**Farallon Ashy Storm-Petrel Population Status Evaluation**
**Interim Programmatic Report Narrative**
**to the Pacific Seabird Program of the National Fish and Wildlife Foundation**

## 1. Summary of Accomplishments

In the second year of the project, *Farallon Ashy Storm-Petrel Population Status Evaluation,* Point Blue refined previous analyses of survival and abundance of the Farallon ashy storm-petrel population, and used that information to develop state-of-the-art population models to project future storm petrel population trends and how they may be impacted by potential changes in burrowing owl over-winter attendance. Analyses in the second year confirmed the strong negative relationship between the abundance of burrowing owls during the winter-early spring and over-winter survival of ashy storm-petrels. Analyses of storm petrel population size indicated that the declining trend seen from 2005 to 2010, during the time of increasing burrowing owl attendance, has abated in the most recent time period, 2010 to 2015, coinciding with a modest reduction in burrowing owl attendance. However, further reduction in owl numbers is needed to produce an increasing population. The population model we developed can provide guidance to managers in planning and implementing steps to aid a species of conservation concern and facilitate recovery. We met our goals for monitoring over 50 active breeding sites and demonstrated proof of concept for monitoring breeding storm petrels with new technology.

## 2. Project Activities & Outcomes

### Activities

a) Test whether reduced burrowing owl abundance in 2012-2015 led to increased survival and abundance of ashy storm-petrels.

In the second year of the project, Point Blue refined its analyses regarding abundance of burrowing owls and its relationship to survival and trends in abundance of ashy storm-petrels. From 2000 to 2005, population size of ashy storm-petrels was increasing, during the period when burrowing owl occurrence and activity at the Farallon National Wildlife Refuge was low. During the next 5 to 6 years, burrowing owl activity strongly increased reaching a peak in 2010/2011. During this period, ashy storm-petrel survival showed a strong decline, as did population size. Thus, the evidence clearly points to the increased abundance and activity of burrowing owl leading to predation of ashy storm-petrels, thus decreasing survival and contributing to the observed population decline. However, recently, burrowing owl numbers have been moderately lower than those observed in 2009-2010 and 2010-2011 (Figure 1). As part of this project, we added data from 2013 to 2016 for ashy storm-petrels and burrowing owls and carried out new analyses for these years (our initial analysis was only through the year 2012). We analyzed survival and population size to determine whether the recent moderate decrease in burrowing owl abundance/activity resulted in increased survival and/or change in the abundance of the ashy storm-petrels population. In the second year of the project, we have refined our analyses, excluding individuals that were presumed to be transients that were only detected once. Thus, the new analyses focused on subadults and adults likely to be part of the breeding population on the South Farallon Islands.

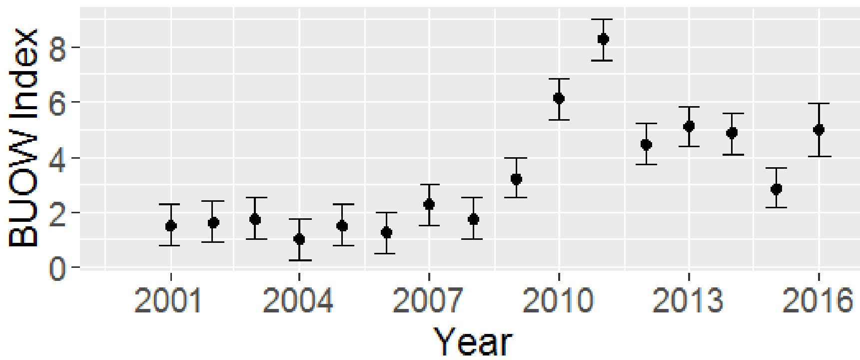


Figure 1. Burrowing owl index of overwinter attendance, 2001-2016, on Southeast Farallon Island. Monthly average of maximum observed owls per month for September of previous year to April of the listed year ± SE.

We hypothesized that with a lower abundance of burrowing owls, the previous decline in population size would be reduced or eliminated, and might even lead to population increase. Such a change in survival and population trend was predicted by our initial modeling exercise[1]. Reduced abundance of burrowing owls in recent years provides the opportunity to assess this hypothesis.

We found that the ashy storm-petrel population trend in recent years has indeed changed, associated with the reduction in burrowing owl attendance (Figure 2). Looking at the full time series, there are three distinct trends. In the first series of years, from 2000 to 2005, when burrowing owl abundance on the island was low, the population displayed a strong increase in population size (increasing at 37% per year, $P < 0.01$), confirming results from our earlier analysis. However, from 2005 to 2010 the population decreased by 11.4% per year ($P < 0.01$), this decrease coinciding with the period of increase in burrowing owl overwinter attendance (Figure 1).

The trend in population size altered during the period 2010 to 2015; it was still a decline of 5.6% per year, but of smaller magnitude than the previous period, and was now not significantly different from zero ($P > 0.3$). In fact, population size was unchanged from 2014 to 2015, and was similar to the population size estimated for 2010 (Figure 2). Analysis of survival confirmed our earlier finding that survival declined strongly as burrowing owl abundance increased during the period of 2005 to 2010. However, survival remained low for 2013-2015, years in which burrowing owl abundance was moderately high, though not as high as in 2010 and 2011. 2013 had the third highest burrowing owl abundance index. Thus, even with moderately high owl abundance, survival was low compared to what it had been during the period 2001-2005 (Figure 3). Our more refined analysis confirmed a strong statistical relationship between burrowing owl abundance and annual survival of ashy storm-petrels ($P < 0.01$). A decrease of 1 unit in the owl abundance index (equivalent to 8 "owl-months" over the period September-April) is associated with an increase in storm petrel survival of 0.8% to 1.4%. This result was used in the demographic modeling (see below).

[1] Nur, N., Bradley, R., Salas, L., & Jahncke, J. 2013. Modeling the impacts of house mouse eradication on Ashy Storm-Petrels on Southeast Farallon Island. Unpublished report to the U.S. Fish and Wildlife Service. PRBO Conservation Science, Petaluma, California. PRBO Contribution Number 1880.

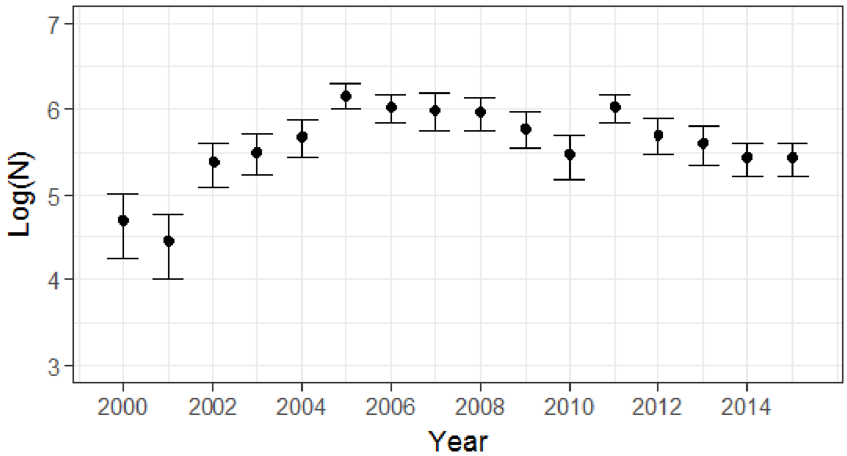


Figure 2. Change in estimated population size index of ashy storm-petrels over time, based on captures of individually-banded ashy storm-petrels, 1999 to 2016. The index reflects estimated population size, on a log-scale. Shown is each year's estimate ± 1 Standard Error of the estimate. 2016 was the last year of capture in the dataset, and so population size could not be estimated for that year.

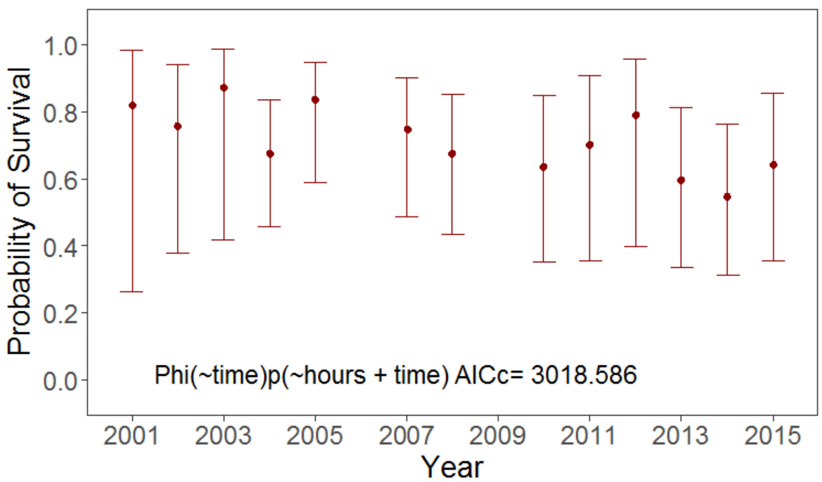


Figure 3. Variation among years for annual survival probability of ashy storm-petrels on Southeast Farallon Island to the year shown in the Figure; thus "2001" refers to survival from 2000 to 2001. Shown are year-specific model estimates and the 95% Confidence Interval around those estimates. 2016 was last year of study and thus survival could not be estimated for that year. Recapture data were inadequate to estimate year-specific survival estimates for 2005/2006 and 2008/2009.

To summarize, the three part-trend in storm petrel population size mirrored the three part-trend in burrowing owl abundance: storm petrel population increase in 2000-2005 when burrowing owl numbers were low, population decline from 2005-2010 during the time that burrowing owl numbers were increasing, and reduced decline from 2010-2015 when burrowing owl numbers were somewhat reduced and/or stabilizing.

b) Assess the current status of the Farallon population of ashy storm-petrels through updated demographic modelling.

We used the information on population trend, baseline survival values, and the relationship between burrowing owl abundance and storm petrel survival to model future population trajectories for the ashy storm-petrel under different scenarios of burrowing owl reduction. The models incorporated the latest information on the relationship between burrowing owl numbers and annual survival of ashy storm-petrels. The future population trend for ashy storm-petrels, in the absence of any management directed at reducing burrowing owls on the South Farallon Islands, is not known. Hence we considered three "baseline" trend scenarios (i.e., projected trends in the absence of a change in owl numbers): moderately strong decline, moderate decline, and population stability. For each baseline trend, we considered the impact of a change in owl numbers (either 50% or 80% reduction in the average number, with reference to 2009 to 2012 owl abundance) on survival of subadult and adult storm petrels and thus on population trend. An important feature of the demographic modeling conducted in this second year is that we included environmental stochasticity of demographic parameters. This provides more realistic scenarios, and allows us to quantify uncertainty of population outcomes, which is important information for wildlife managers. Thus, we can project a range of likely outcomes, as well as estimate the probability that the population will decline over the next 5 to 20 years.

We found that reduction in owl abundance is projected to have strong positive population impacts in all scenarios examined and can reduce or reverse the decline expected with no owl reduction. More specifically, under a moderately strong declining trend based on island data from 2006 to 2012, 80% owl reduction can eliminate the decline (i.e., the trend changes from an average of 63% decline after 20 years, to an average increase of 2% after 20 years), while 50% owl reduction can change a moderate decline (an expected 40% decline after 20 years) to an average increase of 6% after 20 years.

Of equal significance is the variability in outcome. Examining the same moderate decline described above, with 50% owl reduction the median expected decline is now 26%, but there is a 5% probability that the decline will be 68% or greater, while there is a 5% probability of an increase of 39% or more after 20 years. Another way to quantify the impact is to consider the probability that a population will decline. Assuming a moderately strong decline, there is a 99% probability that the population will have declined to any degree after 20 years; however, with 50 and 80% owl reduction, the probability of decline is reduced to 76% and 48%, respectively.

c) Improve our capacity to detect storm-petrel breeding sites for long-term monitoring.

We further increased our capacity to collect high quality reproductive success data for ashy storm-petrels breeding on the Farallon Islands in 2017 by utilizing crevice camera systems. To improve our monitoring efforts of ashy storm-petrels during the 2017 breeding season, we used radio-frequency identification (RFID) readers and passive integrated transponder (PIT) tags on leg bands to detect nest sites and to track nest attendance patterns of breeding birds. We constructed RFID readers, each with two circular antennae (10 cm diameter) for detecting PIT tags. We began PIT tagging adult ashy storm-petrels during our routine mist netting sessions. In total, we deployed 361 PIT tags on the same number of birds. We surveyed both artificial rock walls and natural scree, using crevice cameras to investigate sites where birds were detected.

In total, we recorded 121 detections from 37 unique PIT-tagged individuals. All detections occurred in the artificial rock wall habitat. From all detections, 19 individuals were detected only once and 18 individuals were detected on multiple occasions. Multiple detections of the same individual either occurred when an individual remained in close proximity to the RFID reader antenna or when an individual used the same entrance on multiple occasions. Using the location of RFID readers with detections to focus our search, we ultimately located five additional active nests sites, which is about 9% the total number of active nests.

Unfortunately, a manufacturing error resulted in an estimated 60% of our tags failing within one month of being deployed. The manufacturer has diagnosed the tag failure as the result of improper sealant curing in the tag, resulting in damage to the tag circuitry. This issue was discovered after recapturing a number of individuals with PIT tags that could not be detected by our RFID readers. After realizing this high failure rate, we ceased tagging efforts. As a result of the large number of tag failures, the total number of individuals that could possibly be detected over the whole breeding season was relatively low (about 145 individuals). As such, given that a total of 37 individuals were detected, the detection rate of individuals with functioning tags was relatively high. It should be noted that this comparison does not account for the timing of tag deployment relative to when it was detected, which is relevant given that tags did generally operate adequately for several weeks.

**Outcomes**

a) Strengthen scientific support for management actions to benefit ashy storm-petrels. Through validation of our previous modelling efforts, this project could show strong scientific support for the quantified population level impacts to ashy storm-petrels by reducing burrowing owl numbers through mouse eradication.

The recent population trend demonstrates that the previous decline in population size, when burrowing owl abundance was increasing, is now much reduced and suggests that the population is stabilizing. This finding provides support for the hypothesized population-level impacts of reducing burrowing owl numbers. However, our analysis also indicates that a substantial change in burrowing owl abundance may be required to be able to statistically detect a change in storm petrel survival. Indeed a substantial change in owl abundance is one of the objectives of the proposed mouse eradication project, and thus our results provide support for proceeding with such efforts.

b) Provide the scientific basis, in terms of estimated colony population status, for listing or not listing the ashy storm-petrel under the Endangered Species Act. Evaluation of current demographic trends for the Farallon storm-petrel population will determine if recent declines have continued. These analyses could provide further solid science basis to conservation action.

We have made progress towards better estimation of population trend and status. The previously observed declining trend in population size appears to have been substantially reduced and even eliminated. Further, we have quantified the probability of further decline if no management actions are taken to reduce burrowing owl numbers, critical information in considering a change in listing.

c) Increase quality of long-term monitoring data. Utilize high quality reproductive success data to obtain a better understanding of how ashy storm-petrel populations can be expected to behave in the future, when coupled with the better information on survival and trends in b) and also in a), above. Increased use of high quality cameras and pilot studies using PIT tags will allow us to monitor a minimum of 50 active storm-petrel breeding sites annually for many years to come.

We monitored 53 active storm petrel breeding sites in 2017. Overall, we feel that the 2017 field season has provided a proof of concept for the use of RFID readers to identify new ashy storm-petrel nest sites and to monitor nest activity. Despite technical difficulties with a large number of PIT tags, we added new nests to our long-term monitoring program and established a protocol for using RFID readers in future field seasons.