Papahānaumokuākea Marine National Monument
Permit Application Cover Sheet

This Permit Application Cover Sheet is intended to provide summary information and status to the public on permit applications for activities proposed to be conducted in the Papahānaumokuākea Marine National Monument. While a permit application has been received, it has not been fully reviewed nor approved by the Monument Management Board to date. The Monument permit process also ensures that all environmental reviews are conducted prior to the issuance of a Monument permit.

Summary Information

Applicant Name: Robert J. Toonen[1] & Christopher E. Bird[2]
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Permit Category: Research
Proposed Activity Dates: September 12- 25 2012
Proposed Method of Entry (Vessel/Plane): Vessel
Proposed Locations: Intertidal and shallow water habitats around basaltic islands on which 'opihi occur. Specifically, Nihoa Island, Mokumanamana Island, French Frigate Shoals (La Perouse Pinnacle), and Gardner Pinnacles

Estimated number of individuals (including Applicant) to be covered under this permit: Twelve total people will be covered under this permit, co-listed under the Native Hawaiian Practices application submitted by Shauna Kehaunani Springer.
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Estimated number of days in the Monument: approximately 12 days

Description of proposed activities: (complete these sentences):
a.) The proposed activity would…
aim to examine the biodiversity of the Hawaiian intertidal and shallow subtidal ecosystem, and study the basic ecology of 'opihi populations within the NWHI. Additionally, we propose to conduct the first comprehensive biodiversity survey of the intertidal zone in the NWHI and quantify species presence/absence and relative abundances within and among sites across the basaltic emergent islands. To this end we will sample species of uncertain taxonomy for combined morphological and DNA bar-coding analyses. We also seek to examine population connectivity of intertidal species in comparison to the broad survey of coral reef organisms sampled to date. We find different patterns of larval exchange among the ‘opihi which suggests that intertidal species may differ from the average seen in subtidal taxa, and that has important management implications that need to be confirmed. We propose to examine the reproductive status, timing, and depth of larvae in select ‘opihi populations across the NWHI to better understand natural population dynamics and potential mechanisms of speciation in these

economically, ecologically and culturally important limpets. Finally, we propose to evaluate the ability of ‘opihi to respond to and tolerate heat stress in order to assess adaptive capacity in the face of global warming, especially on the ‘opihi ‘alinalina of LaPerouse Pinnacles that have abandoned their cool mid shore habitat for the hotter high shore habitat.

This work will be tightly linked with the Native Hawaiian cultural practice application and is a joint collaborative study among Na Mamo o Muole'a, the Nature Conservancy, the Hawai‘i Institute of Marine Biology, Friends of Papahānaumokuākea, and the NOAA Papahānaumokuākea Marine National Monument. We will perform the standardized 'opihi monitoring protocol developed through this collaboration, which is inclusive of Hawaiian methods of monitoring, has was specifically developed (and is continuously being refined) to monitor intertidal populations associated with ‘opihi across the Main and Northwestern Hawaiian Islands. To date, communities on the Big Island of Hawai‘i, Maui, Kaho'olawe, Lana‘i and through these efforts the NWHI have been surveyed for intertidal species composition, population size and age structure of organisms associated with ‘opihi. Here we request a permit to conduct the fourth year of surveys and monitoring within the NWHI.

b.) To accomplish this activity we would ….
conduct standardized surveys developed collaboratively among the partners listed above to integrate quantitative scientific data collection with Native Hawaiian observational data. In addition, we will collect some target invertebrates by hand for taxonomic study (combined morphological and DNA-sequence based “bar-coding”) where species identity is in question. We will collect small tissue samples from a handful of very common intertidal species to examine patterns of population connectivity in the intertidal zone and compare that directly to the patterns found in subtidal species, and some ‘opihi will be collected for gonad index and heat stress tolerance experiments as outlined below and in the accompanying Native Hawaiian Practices Permit Application filed by Kehau Springer. Specifically, we will lay a minimum of 20 belt transects per island or atoll to assess class size, population density, community structure, species range, distribution, and rugosity for all identifiable organisms within the intertidal zone. In order to pin-point ‘opihi spawning timing, 20 egg baskets (1.5” diameter x 3” long PVC tubes with 20um nitex mesh enclosing ‘opihi eggs) will be deployed/collected in the morning and evening at each island. When the ship leaves the island, no supplies will be left behind. Fifty plankton samples per island will be collected to identify the depth of different larval species in the water column. Collected ‘opihi will be kept alive for heat stress trials (up to 50ºC) aboard the ship prior to preservation. The samples we request to be collected for this work are summarized in Appendix 1. All data will be stored and analyzed at the Hawai'i Institute of Marine Biology by co-PIs Toonen & Bird. These data will be useful to both the Monument, as well as to local and governmental resource managers in the Main Hawaiian Islands to make effective decisions on managing the resources.

c.) This activity would help the Monument by …
providing baseline knowledge of one of the least studied and potentially most threatened by climate change of all ecosystems in the Hawaiian archipelago. Sea level rise is inevitable at this

point, and the first community to feel the effects of climate change will be the one that lives at the interface of land and sea and experiences the greatest extremes of both environments: the intertidal. Limited knowledge of this ecosystem restricts our understanding of climate change impacts and suitable responses. Further, knowing which species occur and where they live is fundamental to the management of natural resources in any ecosystem, and the Hawaiian intertidal zone is poorly characterized in general. We will also confirm whether or not the intertidal species show a different pattern of population connectivity across the archipelago than do the subtidal ones surveyed to date. These data will provide the first quantitative data on the species present in these ecosystems, their biodiversity, population dynamics and connectivity and also contribute to the ongoing debate about how new species arise in the sea. The tight collaboration of the team comprised of cultural practitioners, research scientists, and resource managers will ensure that the findings are of relevance to a broad group of stakeholders and of direct relevance to the people of Hawai‘i.

Other information or background: Littoral habitats, those lying between the low-tide line and the upper limit of aquatic species on the shore, are among the most studied and well-known aquatic habitats on the planet. A primary exception to that generalization is that this zone is one of the least studied in Hawai‘i. The effects of tides on littoral marine habitats are so ubiquitous that shorelines are commonly described as ‘intertidal’, whereas waves are considered a secondary factor that simply modifies the intertidal habitat. However in Hawai‘i, mean significant wave height exceeds tidal range most of the time, and may be a primary structuring force for littoral communities as outlined in Bird (2006). The patterns of distribution and abundance of organisms on rocky shores, in particular the upper and lower limits of species, along vertical gradients of exposure have been studied extensively in other regions of the globe. Hypotheses addressing the causes of biotic zonation and community structure have evolved from strictly physical to an inseparable combination of physical and biological factors, including physiological tolerance (Connell 1961a b), species interactions (Bruno & Bertness 2001, Menge & Branch 2001), and all other forms of biotic factors.

A fundamental advance in the understanding of biotic zonation on rocky shores was the demonstration that species interactions also affected zonation patterns, where biotic factors generally affect the lower limit of distribution and physical factors affect the upper limit of distribution (Connell 1961a b, Paine 1967). A number of exceptions to this generalization have been demonstrated, many of which highlight the more general effect of biological interactions on the realized distribution of a species. Ultimately, the inseparable interaction between physical and biological factors define the realized limits of species (Denny & Wethey 2001), and intertidal communities are unique in that organisms must cope with some of the most severe extremes of both marine and terrestrial environments. This has led to debate about whether these species are so hardy that they are resistant to change, or whether they live in such extreme environments that climate change will impact them more (e.g., Stillman 2003). Available data from long-term surveys of the intertidal community in California suggest the latter: intertidal communities are one of the first to show ecosystem impacts of climate change that can already be documented and are expected to accelerate given future climate change scenarios (e.g., Barry et al 1995; Sagarin et al. 1999).