of chicks, 5) the feather condition of chicks, 6) number of fledglings and 7) if nest fails, the reason for nest failure.

Disturbance Monitoring: The goals of disturbance monitoring are 1) to identify human activities that cause disturbance, 2) to identify human activities that do not cause disturbance, 3) to estimate rates of human-caused disturbance at individual colonies, and 4) to estimate rates of natural (e.g., predator-caused) disturbance at individual colonies. Disturbance is defined as any event that results in birds flushing from rocks, displacing from nest sites, exposure, displacement, or loss of eggs or chicks, and visible signs of agitation. We will monitor for disturbance during all foraging, transect and nest monitoring surveys. At the beginning and end of each survey, we will record the number of breeding and roosting birds present for each species. During each, we will record all land-based human activity and boat traffic within 1,500 feet, and aircraft flying at altitude of $\leq$1000 feet and within 1,500 horizontal feet of the colony, regardless of whether disturbance occurred or not. Additionally, we will record all natural events (e.g., predatory bird flying over, large waves crashing) that cause disturbance. If disturbance occurs, we will record the number of nesting and roosting birds present for each species, number of birds disturbed and reaction type for each species, number of nests with eggs and chicks exposed for each species, source of disturbance, source altitude and distance from nesting area affected, activity of disturbance source, identification information (e.g., type of vessel or aircraft and any identifying information like license number), direction of travel/duration, and photographic or video evidence.

Graduate Education / Citizen Science: The goal of including a graduate education and citizen science element to this proposal is to expand the level of community involvement in the proposed monitoring program, and to evaluate the effectiveness of including citizen science in future shore-based monitoring efforts within the NCSR and for seabird responses to MPAs in general. We will collect citizen science shore-based monitoring data in collaboration with local volunteer groups during the 2015 field season. The Humboldt Bay/Crescent City areas are home to several science / advocacy NGOs that provide a strong volunteer base for such efforts, including the Redwood Region Audubon Society, Humboldt Bay Keeper, and the Surfrider Foundation. We propose data collection using a simplified version of the protocols described above and a graduate student technician / coordinator. A graduate student (M.S.)

advised by Barton at HSU beginning in the fall semester of 2014 will coordinate citizen science data collection efforts and conduct thesis research focused on quantitatively evaluating the quality of citizen scientist data, particularly focused on sampling variance and costs, compared to data collected by professional biologists.

OUTCOMES AND DELIVERABLES

All data collected will be archived with appropriate metadata following the Monitoring Enterprise metadata standards. At the end of the baseline funding period, all data from each monitoring element will be delivered to the Monitoring Enterprise. For Element 1 this will include a digital copy of the 2014 photos and counts of those photos as well as counts of photos that were loaned to the project. For Element 2 we will provide the link for streaming video in real time. The master recordings that were used to back-up Element 2 will eventually be stored with the US Fish and Wildlife Service at Humboldt Bay National Wildlife Refuge.

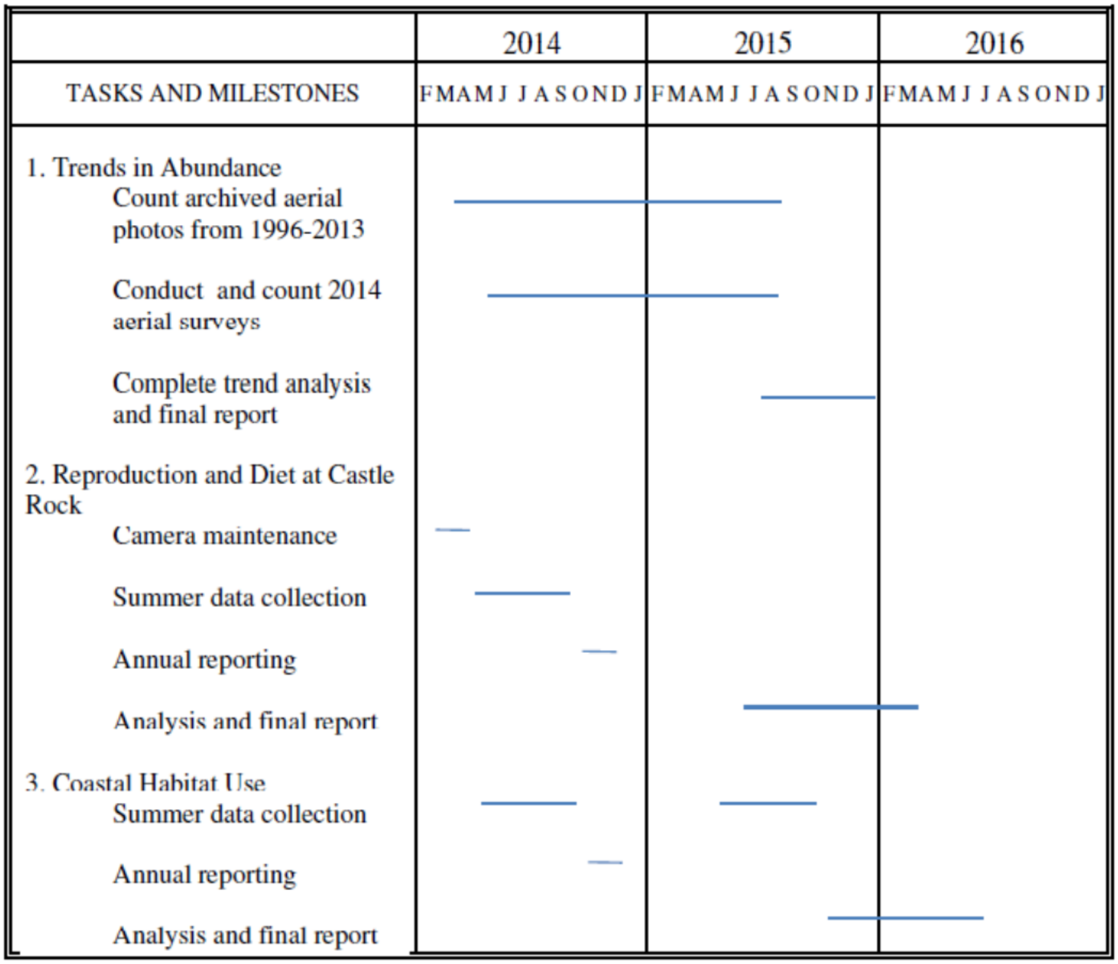
Each proposed monitoring element will produce annual progress reports to Sea Grant and the Monitoring Enterprise on the status of monitoring efforts, including brief summaries of monitoring metrics and overall progress. These reports can also be used to keep policy-makers, managers, educators, and the general public engaged in the MLPA process and informed about the 'health' of seabird populations in the region. Each monitoring element will produce a final report that 1) retrospectively evaluates the value of continued seabird monitoring conducted by each element and 2) integrates the baseline monitoring data with what is currently known about seabird populations, and seabird indicator value, within the NCSR and more generally. These final reports will be combined as individual chapters in an overall final report with an overall introduction and discussion added to include one set of monitoring recommendations.

Element 1 - Trends in Abundance: Tasks associated with the trends and 2014 aerial survey components of this monitoring element will be completed in 2015, with an annual progress report in early 2015, and a single final report including the trend analysis completed by December 31, 2015.

Element 2 - Reproduction and Diet at Castle Rock: Data collection will be conducted during summer 2014 (unless technical difficulties or weather require a delay to 2015). An annual progress report will be submitted following the 2014 summer field season, by the end of the 2014 calendar year. A final report with reproductive and diet outcomes for 2014 and analysis of the temporal variability across available years of data for these monitoring metrics will be submitted in late 2015.

Element 3 – Coastal Habitat Use: Data collection will be conducted during 2014 and 2015, with an annual report in late 2014 and a final report in early 2016. The citizen science/comparison component of data collection will begin in 2015 and results will be included in the 2016 final report for this element.

MILESTONES AND TIMELINES



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APPENDICES

Appendix 1: Original August 2013 Proposal SeaGrant North Coast MPA Baseline Program RFP, "Comprehensive Seabird Baseline Monitoring in the MLPA North Coast Study Region", prepared by Richard Golightly, Daniel Barton, Daniel Robinette, Jaime Jahncke, Craig Strong, and Breck Tyler.

Appendix 2: December 2013 Funding Offer Response Letter to the Monitoring Enterprise, prepared by Richard Golightly and Daniel Barton.

Appendix 1: Comprehensive Seabird Baseline Monitoring in the MLPA North Coast Study Region

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Proposal to California SeaGrant North Coast MPA Baseline Program RFP, August 2013

PROJECT LEADERS AND ASSOCIATED STAFF

Project Leaders

Richard T. Golightly (Ph.D.) is Professor Emeritus in the Department of Wildlife at Humboldt State University. He will lead the overall project and supervise efforts at Castle Rock National Wildlife Refuge and coordinate with UC Santa Cruz.

Daniel Barton (Ph.D.) is an Assistant Professor of Quantitative Population Ecology in the Department of Wildlife at Humboldt State University. Daniel received a B.S. from the Evergreen State College in 2001 and a PhD in Organismal Biology and Ecology from the University of Montana in 2012. He will supervise the at-sea surveys, coordinate HSU's component of the collaborative monitoring effort with Point Blue, and conduct long-term trend analyses.

Daniel Robinette (M.S.) is the Coastal Program Leader at Point Blue Conservation Science (formerly PRBO Conservation Science). Robinette earned his Bachelor of Science in Marine Biology from California State University, Long Beach (CSULB) in 1998 and his Master of Science in Biology from CSULB in 2003. Robinette will develop shore-based monitoring protocols to ensure all data are comparable to data collected in the NCCSR and SCSR. Robinette will take a lead authorship role on annual and final reports for this project.

Jaime Jahncke (Ph.D.) is the director of Point Blue's California Current Initiative. He received his Ph.D. in Biological Sciences from the University of California Irvine (2004), working under the supervision of Dr. George L. Hunt Jr., studying how physical processes associated with coastal waters affect the abundance and distribution of marine birds in Peru and Alaska. Jahncke will advise on at-sea protocols to make data comparable to at-sea data collected in the NCCSR. He will also edit the annual and final reports for this project.

Craig Strong (M.S.) is the owner, operator, and senior biologist at Crescent Coast Research. He received a B.A. in Biology from the University of California, Santa Cruz in 1984, and a M.S. in Marine Science from Moss Landing Marine Laboratories – San Francisco State University in 1991. Strong will coordinate shore-based data collection in the northern portion of the NCSR with Point Blue and HSU.

W. Breck Tyler (M.S.) is a Principal Investigator/Specialist with the Institute of Marine Sciences at the University of California, Santa Cruz. He will assist in overseeing aerial photographic surveys and analyses of colonies.

Associated Staff

Phil Capitolo (B.A.) is an Associate Specialist with the Institute of Marine Sciences at the University of California, Santa Cruz. He will lead 2014 aerial photographic surveys of breeding colonies of surface-nesting seabirds, and will lead determination of whole-colony counts of seabirds and nests from aerial photographs, including coordination with and guidance of HSU staff.

Julie Howar (M.S.) is the data manager and GIS specialist for Point Blue's California Current Initiative. She received her bachelor's degrees in Aquatic Biology and Environmental Studies from UC Santa Barbara, and her master's in Applied Geography with a minor in Wildlife Science from New Mexico State University. Howar will provide mapping support and maintain data collected within Point Blue's database. She will work with the Monitoring Enterprise to ensure metadata standards are met and all data from this project are delivered in an acceptable format.

Eric Nelson (M.S.) is Refuge Manager for the U.S. Fish and Wildlife Service's Humboldt Bay National Wildlife Refuge, which includes Castle Rock. He will assist in overseeing efforts at Castle Rock and coordinate between agencies.

Ken Griggs (M.S.) is Deputy Refuge Manager for the U.S. Fish and Wildlife Service's Humboldt Bay National Wildlife Refuge. He will assist in day to day operation of efforts at Castle Rock.

PROJECT GOALS AND OBJECTIVES

A comprehensive seabird monitoring effort designed to evaluate Marine Protected Area (MPA) performance in the North Coast Study Region (NCSR) is proposed. This monitoring program will establish a robust baseline characterization of regional marine ecosystems by quantifying seabird abundance, reproduction, diet, and related interannual variance, as well as at-sea distributions. This baseline characterization will serve as a foundation to assess the initial and long-term response of seabirds and marine ecosystems to establishment of MPAs.

MPAs may impact seabirds directly, through better protection of nests and by reduced fisheries-related mortality, and indirectly, through altered prey communities. However, to link changes in marine ecosystems to MPAs using seabirds, efforts must be comprehensive enough to distinguish between seabird responses to environmental forcing (i.e., variable oceanic conditions) from their responses to changes in marine ecosystems caused by MPAs. Therefore, to develop a baseline understanding of seabirds in the NCSR that includes environmental variability, we have proposed four independent yet complimentary elements that will use a combination of long-term monitoring and before-after control-impact (BACI) designs to characterize seabird abundance, reproduction, diet, and distribution in the NCSR. Additionally, the multiple seabird species residing within the NCSR utilize a diverse array of habitats. Thus, some elements will focus on MPA impacts to coastally breeding species that forage close to shore while other elements will use more pelagic-oriented seabirds as indicators of the regional oceanographic conditions that mediate change within MPAs. Collectively, these elements will: (1) yield significant power to detect seabird and ecosystem responses to MPAs over various time scales, and (2) provide a whole-region assessment that includes nearly all 27 MPAs within the NCSR and examines most of the ecosystem features identified by the Science Advisory Team (Table 1). This effort will integrate a diversity of collaborators and strengthen cooperative efforts between Humboldt State University, University of California-Santa Cruz, The U.S. Fish and Wildlife Service, Point Blue Conservation Science, and Crescent Coastal Research (Table 2).

Element 1 –Trends in Abundance: We will conduct a region-wide baseline census of seabird breeding populations for focal species (Common Murre, Brandt's Cormorant, Double-crested Cormorant, Pelagic Cormorant, and Western Gull) using standardized aerial photographic surveys of all NCSR colonies during 2014. Regional trends in abundance over a 19-year period (1996-2014) will be quantified using annual counts of breeding focal species at one colony likely to be influenced by MPAs, Castle Rock National Wildlife Refuge (Castle Rock), and one reference colony, False Klamath Rock. Standardized aerial photographic surveys have occurred at these two colonies annually since 1996. We propose to continue aerial surveys of these two colonies in 2014 to (1) establish the current baseline and (2) strengthen our ability to distinguish seabird responses to environmental forcing from MPA-induced changes in marine ecosystems using the proposed metrics. This element will characterize the current abundance of and spatiotemporal variability in seabirds breeding in the NCSR, providing a baseline against which future changes can be judged. Monitoring trends in seabird colony sizes and examining their relationships with ancillary data on oceanographic conditions can provide key contextual information on long-term (often lagged) response of seabird population size to MPA establishment.

Element 2 – Reproduction and Diet at Castle Rock: We will quantify nesting phenology, reproductive success, chick diet, and foraging effort of the most abundant seabird in the NCSR, Common Murre, over a nine-year period (2007-2015). At Castle Rock, a colony likely to be impacted by MPA-caused changes in ecosystems, standardized colony-based surveys for murre reproduction and diet have occurred for the last seven years (2007-2013). We propose to continue these investigations in 2014 and 2015 to strengthen our ability to distinguish seabird responses to environmental forcing from MPA-induced changes in marine ecosystems. This element will characterize the current state of the NCSR in terms of seabird productivity and prey availability, including a quantitative assessment of murre diet, providing a baseline against which future changes can be judged. Because seabird reproduction and diet rapidly respond to changes in the marine ecosystem, including changes at a regional level, this element will effectively indicate short-term (rapid) changes in the composition and abundance of prey used by seabirds that may result from MPAs.

Element 3 – Coastal Habitat Use: We will quantify the distribution of foraging flocks and foraging rates, breeding population size and productivity, roosting distributions, and the rates of human disturbance at breeding and roosting sites for focal species (Pigeon Guillemot, Pelagic Cormorant, Brandt's Cormorant, Black Oystercatcher, and Western Gull) within study sites accessible from shore. To do this, monitoring will occur at series of shore-based sampling sites at MPAs and reference sites across the NCSR. Monitoring foraging rates and distributions, breeding population sizes and distributions, and productivity of seabird focal species at MPAs and reference sites will provide a test of the foraging benefits of MPAs to seabirds and the relationship of foraging benefits to seabird population size and productivity. Monitoring roosting site locations and rates of human disturbance at breeding and roosting sites will provide a test of how MPAs may provide protection for seabirds from disturbance. Methods used in this element are part of a standardized approach across multiple Study Regions within the entire California MPA system and represent an important integration with monitoring efforts designed to test the potential benefits of MPAs for seabirds at a larger spatial scale.

Element 4 - At-sea Distribution: We will quantify at-sea distributions of seabirds (focusing on Common Murre, Brandt's Cormorant, and Cassin's Auklet) at a subset of NCSR MPAs and reference sites, providing a standardized repeatable survey of at-sea foraging and chick-rearing distributions from near-shore to deep ocean habitats. Monitoring at-sea distributions of foraging seabirds inside and outside of MPAs will allow us to determine 1) response of seabird foraging distributions to oceanographic variability and 2) if MPAs may provide foraging benefits to seabirds and cause shifts in seabird foraging distribution. These data will be combined with other at-sea survey data collected from 2013-2016 and with ancillary oceanographic measurements to further define the relationship between environmental variability and biological response, providing context for interpretation of other monitoring metrics.

RATIONALE

Marine Protected Areas (MPAs) alter marine ecosystems and food webs directly, by reducing anthropogenic impacts on the survival and reproduction of marine organisms (Halpern and Warner 2002), and indirectly, through changes in food web structure and trophic structure that may in turn influence behavior, distribution, and abundance of other organisms (Weeks et al. 2010). The widespread impacts of fisheries and other consumptive uses on fish populations and marine ecosystem structure and function have motivated the establishment of MPAs around the world in an attempt to conserve fisheries resources and promote ecosystem health (Agardy 1994). Monitored direct and indirect effects of MPA establishment vary from undetectable to dramatic across a range of marine ecosystems worldwide (Halpern and Warner 2002, Lester et al. 2009). Due to the difficulty of observing all the diverse components of marine ecosystems, many monitoring programs have focused on specific readily-observable organisms whose biology provides an indication of harder-to-observe changes in marine ecosystems (Boyd et al. 2006, Piatt et al. 2007, Le Bohec et al. 2013). Organisms that feed at the top of marine food webs (top predators), which include seabirds, marine mammals, and predatory fish, have been widely recognized as indicators of ecosystem change (Boyd et al. 2006, Einoder 2009). Population sizes, foraging behavior and diet, and productivity of top marine predators, which are principally controlled by bottom-up processes, are strongly influenced by prey distribution and abundance which they effectively indicate (e.g. Velarde et al. 2013). Yet, top marine predators may also exert important top-down influences on prey populations (Estes et al. 2011) making them not only indicators but vital components of marine ecosystems (Heithaus et al. 2008, Myers et al. 2007). Further, their economic and cultural value makes them an important utilitarian natural resource (Anderson et al. 1976). Seabirds and other top predators have generally declined worldwide due to loss of nesting habitat, direct mortality from fisheries, pollution, and reductions in marine ecosystem function (Croxall et al. 2012) and continued loss of these predators may cause dramatic alterations in food web structure and ecosystem function (Heithaus et al. 2008, Myers et al. 2007, Estes et al. 2011).

We propose the use of seabirds as an ideal top predator guild to monitor the ecosystem effects and benefits of MPAs and the regional oceanographic conditions that influence ecosystem response within the NCSR. Seabirds may directly and indirectly benefit from MPAs because of decreased fisheries impacts (bycatch, entanglement, light attraction), reduced disturbance to nesting colonies, and increased abundance of prey populations. Seabirds are well studied and they have been widely adopted as indicators of change in marine ecosystems (Diamond and Devlin 2003, Piatt et al. 2007, Einoder 2009). Seabirds are uniquely observable marine predators; they derive food from the marine environment, yet are constrained to the ocean's surface and nest on land (Schreiber and Burger 2001). Given the value of seabirds as indicators and as key members of marine ecosystems, establishing baselines of seabird abundance, reproduction, diet, and distribution within the NCSR to evaluate future changes will provide a valuable tool for quantifying and characterizing the short-term and long-term effects of MPAs on marine ecosystems. Each of these alternative seabird monitoring metrics provides alternative strengths and drawbacks as indicators of ecosystem change (Piatt et al. 2007, Einoder 2009) and as metrics of short-term and long-term seabird population health (Schreiber and Burger 2001). For instance, seabird reproductive phenology, foraging behavior, and diet may rapidly respond to physical and biological changes, sometimes before these changes are detectable via other monitoring metrics (e.g., Mills et al. 2007, Wolf et al. 2010, Velarde et al. 2013). Yet, seabird populations can be buffered from the effects of short-term environmental variation by their generally long life spans and plastic behavioral responses to environmental variation (Cairns 1992). Thus, use of monitoring metrics that respond to environmental changes on both short- and long-term time scales will facilitate detection of various ecosystem changes, and may allow determination of the mechanistic basis of change (i.e. altered productivity or foraging success detected in the short-term may cause long-term changes in abundance).

A key challenge in ecosystem-based management and evaluation of the effects of reserve systems such as MPAs is determining whether observed changes in monitored ecosystem processes (such as seabird population growth or diet) are caused by changes in management or by confounding environmental variation (Gerber et al. 2005, McCook et al. 2010). This challenge increases with increased environmental variation, since environmental fluctuations may mask the impacts of management. This challenge also increases with increased disparity between the spatial scale of management and monitored ecosystem processes, since events outside managed areas may influence events inside managed areas, and vice-versa. Thus, establishing a baseline monitoring program of highly mobile marine predators in dynamic environments requires establishing not only the current state, but also requires the characterization of normal spatiotemporal variability in monitoring metrics. The proposed elements combine a suite of long-term monitoring approaches with short-term before-after control-impact (BACI) designs that establish both the extent of long-term variability while examining short-term responses using matched controls.

The specific rationale for each proposed element of this project is described separately, but the cohesive understanding of marine conditions provided by monitoring these ecosystems at multiple temporal and spatial scales using diverse metrics motivates this collaborative monitoring project. We propose determining the current abundance of seabirds across the region (Capitolo leads); utilizing historical data of seabird abundance to assess trends and variability (Barton leads in association with Golightly and Capitolo); recent historical data on seabird reproduction and diet at Castle Rock (Golightly leads in association with Nelson and Griggs); an assessment of nearshore foraging locations, abundance, and reproduction using land-based monitoring stations (Robinette and Barton lead); and at-sea use of the MPAs and control sites within the NCSR by seabirds (Barton leads).

Element 1 - Trends in Abundance: Changes in the abundance of breeding seabirds are recognized as a key metric in marine ecosystems because, as top predators, they indicate changes in marine ecosystem processes, especially those that regulate prey availability (Piatt et al. 2007, Einoder 2009, Velarde et al. 2013). Changes in seabird abundances within the California Current System (CCS) are jointly influenced by environmental variation in oceanographic conditions (e.g. Ainley and Hyrenbach 2010) and changes in management practices (e.g. Forney et al. 2001). Numerous studies have noted long-term changes in seabird abundance within the CCS in response to long-term trends in the environment (e.g. Veit et al. 1996). The ultimate impact of MPAs on seabirds will manifest in the form of altered abundance (Furness and Camphuysen 1997).Yet, seabird abundance can be slow to respond to environmental variability and management actions because, most seabirds are long-lived and have low annual productivity (Schreiber and Burger 2001), which can complicate interpretation of response (or lack thereof) to changes in management. Further, the large spatial ranges of some seabird species can exceed the spatial extent of the management jurisdiction of MPAs (Block et al. 2011) but seabirds may still be accurate representatives of change caused by MPAs at regional scales (Durant et al. 2009). Long-term monitoring conducted at large spatial scales provides a baseline against which changes in population size and spatial variation in response can be evaluated. Characterizing temporal variation and trends (defined as annual percentage change in population size) in colony sizes establishes the extent to which populations have fluctuated historically in response to environmental variation, giving context to changes observed following MPA establishment. Further, characterizing spatial correlation in trends among colonies will establish the independence, or lack thereof, among colonies within the NCSR and the potential spatial scale of population responses to MPA establishment. Establishing past patterns of abundance and continuing to monitor changes in seabird colony sizes within and outside of Special Closures, and within and outside of Marine Reserves and Marine Conservation Areas, will provide a test of population-level responses of seabirds to the direct benefits of MPAs (reduction of disturbance within special closures and direct interactions of fisheries) and the indirect benefits of MPAs (increased food availability).

Five species of seabirds, Common Murre, Brandt's Cormorant, Double-crested Cormorant, Pelagic Cormorant, and Western Gull, breed colonially and nest on the surface of isolated islets and rocks, making them readily observable, within the NCSR (Carter et al. 1992, Capitolo et al. 2006). Colonies within the NCSR of these species have been surveyed annually via aerial photographic survey annually since 1996 by a collaborative effort between CDFW, HSU, USFWS, and UCSC (see Capitolo et al. 2006, Thibault et al. 2010). The proposed monitoring will be a collaboration between HSU (Golightly, Barton), UCSC (Capitolo and Tyler), and USFWS (Nelson, Griggs, McChesney). These surveys included almost all seabird colonies of these species within the NCSR, with some colonies near MPAs and others at a distance from MPAs. Each of these species possesses an alternative suite of foraging behaviors, breeding habitat requirements, sensitivity to disturbance, year-round foraging ranges, and responsiveness to oceanographic conditions (Schreiber and Burger 2001). Thus, they may be expected to differ in their population dynamics, response to oceanographic variability, and in future responses to MPA establishment. Yet, each of these species is likely benefit from MPA establishment, particularly at colonies contained within Special Closures (owing to reduced disturbance of colonies; Carney and Sydeman 1999) and at colonies within or proximate to Marine Conservation Areas or Marine Reserves (owing to reduced fisheries impacts and increased prey abundance; e.g. Pichegru et al. 2010). Establishing population trends and continuing to monitor colonies within and outside of newly established MPAs will thus provide both a long-term perspective and a strong BACI design with 17 years (1996-2012) of 'before' data. BACI design within the trend analysis will allow for tests of short and long-term changes in the abundance of seabirds nesting at colonies near and far from MPAs.

Element 2 - Reproduction and Diet at Castle Rock: While measures of seabird abundance can provide information on long-term changes in the regional marine ecosystem, linking MPAs to short-term (rapid) changes in the marine environment using seabirds will require monitoring metrics that change immediately in response to events that alter ocean condition. Alterations in the productivity of marine ecosystems will be immediately reflected by changes in reproduction (phenology and success) and diet (prey consumed and foraging effort; Boyd and Murray 2001, Diamond and Devlin 2003). Reproduction is energetically demanding and, to produce young, individuals depend on an abundance of energy-rich prey (Boyd et al. 2006). Prey available within flight distance of a colony determines what seabirds feed to chicks, particularly for species that opportunistically capture abundant prey. The abundance of prey within flight distance of a colony influences activity budgets of breeding seabirds; for example, Common Murre (hereafter murres) spend more time at the colony when prey are abundant but, as prey become scarce, breeding individuals increase time spent foraging at sea (Zador and Piatt 1990, Harding et al. 2007). Altered patterns of prey availability due to management actions such as MPA establishment are thus likely to be rapidly reflected in seabird reproduction and diet.

Unambiguous determination of nesting phenology, nesting success, and causes of nest failure require direct colony-based measures. Also, for some species (e.g. murre), colony-based observations allow for investigation of prey base and foraging effort. Murres breeding at Castle Rock were identified as the most appropriate colony-based monitoring metric within the NCSR. Murres are a common, widely distributed seabird that is recognized as an excellent indicator species given the responsiveness of this species to prey availability in the marine environment, ease of productivity monitoring, and ability to quantify diet via observation (Miller and Sydeman 2004). Castle Rock, likely to be impacted by MPA establishment due to its location relative to SMCAs (see Element 1), is the largest single-island colony of murres south of Alaska (Manuwal et al. 2001); almost half of all murres in the North Coast region nest at Castle Rock (Carter et al. 1992), with 166,500 breeders counted at this colony in 2006 (USFWS, unpubl. data).

We propose a single-species approach to monitoring colony-based measures, yet the response of murres to ecosystem changes that result from MPAs should be representative of other seabirds and especially other alcids. Foraging conditions experienced by seabirds nesting at the same colony are generally similar because the distance that seabirds can travel to forage while breeding is limited by their need to incubate eggs and feed chicks (Ainley 1977, see Fauchald 2009 for review), and this is especially true for piscivorous pursuit divers (alcids, cormorants) that have high energetic costs of flight and short foraging ranges due to high wing loading (Pennycuick 1987). Seabirds also frequently aggregate into multi-species flocks while foraging, which predisposes different species to depend on the same prey base (Diamond 1983) despite some specialization (Ainley et al. 1990). Further, specific life-history attributes of murres make them ideal indicators of marine ecosystems at mesoscales such as the NCSR. In California, murres do not disperse after breeding (Manual et al. 2001) and consequently rely on local prey year-round, and during nesting, usually forage within 40 km of their colonies (Ainley et al. 2002). Murres are generalists that forage deeper than many other seabirds (up to 180 m) yet exploit a variety of sub-surface habitats providing a representative sample of the composition and abundance of localized prey populations (Ainley et al. 1996, Hedd et al. 2009). Their diet includes smelt, rockfish, salmon, herring, sardine, capelin, anchovy, cod, hake, lingcod, flatfish, surfperch, sculpin, sand lance, euphausiids, squid, and shrimp (Croll 1988, Ainley et al. 1996, Eigner 2009).

The productivity and diet of murres nesting at Castle Rock has been studied each year since 2007. To date, this effort has been a collaborative effort between the National Wildlife Refuge System (Nelson, Griggs, and McChesney) and Humboldt State University (Golightly). Currently, there are no other seabird productivity studies within the NCSR with this degree of accuracy or longevity. An additional two years of study will ensure that murre reproduction and diet will provide a robust baseline from which to assess changes in NCSR marine ecosystems that result from MPA establishment.

Element 3 – Coastal Habitat Use: Many seabird species concentrate in coastal habitats during the breeding season or year-round for nesting, roosting, and foraging, and these species are likely to benefit from MPAs established in California state waters. In the absence of previously extant long-term monitoring data (such as those described in Elements 1 and 2) before-after control-impact (BACI) study designs of monitoring metrics likely to respond to MPA establishment yield a strong test of the potential direct and indirect benefits of MPAs to seabirds and ecosystem features indicated by seabirds (Gerber et al. 2005). Further, BACI designs can provide both intensive and spatially extensive monitoring across the entire NCSR, a potential limitation of longer-term monitoring conducted at a subset of sites or a single site. Isolating responses to management from the confounding nature of environmental forcing is achieved by monitoring both within and outside of MPAs (i.e. by utilizing controls). Seabird monitoring metrics likely to respond at small spatial scales to MPA establishment, and thus be easily detectable within this BACI design, include foraging distributions and rates (Robinette et al. 2007, Robinette et al. 2010), breeding population size and productivity (Montevecchi and Myers 1995), roosting distributions (Carney and Sydeman 1999), and levels of disturbance at roosting and breeding sites.

Seabird species with high susceptibility to disturbance and limited near-shore foraging ranges are most likely to show benefits of MPA establishment at fine spatial scales, such as within a single MPA in comparison with a matched reference site. Brandt's Cormorants, Pelagic Cormorants, Pigeon Guillemot, and Western Gull are all species that have limited foraging ranges and are concentrated in shallow near-shore environments. For instance, Pelagic Cormorants typically forage within 15 km of breeding colonies (Hobson 1997) and Pigeon Guillemot within six kilometers of breeding sites (Litzow et al. 2000). Thus, these species are closely tied to near-shore habitats during the breeding season and further indicate prey availability at fine spatial scales in southern California (Litzow et al. 2000, Robinette et al. 2007). Changes in prey availability following MPA establishment may directly affect foraging distributions and rates, breeding population size, and productivity (Montevecchi and Myers 1995), and thus these monitoring metrics provide both a measure of ecosystem response (as they indicate prey availability) and seabird response (as they influence seabird abundance and demography). Further, each of these species can be negatively affected by human disturbance of roosting sites (Carney and Sydeman 1999) and nesting colonies (McChesney 1997) and are therefore likely to benefit from MPA establishment.

We propose quantification of foraging distributions and rates, roosting distributions, breeding population size and reproduction, and levels of disturbance at roosting and breeding sites using shore-based techniques at a series of MPA and reference sites spanning coastal habitats within the entire NCSR (Figure 1). Quantifying these directly observable metrics within a BACI design establishes a baseline against which future changes can be measured, as well as assessment of initial impacts of MPA establishment. Point Blue Conservation Science has implemented similar monitoring projects with standardized protocols within the NCCSR and the SCSR, increasing the value of this monitoring element within the entire California MPA region. This proposal element represents collaboration between Point Blue, Humboldt State University, and Crescent Coastal Research to expand standardized monitoring to the NCSR. This proposal element further includes graduate education and a citizen science component in these efforts, meant to evaluate the efficacy of employing citizen scientists in monitoring programs. Citizen science is a tool increasingly relied upon within targeted and surveillance biological monitoring due to a combination of potentially wide geographic scope, low cost, and educational value (Bonney et al. 2009). Yet, data from citizen scientists is rarely compared to monitoring data collected in a more standardized, rigorous fashion by professional biologists, despite the importance of such comparisons.

Element 4 – At-sea Distribution: Foraging distributions of breeding seabirds can indicate prey distributions and oceanographic conditions (Furness and Camphuysen 1997). Seabird foraging distributions respond rapidly to changes in prey availability (Monaghan 1996) especially in pelagic environments where prey bases are less predictable (Boyd 2012) independent of whether these changes are caused by oceanographic variation or management impacts. Thus, changes in seabird foraging distributions may quickly indicate changes in prey availability following MPA establishment. Yet, oceanographic variation strongly influences foraging distributions at large scales (Ainley and Hyrenbach 2010) and population growth rates of marine organisms including seabirds (Wolf et al. 2009), and thus consideration of the effects of such variation is critical in design of monitoring projects and evaluation of population and ecosystem response to MPA establishment. Further, at-sea foraging distributions have a significant influence on the susceptibility of seabird species to negative interactions with fisheries (Yeh et al. 2013), and thus at-sea distributions may significantly influence how MPA establishment may benefit foraging seabirds directly through reduction of fisheries interactions. Quantifying at-sea habitat use of seabirds at a long-term oceanographic monitoring site (Pacific Coast Ocean Observing System or PaCOOS – Trinidad Head) and a series of MPAs and reference sites within the NCSR utilizing boat-based at-sea surveys will provide 1) wide scale indication via seabirds of shifts in oceanographic conditions and 2) a measure of a monitoring metric that may respond rapidly to changes in prey availability within a BACI design. However, at-sea foraging distributions of many seabirds that forage within the NCSR may be influenced by events that occur well beyond the NCSR, or even beyond the CCS; for instance, Sooty Shearwater is a species that breeds in the southwest Pacific yet is one of the most abundant birds in the NCSR at some times of year (Barton, unpubl. data). Thus, focusing at-sea monitoring efforts on locally breeding seabird species during the breeding season, when most individuals at sea are tied to breeding attempts, likely yields a stronger measure of seabird and ecosystem response to MPA establishment.

Three focal species selected for at-sea habitat use surveys are Common Murre, Cassin's Auklet, and Brandt's Cormorant. Each of these focal species breeds within the NCSR and is locally abundant at sea within parts of the NCSR (Barton, unpubl. data). Yet, each differs in dietary specialization: Cassin's Auklet is principally a planktivore (Wolf et al. 2009), while murres and Brandt's Cormorant are principally generalist piscivores (Ainley et al. 1996, Hobson 1997). Each species is also associated with alternative ecosystem features (Table 1) and oceanographic conditions (Ainley and Hyrenbach 2010). The proposed monitoring will expand upon an at-sea seabird monitoring program begun in 2013 in collaboration between HSU (Barton) and NOAA/NMFS (Dr. Eric Bjorkstedt). Currently, seabird observers are placed on monthly year-round NOAA/NMFS PaCOOS cruises conducted off Trinidad Head aboard the R/V Coral Sea, allowing collection of data on foraging seabirds in conjunction with detailed physical and biological oceanographic data. Data collected on these cruises includes areas within an MPA (Samoa SMCA) and reference sites. We propose expanding upon the current design by including seabird observers on cruises included in HSU's Offshore Soft and Rocky Bottom ROV proposal to this RFP (PIs: Dr. Brian Tissot and Dr. Timothy Mulligan). Co-PI Barton has currently secured permission to place seabird observers on scientific missions conducted on the R/V Coral Sea in collaboration with Bjorkstedt and Mulligan. This shared use of a cost-prohibitive resource (boat time) represents a major efficiency in this proposal element. The proposed monitoring will provide baseline monitoring to measure how at-sea foraging distributions respond to oceanographic variation and to MPA establishment and their degree of overlap during the breeding season with established MPAs, providing an indication of MPA value in reducing seabird conflicts with fisheries.

Coordination with other monitoring projects: Elements of the proposed seabird monitoring project are coordinated with several other proposals contributed to the NCSR MPA baseline monitoring program. The at-sea survey element will be coordinated with monitoring sites included in HSU's Offshore Soft and Rocky Bottom ROV proposal (PIs: Dr. Brian Tissot and Dr. Tim Mulligan) via the proposed shared use of the R/V Coral Sea for conducting surveys at these sites. The coastal habitat use element will be coordinated with site selection in Reef Check's Citizen-scientist Monitoring of Rocky Reefs and Kelp Forests proposal (PIs: Dr. Jan Friedwald and Greg Hodgson) via shared site selection in McKerricher SMCA and Ten Mile SMR/SMCA. The trends in abundance element will be sharing population size estimates of seabirds surveyed with Crescent Coastal Research's boat-based near shore population surveys conducted within the NCSR (PI: Craig Strong). These coordination efforts are preliminary and the presence of Co-PIs Golightly and Barton at Humboldt State University, which is contributing several additional proposals, may allow for further development of coordination among additional monitoring projects over time.

APPROACH TO BE USED

Element 1 – Trends in Abundance: Seabird colony sizes within the NCSR have been extensively monitored by a collaborative effort between HSU, CDFW, USFWS, and UCSC since 1996 using aerial photographic surveys (Capitolo et al. 2006). The colonies photographed cover the entire NCSR and almost all MPAs within it, as well as numerous sites outside of MPAs. However, many of these aerial photographs have not been quantified (i.e. the birds in them have not been counted and compiled into a single dataset, particularly since 2004) and thus trends in the colony abundances of these species within this region are still unknown, yet a photographic record has been established and is available for development and analysis. Indeed, long-term declines (1979-2009) have been noted for at least one murre colony (Thibault et al. 2010) within the NCSR. We propose development of a complete 1996-2014 time series for two focal seabird colonies within the NCSR for these five species of seabirds. Costs of translating photos to quantitative datasets are very high and, consequently, we propose to complete the colony size measurements at Castle Rock, the largest colony in the region and close to MPAs, and False Klamath, the second largest colony in the region and more distant from MPAs. In this way we hope to maximize the benefit of past aerial photographic efforts while minimizing the costs of recovering the quantitative data.

Counting of archived photographic surveys (1996-2013): We will count currently unprocessed aerial colony survey data for Castle Rock and False Klamath Rock following standardized established methods previously described in detail (e.g. Capitolo et al. 2006, Thibault et al. 2010), and develop a database of the two colonies from 1996-2013. Surveys were conducted using overflights of seabird colonies within the NCSR during the summer breeding season. Photographs (slide film, then later, digital) of seabird colonies throughout the 1996-2013 interval were carefully spatially referenced, cataloged and archived. Photographs from 1997, 1999, 2001, and 2003-2004 were previously counted (Capitolo et al. 2006) by 'dotting' individual birds in photographs that cover the extent of each colony. However, photos from 1996, 1998, 2000, 2002, and 2005-2013 have not yet been counted, due to lack of available funds. This element will yield a nearly unparalleled 18-year dataset on five seabird species identified as indicative of multiple ecosystem features. A significant component of conducting these surveys over this 18-year interval has already been conducted and, therefore, Sea Grant funds provided to this project goal will be very efficient given the extent of previous expenditures by USFWS, CDFW, UCSC and HSU. Additionally, the retrospective strength of these long-term data is impossible to re-create.

Continuation of photographic surveys (2014): To bring the counts at Castle and False Klamath Rocks up to date, and establish a baseline across the region, we propose to conduct an aerial photographic mission across the entire region and quantitatively translate those photos into datasets (Capitolo et al. 2006). This will provide a baseline of current abundance of breeding seabirds in the NCSR.

Trend Analysis: We will use the long-term data (1996-2014) developed from Castle and False Klamath Rocks in model-based analyses specifically designed to establish a baseline against which the effects of MLPA establishment on seabird colony sizes can be evaluated, given the temporal variability inherent in the marine environment. Conceptually, the baseline provided by a long-term time series is characterized by two key elements: first, long-term trends in seabird abundance (both region-wide and at individual colonies), and second, the extent, type, and causes of temporal variation in colony sizes. Information on pre-existing trends and temporal variation provides an important means of determining whether changes following MPA establishment are due to changes in management practices or environmental variability. We will use log-linear Bayesian state-space models partitioned into process and observation components (e.g. Moore and Barlow 2011) to estimate the average annual percentage change in total population size, annual change in individual colony sizes, temporal process variance and temporal autocorrelation structure, and observation variance. We will use a Gibbs sampler (a Markov Chain Monte Carlo approach) to estimate the posterior probability distributions of model parameters, using minimally informative prior probability distributions. We propose a Bayesian approach because of the ease of interpretation provided by posterior probability distributions of estimated parameters, which are interpretable as the probability that a trend occurred at a particular rate (Wade 2000). Further, we will estimate statistical power to detect responses of 10, 25, and 50 percent over 2, 5, 10, and 20 year time scales following MPA establishment.

We will additionally use Bayesian generalized additive models (GAMs) to test whether seasonal sea surface temperature (publicly available source: NOAA Pathfinder Sea Surface Temperature dataset) and seasonal net primary productivity data (publicly available source: NASA SeaWIFS/MODIS NPP dataset) predict change in seabird colony population size over time, using a Deviance Information Criterion (DIC) model selection approach (Ward 2008). This approach will explicitly allow evaluation of the extent to which oceanographic variability may confound measurement of the effects of MPA establishment over the short- and long-term, by informing whether observed changes were caused by oceanographic conditions or response to management changes. Finally, we will use Bayesian change point analysis (e.g. Thomson et al. 2010) to identify specific time points at which trends in colony sizes changed, further providing a framework for future evaluation of the impacts of MPA establishment, including the effects of special closures, marine reserves, and marine conservation areas. Further, 8 of the 19 years in the analysis will overlap with specific reproductive data (collected in Element 2)

Element 2 - Reproduction and Diet at Castle Rock: Efforts at Castle Rock in 2014 and 2015 will focus on aspects of Common Murre reproduction and diet that effectively indicate altered prey availability within the foraging range of individuals that nest at this colony. Specifically, we propose to investigate nesting phenology, nesting success, prey composition, and time allocation of chick-rearing individuals (as a proxy for foraging effort). Most murre colonies in northern California, including Castle Rock, are on islands too distant to be observed from the mainland, a technique used extensively in central California (McChesney et al. 2009) and central Oregon (Suryan et al. 2012). The small size of islands along the coast in this region excludes the possibility of human presence at colonies without deleterious disturbance. To overcome the challenges of monitoring seabirds in the North Coast region, a remote-controlled audiovisual monitoring system capable of viewing the majority of the island was installed on Castle Rock in 2006. We propose use of this system to determine hatching success, fledging success, nesting phenology, time budgets of chick-rearing individuals, rate of chick provisioning, frequency of kleptoparasitism, and the daily composition of prey fed to chicks. These two new years will be added to seven existing years for which data were collected (2006-2013). This would provide nine years of data for each parameter of interest. This long-term data set would provide sufficient power to establish a baseline for assessment of change. All data will be collected using standardized protocols established for murres and used at multiple colonies in the California Current (McChesney et al. 2009, Eigner 2009), thereby maximizing comparability of results through time and across space. The remotely-controlled camera will be used for data collection purposes and video of all surveys will be recorded and permanently archived. This system is especially useful for accurate prey identification because prey can be viewed in great detail (Figure 2) and identification can be verified. Further, this system allows citizen viewing in real-time over the internet and the potential for citizen participation in observing the murres (while preserving the original data for scientific review, if necessary). We plan to include public participation in the data collection. Overall, using this camera system has been a cost-effective tool to establish detailed information on year-to-year changes in the productivity and diet of murres.

Reproduction: Nesting phenology and success will be determined by monitoring all nests initiated within a $14 m^2$ area surrounding the cameras (following methods used by the Common Murre Restoration Project 1996-2013; Eigner et al. 2012). This area generally includes about 100 nesting individuals and has been selected to ensure visibility of all nesting attempts. Surveys will begin just prior to the initiation of any nests in the monitored area and occur every other day until all nests had either successfully fledged chicks or failed. During each survey, an observer uses the cameras to determine the status of the nest-sites (i.e., presence of an egg, chick, or nothing).

Diet and Foraging effort: For murres, foraging effort is often inferred by quantifying time allocation of breeding pairs during the chick-rearing period because the energy demands on breeding pairs are maximal and, relative to the incubation period, the resulting attendance patterns are more reflective of the conditions of the marine environment (Harding et al. 2007); when food is abundant, breeding pairs will spend up to half of their day together (co-attendance) at the colony and, as food becomes increasingly scarce, the duration of co-attendance is reduced to maintain feeding rates required by young (Burger and Piatt 1990, Zador and Piatt 1999, Harding et al. 2007). In times of extreme food shortage, both members of a breeding pair will leave their chick unattended at the colony while they search for prey (Ashbrook et al. 2008). To quantify time allocation, chick provisioning rates, and the frequency of kleptoparasitism a subset of chick-rearing pairs (about 15 to 20 per year) will be monitored from dawn until dusk every seven days, beginning when chicks are present at 66% of breeding sites and continuing for a three week period. The daily composition of prey delivered to the colony will be assessed by conducting surveys to observe prey delivery events each day beginning when chicks are present at 10% of breeding sites and ending when 90% of chicks have departed the colony (following Miller and Sydeman 2004). During diet surveys, the camera will be controlled by an observer to detect murres delivering prey to the colony. Each prey item will be identified to the most specific level possible from high quality video recordings (39 frames per second at a resolution of 720 x 480 pixels; Figure 2).

Element 3 – Coastal Distribution and Foraging Behavior: We will apply methods developed by Point Blue for monitoring foraging rates and distributions, breeding population sizes and distributions, productivity, and disturbance rates of seabird focal species within coastal habitats of the South Coast and North Central Coast Study Regions (SCSR and NCCSR) to the NCSR. The proposed monitoring significantly adds to a regional perspective on seabird and ecosystem responses to MPAs by standardizing data collection protocols across regions, in addition to meeting monitoring goals within the NCSR. Within the NCSR, access to many sites from shore is limited by ownership and the remote nature of the study area. Potential study sites that will require evaluation on the ground are, from south to north, MacKerricher SMCA, Ten Mile Beach SMCA and SMR, South Cape Mendocino SMR, Samoa SMCA, Reading Rock SMCA, and Pyramid Point SMCA. These sites and matched references should allow for data collection on foraging rates and distributions, and transects, while MacKerricher SMCA, South Cape Mendocino SMR, and Pyramid Point SMCA provide the best potential sites for nest and roost monitoring.

Foraging rates and distributions: For each rocky coast MPA identified above, we will monitor the abundance of foraging seabirds at one site inside the MPA and one control site several km away from the MPA. Our objectives will be to 1) define within-season foraging trends and 2) determine if seabirds and marine mammals forage more inside or outside MPAs. We will conduct surveys from April through July in 2014 and 2015. We will survey each site once a week during one of the following time periods: 0600-0900, 0900-1200, 1200-1500, or 1500-1800, rotating sites among the four time periods per week to develop a complete 12-hour assessment of foraging activity. We will make observations from a single observation point, using binoculars and a 20-60x spotting scope to record the numbers foraging individuals for all species observed within a 1km radius (see Figure 3 for sampling scheme). We will record only those animals that are actively foraging. We will describe seasonal and spatial trends for individual species as well as for indices of species richness and diversity.

Transect monitoring: The goals of transect monitoring are three-fold: 1) to document the size and distribution of annual breeding and roosting populations for each focal species within the NCSR study area, 2) to identify nests that can be followed for estimating annual productivity, and 3) identify areas of dense breeding and roosting populations to monitor for disturbance. We define a transect as a length of coastline that can be surveyed within a four-hour period. We will divide each transect into manageable counting blocks based on easily recognizable geographic features. We will define observation points along each transect. During a given survey, observers will travel to each observation point and view the counting blocks assigned to that observation point. Figure 4 shows an example of a transect that we established in the South Coast Study Region. Beginning the week of April 1, we will conduct one transect survey per week at each of the areas identified above. Surveys will be conducted between the hours of 0600 and 1000 as this is the peak time for Pigeon Guillemot rafting activity and roosting activity by non-breeding birds. For each survey, we will begin at one end of the transect and visit each observation point. We will alternate starting points between the north and south ends of the transect on a weekly basis to minimize time bias on guillemot raft counts. From each observation point, we will scan the adjacent count blocks using binoculars and a spotting scope. We will record the number of nesting, roosting, and rafting (for guillemots only) birds observed within each counting block. We will do this for each of the focal species identified above. Additionally, we will use a detailed map of the study area to mark 1) individual rocks within a given counting block that have high abundances of breeding and/or roosting birds and 2) the specific location of Black Oystercatchers. The former information will be used to identify rocks for disturbance monitoring while the latter will be used to estimate territories of breeding oystercatcher pairs.

Nest monitoring: The overarching goal of nest monitoring is to record annual nesting phenology and estimate annual colony productivity. Both phenology and productivity are good indicators of the underlying oceanographic conditions affecting annual population size. Recording phenology requires weekly checks on individual nests within a given colony. Productivity can be calculated as either 1) the number of fledglings produced per adult breeding pair or 2) the percentage of total eggs laid that hatched and successfully grew into fledglings. The first calculation requires only knowledge of the number of fledglings produced within a given nest. The second requires more detailed knowledge of how many eggs were laid, how many of those eggs hatched, and how many of those chicks fledged. For each focal area possible, we will follow 30 nests of each focal species. We will identify monitorable nests during our transect surveys of each focal area. A monitorable nest is one for which eggs, chicks, and fledglings can be clearly viewed and enumerated without disturbing the nesting adults. Once nests are identified, they will be monitored every 7 days. During each monitoring visit, we will record 1) nest condition, 2) number of adults attending the nest and whether one is in incubating posture, 3) number of eggs, 4) number of chicks, 5) the feather condition of chicks, 6) number of fledglings and 7) if nest fails, the reason for nest failure.

Disturbance Monitoring: The goals of disturbance monitoring are 1) to identify human activities that cause disturbance, 2) to identify human activities that do not cause disturbance, 3) to estimate rates of human-caused disturbance at individual colonies, and 4) to estimate rates of natural (e.g., predator-caused) disturbance at individual colonies. Disturbance is defined as any event that results in birds flushing from rocks, displacing from nest sites, exposure, displacement, or loss of eggs or chicks, and visible signs of agitation. We will monitor for disturbance during all foraging, transect and nest monitoring surveys. At the beginning and end of each survey, we will record the number of breeding and roosting birds present for each species. During each, we will record all land-based human activity and boat traffic within 1,500 feet, and aircraft flying at altitude of $\leq$1000 feet and within 1,500 horizontal feet of the colony, regardless of whether disturbance occurred or not. Additionally, we will record all natural events (e.g., predatory bird flying over, large waves crashing) that cause disturbance. If disturbance occurs, we will record the number of nesting and roosting birds present for each species, number of birds disturbed and reaction type for each species, number of nests with eggs and chicks exposed for each species, source of disturbance, source altitude and distance from nesting area affected, activity of disturbance source, identification information (e.g., type of vessel or aircraft and any identifying information like license number), direction of travel/duration, and photographic or video evidence.

Graduate Education / Citizen Science: The goal of including a graduate education and citizen science element to this proposal is to expand the level of community involvement in the proposed monitoring program, and to evaluate the effectiveness of including citizen science in future shore-based monitoring efforts within the NCSR and for seabird responses to MPAs in general. We will collect citizen science shore-based monitoring data in collaboration with local volunteer groups. The Humboldt Bay/Crescent City areas are home to several science / advocacy NGOs that provide a strong volunteer base for such efforts, including the Redwood Region Audubon Society, Humboldt Bay Keeper, and the Surfrider Foundation. We propose data collection using of a simplified version of the protocols described above and a graduate student technician / coordinator. A graduate student (M.S.) advised by Barton at HSU will coordinate citizen science data collection efforts and conduct thesis research focused on quantitatively evaluating the quality of citizen scientist data, particularly focused on sampling variance and costs, compared to data collected by professional biologists.

Element 4 – At-sea Distribution: This element is designed to assess foraging distributions of seabirds inside and outside of MPAs in the NCSR in areas only accessible via larger vessel. The proposed monitoring will consist of standardized at-sea surveys conducted from the R/V Coral Sea, owned and operated by HSU. Observers onboard NOAA/NMFS PaCOOS cruises will conduct monthly year-round surveys along the Trinidad Head PaCOOS Line and onboard HSU Offshore Soft and Rocky Bottom ROV proposal cruises (PIs: Dr. Brian Tissot and Dr. Tim Mulligan) conducted over 15 sea days in 2014 and 2015 at Point St. George Reef SMCA, Reading Rock SMCA, Mattole Canyon SMR, Sea Lion Gulch SMR, and Ten Mile SMR, along with matched reference sites. The proposed BACI design includes 6 of the NCSR MPAs, reference sites, and a reference site coordinated with intensive oceanographic data collection (PaCOOS) during 25-30 sea days per year in 2014 and 2015. Observers will be placed at a site near the bridge with a 5.5 m eye height, and all seabirds observed within 300 m of the Coral Sea on the forward quarter with less glare will be recorded using a PDA and recording assistant (Tasker et al. 1984) while the ship is underway. When the ship is station-keeping during oceanographic or fisheries investigations, 30-second 300m radius 'snapshot' surveys will be conducted every 15 minutes.

OUTCOMES AND DELIVERABLES

All data collected will be archived with appropriate metadata following the Monitoring Enterprise metadata standards. At the end of the baseline funding period, all data from each monitoring element will be delivered to the Monitoring Enterprise. Each proposed monitoring element will produce annual progress reports to Sea Grant and the Monitoring Enterprise on the status of monitoring efforts, including brief summaries of monitoring metrics and overall progress. These reports can also be used to keep policy-makers, managers, educators, and the general public engaged in the MLPA process and informed about the 'health' of seabird populations in the region. Each monitoring element will produce a final report that 1) retrospectively evaluates the value of continued seabird monitoring conducted by each element and 2) integrates the baseline monitoring data with what is currently known about seabird populations, and seabird indicator value, within the NCSR and more generally.

Element 1 - Trends in Abundance: Tasks associated with the trends and 2014 aerial survey components of this monitoring element will be completed in 2015, with an annual progress report in early 2015, and a single final report and trend analysis completed by December 31, 2015.

Element 2 - Reproduction and Diet at Castle Rock: Data collection will be conducted during summer 2014 and 2015. An annual report will be produced in 2014, and a final report and analysis of temporal variability of these monitoring metrics in late 2015 or early 2016.

Element 3 – Coastal Habitat Use: Data collection will be conducted during 2014 and 2015, with an annual report in late 2014 and a final report in early 2016.

Element 4 – At-sea Distribution: Data collection will be conducted during 2014 and 2015, with an annual report in late 2014 and a final report in late 2015.

MILESTONES AND TIMELINES FOR DEVELOPMENT AND RECOVERY

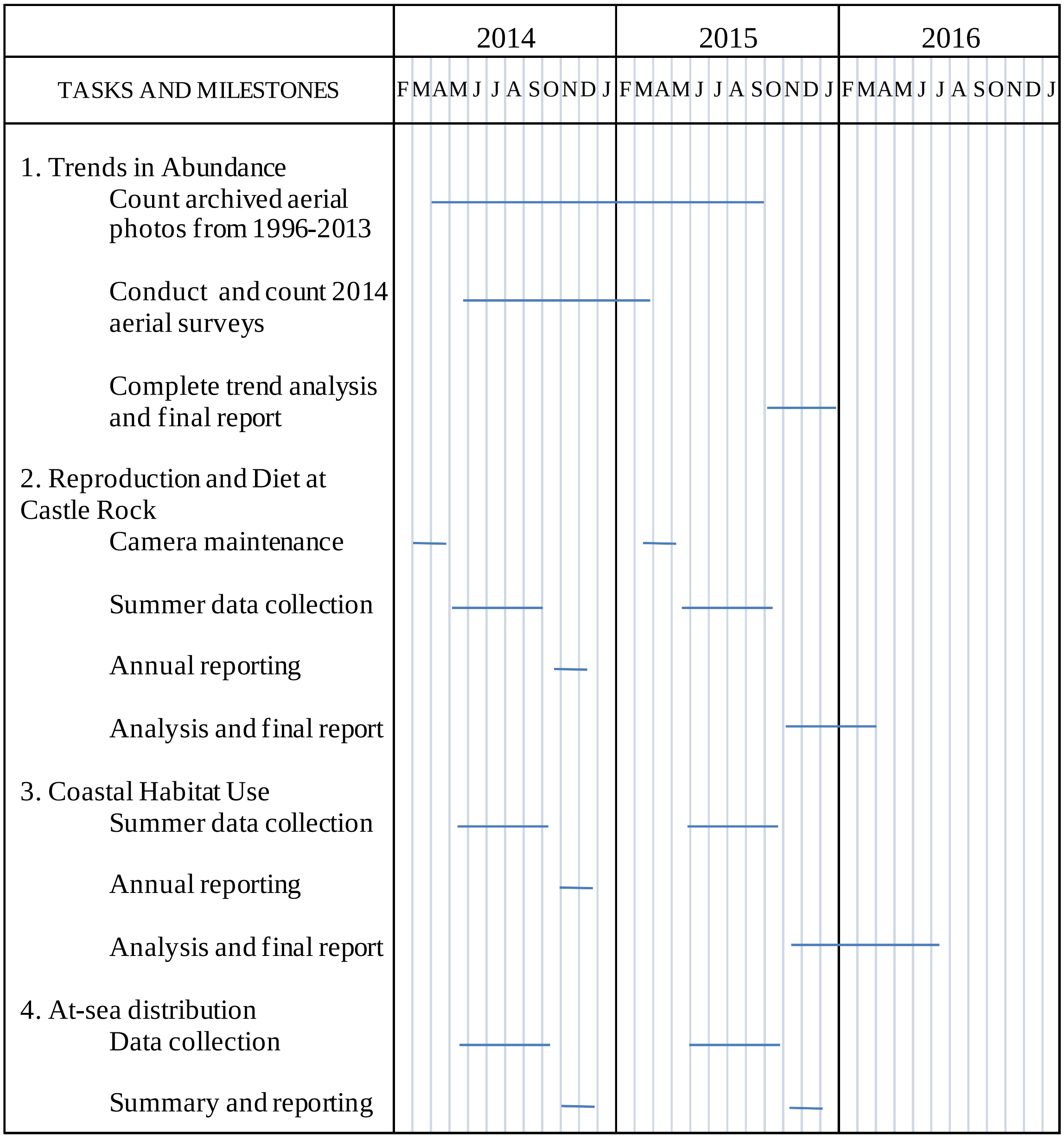

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Table 1. Ecosystem features, focal species, temporal, and spatial scale by proposed monitoring element for North Coast Seabird Monitoring.

Monitoring Element	Ecosystem Features Monitored	Focal Species	Temporal Scale	Spatial Scale
1: Trends in Abundance	Rocky Intertidal Soft-bottom Intertidal & Beach Kelp & Shallow Rock Mid-depth Rock Soft-bottom Subtidal Nearshore Pelagic	Brandt's Cormorant Pelagic Cormorant Double-crested Cormorant Common Murre Western Gull	1996-2014 (very long)	Focused sample that represents the study area (2 of the MPAs; trends for Castle Rock and False Klamath; region wide aerial counts)
2: Reproduction and Diet at Castle Rock	Rocky Intertidal Soft-bottom Intertidal & Beach Kelp & Shallow Rock Mid-depth Rock Soft-bottom Subtidal Nearshore Pelagic	Common Murre	2007-2015 (long)	Focused sample that represents the study area (2 of the MPAs; reproduction and diet at Castle Rock by murres as representative seabirds)
3: Coastal Habitat Use	Rocky Intertidal Soft-bottom Intertidal & Beach Kelp & Shallow Rock Mid-depth Rock Soft-bottom Subtidal	Black Oystercatcher Brandt's Cormorant Pelagic Cormorant Pigeon Guillemot Western Gull	2014-2015 (short)	Samples dispersed across the study area; intensive local measurements, covering numerous MPAs and controls
4: At-sea Distribution	Kelp & Shallow Rock Soft-bottom Subtidal Mid-depth Rock Nearshore Pelagic Deep Ecosystems	Brandt's Cormorant Common Murre Cassin's Auklet	2014-2015 (short)	Matched MPA / control design covering 5 MPAs

Table 2. Institution, lead staff, amount requested, match (auditable contributions documented in proposed budgets), and leverage (in-kind contributions by USFWS/HSU collaborators not included in proposed budgets – see narrative) by institution for proposed monitoring elements for North Coast Seabird Monitoring.

Monitoring Element	**Lead Institutions**	**Lead Staff**	**Total SeaGrant Request**	**Total Request by Institution**	**Total Match, by Institution**	**Total Leverage, by Institution**
1: Trends in Abundance	UC - Santa Cruz Humboldt State University U.S. Fish and Wildlife Service	Capitolo, Golightly, Barton, Griggs, McChesney	$125,771	$58,300 (UCSC) $67,471 (HSU)	$7,040 (UCSC) $26,824 (HSU)	$20,964 (USFWS)
2: Reproduction and Diet at Castle Rock	Humboldt State University U.S. Fish and Wildlife Service	Golightly, Nelson, Griggs	$122,212	$122,212 (HSU)	$77,219 (HSU)	$15,960 (USFWS) $34,000 (HSU)
3: Coastal Habitat Use	Point Blue Conservation Science Humboldt State University Crescent Coastal Research	Robinette, Barton, Strong	$217,732	$101,582 (PBCS) $105,110 (HSU) $11,040 (CCR)	$31,800 (PBCS) $43,063 (HSU) $2,400 (CCR)	
4: At-sea Distribution	Humboldt State University	Barton	$38,122	$38,122 (HSU)	$6,100 (HSU)	$57,600 (HSU)

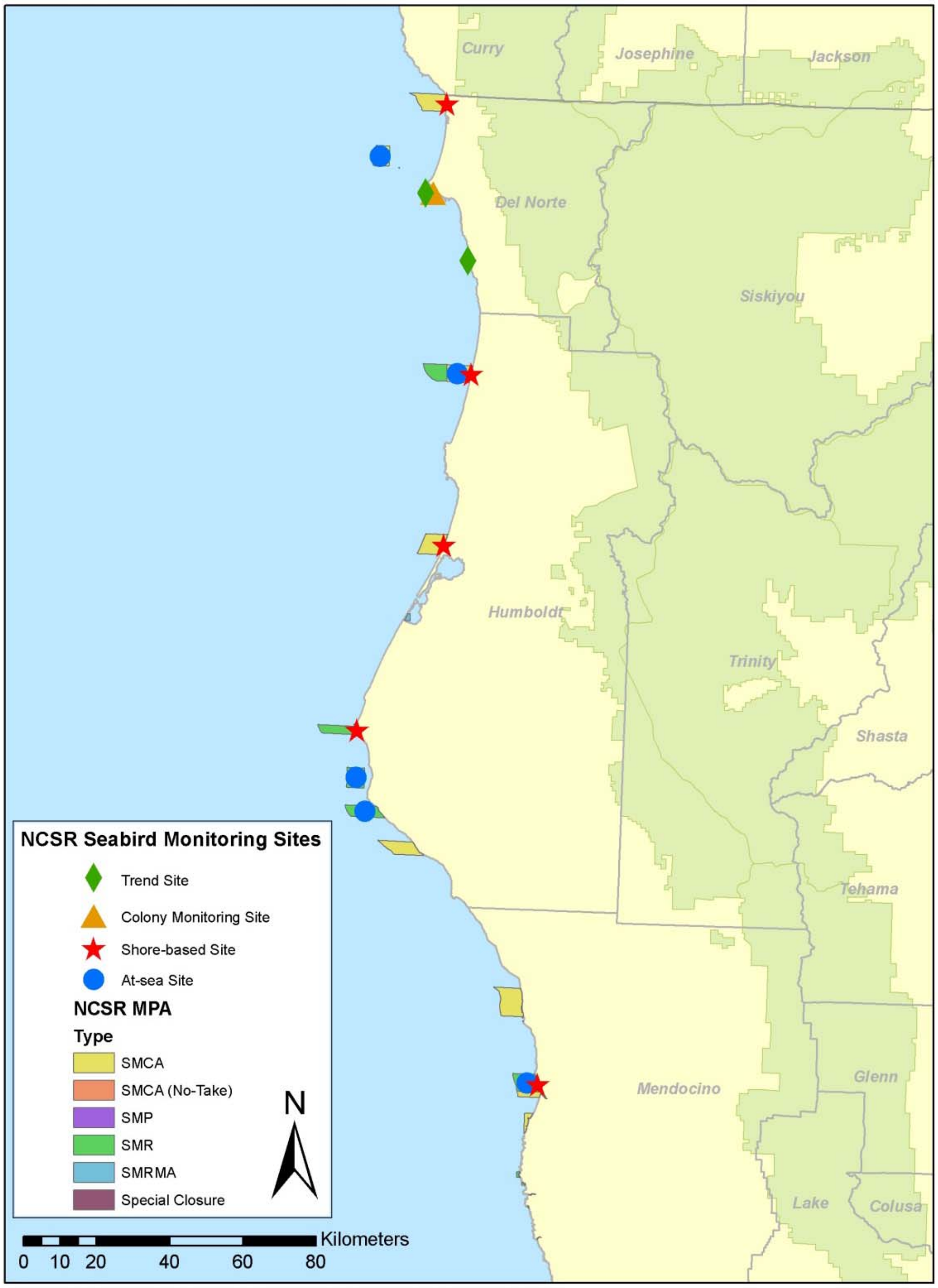

Figure 1. Proposed MPA seabird monitoring sites within the North Coast Study Region (NCSR).

Figure 2. Detail of smelt observed using the camera system at Castle Rock.

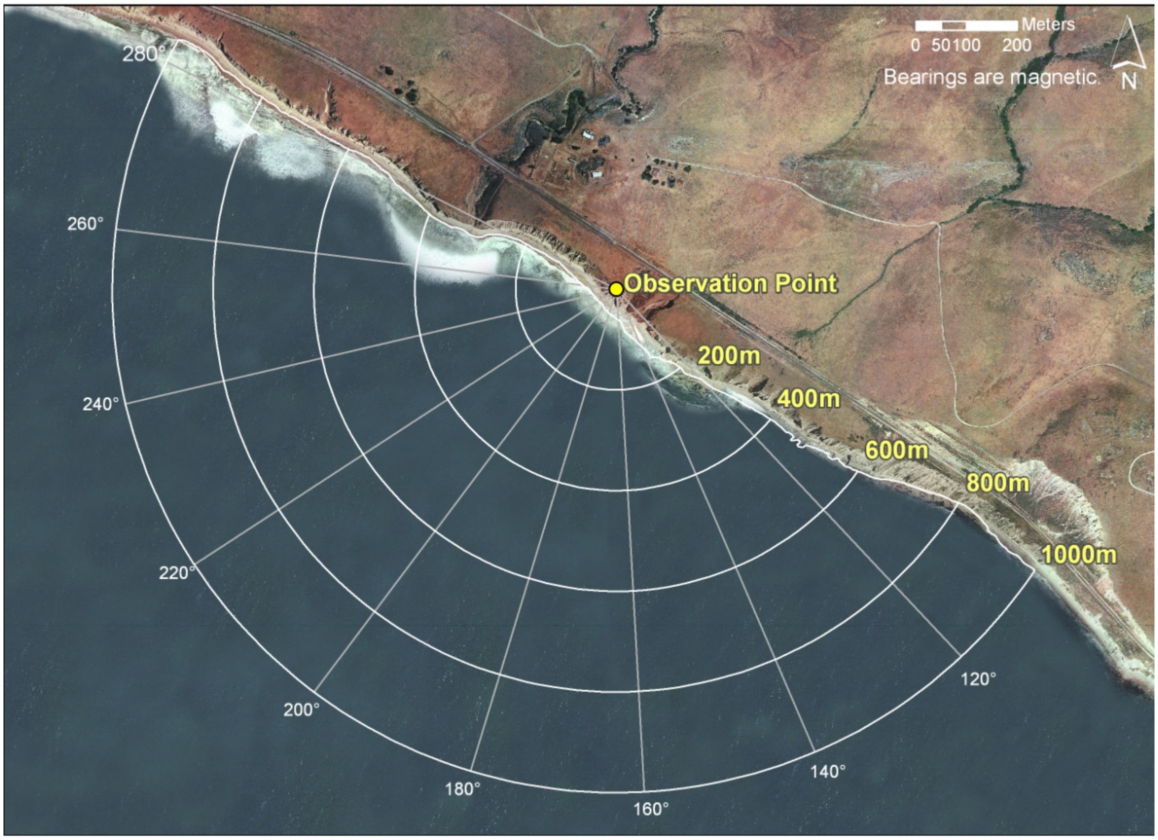

Figure 3. Foraging observation scheme adopted from PRBO’s Vandenberg Seabird Program. Observations will be made within a 1km radius of the observation point.

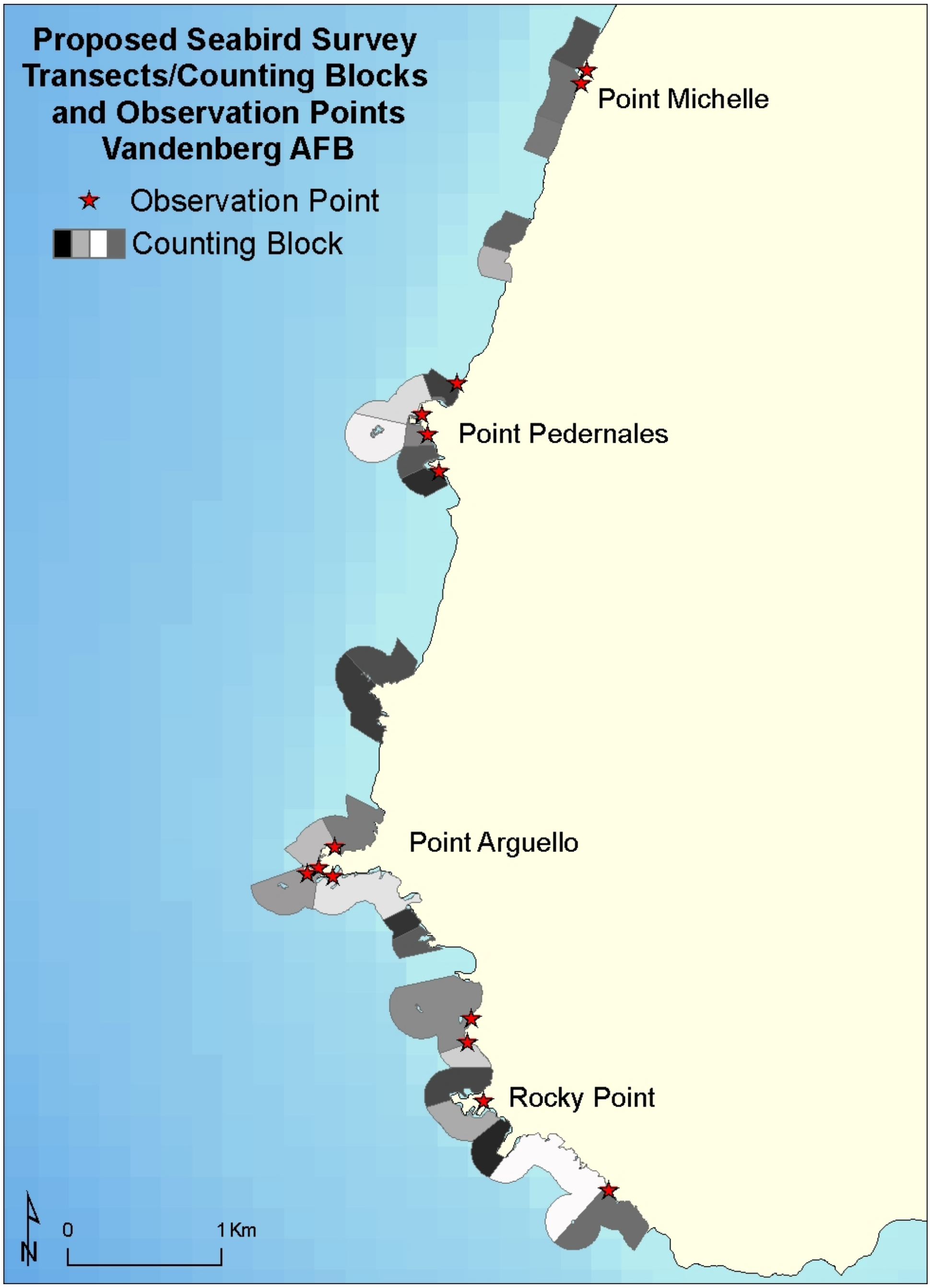

Figure 4. Transect established for monitoring breeding and roosting birds at Vandenberg Air Force Base, central California. Gaps in the transect represent sandy beach habitats that are not typically used by our focal species.

Appendix 2: Funding Offer Response Letter, December 2013

Dr. Erin Meyer
MPA Monitoring Enterprise
California Ocean Science Trust

Dear Dr. Meyer:

Outlined below are the proposed changes to our "Comprehensive Seabird Baseline Monitoring in the MLPA North Coast Study Region" which were necessitated by the funding level of $225,000. We are excited about the opportunity to contribute to the seabird component of the North Coast Monitoring Program. The reduced funding and thoughtful comments from the technical reviewers and the Panel posed several difficult decisions. We reviewed and evaluated all comments by the reviewers and Panel in making our adjustments. We did not change our budget in parallel for each objective; rather we sought to maintain the scientific value of the proposed monitoring by maintaining some aspects while reducing or eliminating others. This effort was conducted with the full participation of our partners.

We attempted to follow the guidance provided in the reviews. In some cases the recommendations were not feasible with a reduced budget (eg: we could not conduct additional aerial surveys or include separate analyses for Marbled Murrelets without additional resources). In other cases, the natural history of seabirds and their spatial use of the ocean dictated design or methodology that was not consistent with the recommendations. However we did note each concern or comment and tried to address them in our design modifications. In addition to trying to maintain the quality of the science within the new budget, we also prioritized the maintenance of the broad partnerships established in the proposal and inclusion of citizen science and student participation. Some recommendations were rendered moot because of the work plan alterations.

We had proposed four major elements to the overall project. Each element of our proposal had been designed to stand alone if need be. However, together they were much stronger supporting and informing each of the companion elements. For example, the counts in Elements 1 and 3 have potentially much greater explanatory value regarding the variation in the marine environment when informed by the reproductive and diet information in Element 2. Consequently we plan to maintain Elements 1, 2, and 3 in the revised work plan, although Element 2 will suffer a proportionally greater budget reduction than Element 1 and 3. We are going to eliminate our proposed Element 4 based on the recommendations from the reviews and the Panel.

Below we identify our revised changes to each remaining element in our proposal and how we hope to achieve these goals with the reduced budget:

1. Element 1 consists of an aerial survey of breeding seabird colonies though out the study area and retrospective counts of breeding seabirds from aerial photos of two colonies to establish trends and extent of spatial/temporal variation in the count metric. To minimize cost for the area wide counts we have asked California Department of Fish and Wildlife to allow "in-house"

rates on their aircraft (this is not yet confirmed). We have also shifted some personnel, especially at the senior level, from reimbursed to a donated status. Further we have located equipment that can be borrowed rather than purchased. We also propose more significant design changes to the trend analysis. We will focus on two colonies to assess variation, one in the north (Castle Rock as initially proposed) and Vizcaino Rock and Rockport Rocks in the southern part of the study area (the latter are new to our plan); we will eliminate plans to count birds at False Klamath Rock as a control to Castle Rock. There are two benefits to this change. The new site in the southern portion of the region allows us to gain greater efficiency because many years of aerial-photo counting are already completed. In addition, this change will add cross validation of counts at Vizcaino Rock with Element 3 as this is also a planned site for one of the shore-based surveys. Although we will no longer have the comparison of a near and far colony relative to a protected area, we should still have the ability to gain insight into annual variation in counts at two different locations along the California Current System in the NCSR. We are proposing to reduce the budget of this element by approximately 35% from what we had originally proposed (final numbers may change modestly).

2. Element 2 provided the ability to assess variation in diet and reproduction at Castle Rock (the largest seabird colony in the NCSR, and largest single-island Common Murre colony in the state of California). We had proposed using data from previous years and add two more years to increase power in the data. The pre-existing data set for reproduction and diet from this colony is for a much shorter period than the aerial surveys. Budget limitations will require that we now collect data only in 2014 (the same year as the aerial survey). Further to fit the new budget we will need to reduce the parameters assessed in 2014 and recruit more volunteer assistance (additional citizen science) to assist in data collection. Lastly we will move some expenses to the leveraged and donated match component of the budget. This will result in an approximate 63% reduction in the budget for this element relative to what we had originally proposed.
3. Element 3 provided shore-based surveys of birds that can be consistently counted from shore vantage points. Note that this is a generally different subset of the seabird community than counted in Element 1. However, birds in both counts are subject to the same oceanographic forcing parameters and information in Element 2 may inform both data sets. We may gain additional savings by eliminating our northern most sites which will reduce travel (both travel costs and staff time while traveling). Further budget reductions were achieved because Point Blue was able to reduce costs by increasing efficiencies in the partnership with HSU to coordinate data collection efforts. The revised partnership gives Point Blue a smaller role in field coordination, but allows Point Blue to maintain its lead role in data management, data analysis, and report writing for Element 3. This has resulted in an even greater reduction in travel costs, including reduced staff time for travel. Overall, Element 3 was reduced by approximately 51% from what we had originally proposed.
4. Element 4 has been eliminated consistent with the recommendations.

In addition to the proposed scope of work, the Panel recommended inclusion of Marbled Murrelets. We did not originally include murrelets in our initial proposal for several reasons. First and most significantly, Marbled Murrelet abundance in the NCSR is rigorously monitored as part of The Northwest

Forest Plan for status assessment relative to recovery goals for this endangered species. Fine scale boat surveys have been conducted annually (and to present) and there is an existing federal task group conducting detailed analyses and annual reanalysis of these data for trends in abundance and distribution. We sought not to duplicate this effort. Secondly, murrelets are at relatively low abundance and we therefore think that they are poor candidates for an indicator species as part of long-term monitoring to reflect the wider questions (ocean condition, changes due to MPAs, etc.). We do agree that baseline data on murrelets are important to assessing healthy marine ecosystems. Thus, to meet the concerns of the Monitoring Enterprise (ME) regarding inclusion of murrelets we will access and reference the status of these data (no new analyses) in our reporting. I have verbally discussed this with the lead of the task group (Dr. G. Falxa for the USFWS) and they are comfortable with our brief inclusion of their results. Additionally we will add any murrelet detections from shore based surveys into Element 3. Ten years ago I conducted similar shore based surveys specifically designed to detect murrelets but these data lacked power to make inferences; thus outcomes added to Element 3 may be more descriptive than inferential. The Northwest Forest Plan murrelet monitoring may experience a shortfall in 2015 due to the federal budget sequester, and should the ME want to maintain annual Marbled Murrelet surveys, the ME could also participate in that effort by providing additional support to this new objective.

We look forward to discussing these proposed changes with you. We are still awaiting some final adjustments to the budget and our indicated percentage changes may still need some further refinement.

Respectfully,

Richard T. Golightly

Daniel C. Barton