# Biology and Conservation of the Juan Fernández Archipelago Seabird Community

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**TABLE OF CONTENTS**

## INTRODUCTION

Six species of seabirds breed on the Juan Fernández Archipelago: the pink-footed shearwater (*Puffinus creatopus*), Juan Fernández petrel (*Pterodroma externa*), Stejneger's petrel (*Pterodroma longirostris*), Kermadec petrel (*Pterodroma neglecta*), white-bellied storm petrel (*Fregetta grallaria*), and Defilippe's petrel (*Pterodroma defilippiana*). The first five breed during the austral summer, while the Defilippe's petrel breeds during the austral winter. We began a research program focused on the first four species, the pink-footed shearwater, Juan Fernández petrel, Stejneger's petrel, and Kermadec petrel, investigating their basic ecology and factors potentially important for future conservation measures.

## OBJECTIVES

### Pink-footed shearwater (*Puffinus creatopus*), Juan Fernández petrel (*Pterodroma externa*), and Stejneger's petrel (*Pterodroma longirostris*)

These three species breed in aggregations of burrows on Robinson Crusoe and Santa Clara (*P. creatopus*) and Alexander Selkirk (*P. externa* and *P. longirostris*). The accessibility of colonies allowed us to begin investigating various ecological parameters simultaneously:

1) breeding population estimates
2) breeding biology and behavior
3) foraging ecology
4) competition with, and predation by, introduced mammals

### Kermadec petrel (*Pterodroma neglecta*)

This species nests on small islets and rock outcrops offshore of Robinson Crusoe. Due to the difficulty of access for this species, we targeted the colony on a single outcrop, Morro Juanango, with the following initial objectives:

1) establish a monitoring quadrant
2) mark nests within the quadrant
3) determine status of each marked nest
4) obtain preliminary measurements and samples

### Community involvement

We placed priority on interacting as much as possible with the local community in order to encourage involvement in conservation issues and enhance the sense of pride towards, and ownership of, the islands' valuable natural resources.

## RESEARCH ON THE PINK-FOOTED SHEARWATER (*Puffinus creatopus*)

The majority of work for this species was conducted on Isla Santa Clara, primarily because of the accessibility of nest cavities. Relative to burrows on Isla Robinson Crusoe, Santa Clara burrows were shorter, shallower, and less sinuous, thereby providing access to nest cavities via an infrared burrow camera and the excavation of access holes. However, additional studies were conducted on Robinson Crusoe, and these research

efforts will be summarized in this section. In collaboration with CONAF (Corporación Nacional Forestal, the Chilean National Park Service) and the municipality, we also began a monitoring program on Labrador Ridge, just southeast of the town of San Juan Bautista (see Community Involvement below).

**Breeding population estimates**

*Methods.* Isla Santa Cruz covers 221 hectares (2.21 $km^2$) and the majority of its terrain can be covered on foot. Over the course of the season, all accessible areas were systematically walked and burrows were counted individually. Some areas could not be accessed directly, and in some of these cases, counts were done with binoculars or numbers of burrows were estimated based on comparable nearby direct counts. Finally, a binocular survey of the east-facing cliffs of the islands was conducted by boat. Some portions of the island could not be accessed or even viewed from a distance, such as small drainages and the west-facing cliffs. While we feel that the vast majority of suitable terrain was censused, it should be noted that the burrow count estimates provided here must be considered minimums.

Burrow estimates provided the total number of burrows available for occupation, and a variety of methods were employed to estimate the proportion of burrows actively used by shearwaters. The European rabbit (*Oryctolagus cuniculus*) is an introduced inhabitant of Isla Santa Clara, and may share (with shearwaters) or solely occupy a significant number of available burrows. Three colonies were chosen to evaluate burrow occupancy: Refugio, near base camp; Volcán Chico, a slope of a mid-sized peak; and Cerro Alto, a saddle on the summit of the island. At each of these colonies, 4 plots of 12 burrows each were chosen randomly, for a total of 48 burrows at each colony, and an island total of 144 burrows. For 6 consecutive days, the mouth of each burrow was cleared and re-set, and the following indicators were monitored:

Two to four toothpicks were inserted at the mouth of each burrow, and their status (up, down, or leaning) was noted. This provided information on whether a burrow was being used, though it did not distinguish between shearwater or rabbit.

Fine dirt was sifted through a colander around the mouth of the burrow, and identifiable tracks were noted. This allowed a distinction between shearwater and rabbit, but did not necessarily distinguish between visits by breeding shearwaters and prospecting birds (though we expected the number of prospectors to be low, see below).

The presence of other signs were noted, such as feathers, fresh guano, vegetation, and/or strong procellariidae (shearwaters and petrels) odor coming from the burrow mouth. These observations were intended to provide supplementary information to assist in categorizing burrow use based on the above indices.

After the six-day monitoring period, all 144 burrows were inspected with an infrared video camera mounted on a 1.75 m hose to determine if the burrow was occupied, empty, or unknown (burrow too long or sinuous to confidently categorize as empty). As well as providing direct check s for occupancy of a proportion of the burrows, the camera data can also be used in part to calibrate the accuracy of the above indirect measures of occupancy. Because an egg was not always visible underneath adults, the camera method could not always distinguish between breeding and prospecting birds. However, burrow occupancy was assessed fairly late in the incubation period; therefore,

we believe that a very large proportion of the adults observed inside burrows during daytime hours were active breeders.

On Robinson Crusoe, study sites were established at three additional colonies: Vaquería, Piedra Agujereada and Puerto Francés. A complete count of burrows at the Vaquería plot was conducted, and burrow occupancy was monitored for 7 days as described above. However, because of the greater length of burrows at Vaquería we were unable to check burrows with the camera. The complete Vaquería colony extends beyond the study plot, and no comprehensive censuses were conducted there or at the other two Robinson Crusoe colonies (Piedra Agujereada and Puerto Francés). However, very crude estimates given walking coverage of the area are provided.

*Results.* On Isla Santa Clara, 4,044 burrows were counted individually, either directly or with binoculars. In addition, the number of burrows in a few less accessible areas was estimated to be 895, bringing the total estimate of burrows on Santa Clara to 4,939. Because some areas could not be reached at all, we consider this estimate to be a minimum.

Nighttime observations (see Breeding biology and behavior below) showed that adults frequently defecated in front of and entered neighboring burrows, suggesting that many of our indirect indicators of burrow occupancy were not as reliable as we expected. That is, disturbance of toothpicks, shearwater tracks, and other features such as fresh guano do not necessarily indicate active use of a burrow for reproduction. These data therefore require very detailed attention, and here we provide estimates based only on the direct observation of burrow occupancy using the infrared burrow camera. These examinations revealed considerable variation among sites on Santa Clara.

Burrow occupancy data for Isla Santa Clara using an infrared burrow probe

| | Occupancy category (%) | | | |
|---|---|---|---|---|
| Colony | Active | Empty | Unknown | Range of potentially active* |
| Refugio | 60 | 15 | 25 | 60-85 |
| Volcán Chico | 37 | 46 | 17 | 37-54 |
| Cerro Alto | 39 | 41 | 20 | 39-59 |
| Mean of midpoint values of ranges | | | | 55.7 |

* Range = Active – (Active + Unknown)

Combining our burrow counts and infrared probe data therefore provides an estimate of 4,939 x 0.557 = 2,751 occupied burrows, or breeding pairs, on Isla Santa Clara.

On Robinson Crusoe, the Vaquería plot included 480 burrows counted individually, but we estimated at least 800 burrows in the extended colony. Study plots at Piedra Agujereada and Puerto Francés have not yet been censused, but our rough estimates (of plots, not entire colonies) are 450 and 300 burrows, respectively. Burrow occupancy data for Vaquería was unfortunately lost in the storm (see below), so we have no way to assess the number of pairs making use of this colony.

*Discussion.* These results represent the first direct census of Isla Santa Clara. In 2000, Daniela Guicking and Wolfgang Fiedler provided an estimate of1500-2000 breeding pairs, and our direct count suggests the presence of a larger population relying on Santa Clara for reproduction. Due to the large size and rugged terrain of Robinson

Crusoe, a direct count appears unfeasible. We are currently researching alternative methods for assessing population size, such as the use of radar at the base of drainages to track adults coming in at dusk via heavily used fly-ways.

**Breeding biology and behavior**

*Methods.* On Santa Clara, incubation, chick hatching, and chick growth were monitored initially for 21 burrows. Study nests consisted of burrows with access holes dug into the nest chamber (13), accidental burrow collapses (5), and short burrows accessed directly from the mouth (3).

Incubating adults were checked every other day, and once chicks had hatched, they were measured every third day. Mass (g), wing length (mm), culmen length (mm), and tarsus length (mm) were measured, and eruption of primary feathers was noted.

Adult nighttime colony attendance and surface behavior were monitored with night vision goggles, infrared beam, and red-coated headlamps and divelights as often as weather and logistics permitted, both at Santa Clara and Vaquería (Robinson Crusoe). Observations were conducted for 2-9 hours on 20 nights at Santa Clara, and from 5-9 hours on 11 nights at Vaquería. The following scans were conducted every 30 minutes: the total number of two types of vocalizations heard during a five minute sample and the total number of birds visible on the surface in a defined region of the colony. In addition, the maximum instantaneous number of birds visible in the sky during a one minute scan, using a defined field of view in the night vision goggles, was recorded once each hour. Finally, behavioral observations were conducted continually, recording the general movements (arrival, departure, burrow entry and exit, and interactions) of all individuals in a defined area of the colony.

*Results.* Of the 21 nests we began monitoring, we collected hatching date data for 17 nests. All chicks hatched between 27 January and 10 February, and 71% (12/17) of hatchings occurred during the week of 2-8 February. Chicks were left unattended 1-3 days after hatching and adults were almost never found in the burrows during the day after this initial, brief brooding period.

For the remaining 4 nests, the egg never hatched (infertile or inconsistent adult attendance, 3 nests) or the adult moved with the egg out of reach from the access point (1 nest). One chick was found crushed on the day of hatching and one chick moved out of reach after hatching, leaving consistent data for chick growth for a total of 15 nests. From these data, we estimate a hatching rate of 85% (17/20). For successfully hatched chicks, we calculated a survival rate to day 36-46 of 88% (14/16), and estimate overall survival to day 36-46 (including unhatched eggs) to be 75% (15/20). However, see below (The storm) for additional mortality information related to the 17-18 March rains.

A summary of growth parameters for 12 chicks is presented below (of the 15 total study chicks, these 12 were all measured on the same days):

Mean chick measurements and differences for days 0-5 and 36-41

| | Mass (g) | Wing chord (mm) | Culmen (mm) | Tarsus (mm) |
|---|---|---|---|---|
| Mean, day 0-5 | 139.4 | 27.4 | 20.4 | 24.7 |
| Mean, day 36-41 | 749.6 | 91.8 | 36.9 | 53.9 |
| Growth (difference between means) | 610.2 | 64.4 | 16.5 | 29.2 |

| | | | | |
|---|---|---|---|---|
| Mean growth per day | 17.0 | 1.8 | 0.5 | 0.8 |

Measurements for mass were extremely variable, and individual chicks both gained and lost weight over the course of the season. In contrast, variability in measurements for wing chord, culmen, and tarsus were low. This pattern is expected, given that mass is strongly related to the sporadic delivery of meals from a parent, while the other growth measures represent the slow but steady transition of resources into the growth of tissues. By the time of our departure, the emergence of primary feathers had been observed in 100% (15/15) of chicks.

Nighttime observations provided preliminary data on various behavioral parameters, many of which will warrant further attention. Monitoring of individual burrows on consecutive nights on Santa Clara yielded numerous observations of foraging trip durations in the 2-3 day range. In addition, we noted cycles of low and high activity (vocalizations and presence/activity on colony surface). Preliminary review of Santa Clara behavioral data suggest a partial correlation with lunar cycles; however, it is clear that other factors play a role. In addition, vocalizations were strongly associated with presence/activity on the surface, while sky scans were consistently low and did not seem to be a good indicator of colony behavior. We attempted to compare surface behavior between Robinson Crusoe, where mammalian predators are presents, and Santa Clara, where mammalian predators are absent. However, the data for Robinson Crusoe were lost in the storm (see below), and we cannot therefore quantify any differences in behavior.

Two different types of vocalizations were recognizable, categorized as Type I and Type II. Calls at Vaquería (Robinson Crusoe) were almost entirely Type I vocalizations, while calls at Refugio (Santa Clara) were almost entirely Type II vocalizations. The reasons for these local differences are unknown.

*Discussion.* This study represents the most thorough study to date on breeding phenology (timing), chick growth, and adult nocturnal behavior for the pink-footed shearwater. Future studies will require early and late season observations to determine dates of laying and fledging, respectively. In addition, this season provided us with preliminary data for hatching rate and survival to day 36-46, but survival to fledging would be a valuable parameter to measure. Ultimately, a banding program would also allow us to address chick survival to adult stage, as well as adult mortality.

We hope to pursue the variety of interesting behavioral questions generated by the nocturnal observations that were conducted. Investigations of the factors that regulate activity cycles would be particularly useful, as well as efforts to explore the differences in vocalizations between Robinson Crusoe and Santa Clara. Vocalization "dialects" have been demonstrated in a variety of other vertebrates, and may be related to the amount of interchange between populations on the two islands. We also remain interested in investigating potential differences in surface behavior due to the presence/absence of predators on the two islands, and will repeat our efforts in coming seasons.

**Foraging ecology**

*Methods.* The foraging ecology of pink-footed shearwaters on Santa Clara was assessed both directly and indirectly. Two dummy satellite transmitters were successfully deployed and retrieved on two different breeding adults. Active solar powered satellite transmitters were subsequently deployed on 2 breeding adults to directly monitor their

foraging trip locations and durations. In addition, a variety of samples were collected for stable isotope analyses (see results).

*Results.* The four adults carried transmitters for 11 (dummy 1), 2 (dummy 2), 5 (active 1), and 9 (active 2) days, respectively. Visitation to the colony by tagged birds was witnessed directly during nighttime observations on 2 occasions, demonstrating foraging trip durations of 2 and 3 days. Satellite data yielded estimates of foraging trip lengths ranging from 2-4 days. These ranges are consistent with those observed for untagged birds, suggesting that tagging did not affect foraging trip duration. Preliminary analysis of foraging locations and trip durations are presented in Figure 1. Our data suggest trips heading both northeast and southeast of the islands and ranging 70-258 km from the colony.

Blood samples were taken from 8 adults captured on the colony surface, and from 9 chicks monitored during the breeding biology study described above. Nineteen adult carcasses and 16 discarded eggs were also scavenged for tissues (bone, feather, shell) for additional stable isotope analyses. Stable isotope analyses will be conducted to determine the trophic level at which adults are feeding and chicks are being fed.

*Discussion.* The success of tag retrieval provides us with the groundwork to further develop a comprehensive foraging ecology study. In future seasons, we hope to deploy more transmitters, sample diet and trophic level via stomach flushing and stable isotope analyses, as well as integrate oceanographic parameters to put shearwater foraging behavior into a regional context. Satellite tagging efforts on Isla Mocha (2 breeding adults) suggest that Mocha birds may go on longer foraging trips (10-14 days), but that distance traveled from the colony may be comparable to Juan Fernández birds.

**Competition and predation**

*Methods.* Competition between shearwaters and rabbits was assessed on Santa Clara by monitoring presumed egg ejection from burrows at all three study colonies. Upon commencement of the study, all ejected eggs were removed from the plots, and continual monitoring was conducted thereafter. Although we cannot rule out ejection of eggs by other shearwaters, this is a very uncommon occurrence in related species. This conclusion is further supported by our observations of infertile and abandoned eggs remaining in burrows, even those that were no longer actively attended by adults.

On Robinson Crusoe, we monitored egg ejection in a similar manner at all three study colonies, except that each colony was visited only once each month (3 checks each). In addition, we made preliminary attempts to assess predation threats by rats, cats, and coatis. While colonies were being censused for ejected eggs, carcasses were also recorded, assessed for wounds, and removed from the plot.

Rat traps baited with peanut butter were set at Vaquería for a total of 760 trap-nights, and at Piedra Agujereada rat traps were set for a total of 160 trap-nights. At each of these two sites, three to four 1 $m^2$ track pads were also established for 30 track-nights at Vaquería and 12 track-nights at Piedra Agujereada. Pads were set by sifting fine dirt centered around a stake baited with tuna, tuna oil, and dry cat food. Finally, mammal eye-shine was also noted during nighttime scans conducted for shearwater behavioral observations.

*Results.* Study plots on Santa Clara revealed an egg ejection rate of 14% from burrows occupied by shearwaters. Study plots from Robinson Crusoe suggest an egg

ejection rate of 0.2%. Adult carcass counts were highest at Piedra Agujereada, where predation rate may be as high as 10%. Five rat samples (muscle) were collected at Vaquería, and eight rat samples (muscle and bone) were collected at Piedra Agujereada for stable isotope analysis. Track pads at both Vaquería and Piedra Agujereada demonstrated visitation by rats and rabbits, as well as tracks that were unclear and therefore unidentifiable. There were no positively identifiable cat or coati tracks, but additional work is necessary in order to assess visitation by these mammals.

Local hunters and park employees supplied us with one cat and four coati tails, and we opportunistically collected six cat scat samples, all of which will be used for stable isotope analysis of diet.

Finally, eye shine was observed repeatedly at both Vaquería and Refugio, but use of an infrared beam and night vision goggles confirmed that it belonged to rabbits or rats (Robinson Crusoe only) on all occasions.

*Discussion.* Understanding interactions with introduced mammals will be critical for conservation of the entire seabird community. Our preliminary efforts have provided us with a sense of the importance of threats posed to seabirds from competition with rabbits and predation from other mammals, and that these interactions warrant further study. In addition, we acquired valuable samples for stable isotope analyses, allowing us to indirectly assess the diet of rats in particular, and with less power, of cats and coatis. From personal observation and discussion with CONAF staff and locals, it appears that feral cats and coatis are present near shearwater colonies, but not in great abundance. Islanders in particular have commented that coatis have declined significantly in recent years. At present, we do not know what factors are regulating cat and coati populations, but it is an important area for future research. Investigating the impact of introduced mammals remains a high priority for our program. Cats and rats have devastated seabird populations world-wide, and the simple presence of these predators on the islands poses the same potential risk. The variation in levels of adult mortality due to predation and its relationship to the distribution of introduced predators is therefore of particular interest for future studies.

**The storm**

On 17-18 March, the Juan Fernández Archipelago experienced an unusually high level of rainfall. This storm caused severe damage to terrain and to the seasonal lobster village on Isla Alexander Selkirk. Photos of Selkirk were provided to CONAF by Peter Hodum, and the effect of the event on Selkirk seabird research efforts are addressed in the Juan Fernández and Stejneger's petrel section below.

The storm also affected Isla Santa Clara. Fortunately, no damage occurred to the CONAF refuge, but a recently constructed dam and brackish water rerouting system were destroyed, and the cemented anchor of a zip-line for transporting gear was loosened and made inoperable. The storm occurred during our last 3 days at the Santa Clara field site, and it was clear that significant damage was done to burrows. We attempted to quantify the potential impact of the rains, but could not follow up due to our departure.

There were notable differences in the effects of the severe weather at the two sites where assessment was conducted. At Refugio, where there is absolutely no vegetation to prevent erosion, the rain storm appeared to have a significant impact. Thirty-three percent of burrows had collapsed, had mouths completely filled with mud, or were simply no

longer identifiable, while another 27% of burrows had either partially collapsed or had mouths partially filled with mud. Forty percent of burrows appeared unaltered. At Cerro Alto, where recent milder rains had encouraged growth of ground cover at the colony, damage was limited to only 4% of burrows. In addition, the slope of the Refugio colony is much steeper than at Cerro Alto, and this may have also contributed to the difference in responses to the storm.

Because chicks fast for days at a time as a natural part of their biology, and adults are capable of digging out burrows, we cannot translate this burrow damage directly into mortality. However, we suspect that parts of the shearwater population suffered higher than average mortality due to a combination of extreme weather and lack of vegetation. Whether this lack of vegetation is a result of recent grazing pressure from rabbits, historical factors relating to heavy grazing or differences in soil quality, or both, is unknown.

## RESEARCH ON THE JUAN FERNÁNDEZ (*Pterodroma externa*) and STEJNEGER'S PETREL (*Pterodroma longirostris*)

An important component of our project is to establish research programs on Isla Alexander Selkirk. This field season we began to investigate the breeding ecology and conservation status of the two endemic species of petrels that breed there, the Juan Fernández Petrel (*Pterodroma externa*) and Stejneger's Petrel (*Pterodroma longirostris*). Peter Hodum and Ronnie Reyes traveled from Isla Robinson Crusoe to Isla Alexander Selkirk on 26 February 2002 and began fieldwork in the Tres Torres and Cordón de los Inocentes Bajos sectors on 28 February. Fieldwork continued through 19 March, at which point the impending evacuation of the island prematurely ended our time in the field. We returned to Isla Robinson Crusoe on 21 March 2002.

Our efforts on Isla Alexander Selkirk focused on four general areas of research: population biology, breeding biology and behavior, foraging ecology, and predation. The objectives and methods are the same for both petrel species.

### Population biology

We did not have time to conduct a thorough census during the relatively short time we had on Selkirk. Instead, we focused on determining percentage occupancy of burrows using toothpick lattices, determining how to differentiate between burrows of the two species, and determining nesting habitat preference of the two species.

In this context, occupancy is a measure of activity at a nest (i.e. whether or not the lattice placed in the mouth of a burrow has been knocked down by a bird either entering or leaving). Occupancy does not imply anything about the reproductive status of a nest, but rather only whether or not a burrow is being visited.

*Juan Fernández petrels*

Of 88 Juan Fernández petrel burrows monitored for occupancy, 87 (98.8%) showed signs of activity. Fifty-six of these nests were in the grassy plain beside the campsite at Tres Torres and 32 were located in the canelo-tree fern forest on the edge of the grassy plain. All 56 burrows in the plain and 31 of 32 burrows in the forest and showed signs of petrel activity. On 12 March we attempted to determine nest contents for all 32 forest burrows using the infrared burrow probe and the results are as follows: 7

burrows with unattended chicks (21.9%), 4 burrows with adults (2 of which definitely had neither a chick nor an egg) (12.5%), 1 burrow with an unattended egg (3.1%), 13 empty burrows (40.6%), and 7 burrows with undetermined status (21.9%). It is important to note that this census was conducted at the conclusion of the hatching period and thus is a conservative estimate of reproductive activity. A failed breeding attempt earlier in the season may have appeared as either an empty burrow or one with adults present.

*Stejneger's petrels*

Twenty-five Stejneger's petrel burrows were also monitored using lattices. These nests were located along the top of the Cordón de los Inocentes Bajos. All 25 showed signs of activity, and 8 of 10 that were successfully checked with the burrow probe had chicks with the remaining two burrows each containing an abandoned egg.

*Burrow identification*

In order to determine whether or not burrows of the two species could be consistently distinguished using dimensions of the burrow entrance, we measured the maximum width and height (in mms) of burrow entrances for 25 Juan Fernández petrel and 13 Stejneger's petrel nests. Juan Fernández petrel nests were significantly larger in both the entrance height and width dimensions (Juan Fernández petrel burrow dimensions: average width =146 mm, average height = 112 mm; Stejneger's petrel burrow dimensions: average width = 99 mm, average height = 89 mm). Thus, it appears that using maximum burrow entrance dimensions provides a reliable means of determining which species uses a particular burrow.

*Breeding habitat preference*

We began to quantify breeding habitat preference of the two species by establishing 8 quadrants in each of 5 different habitat types and counting burrows of each species in each quadrant. This work is the basis for Ronnie Reyes' senior thesis (under the direction of P. Hodum and R. Schlatter) and he is currently doing the analyses. We can provide this information when it becomes available.

**Breeding biology and behavior**

To begin our study of reproductive biology of the two species, it was necessary to establish study areas with marked nests. We established two study areas for Juan Fernández petrels, one on the grassy plain adjacent to the Tres Torres campsite and one in the canelo-tree fern forest adjacent to the plain. We established one study area for Stejneger's petrels along the top of Cordón de los Inocentes Bajos. In each study area we marked nests that we were able to probe successfully using the burrow scope. These nests were checked regularly throughout our visit.

*Juan Fernández petrels*

We marked 24 nests in the grassy plain, the eggs or chicks in which could be monitored by either burrow probe or access holes that we excavated. Of the 24, 20 (83%) had either an egg or chick when first checked in early March, with 15 chicks ultimately hatching. This yields a preliminary hatching success of 75% (15/20). We marked 9 nests in the forest study plot, all of which were also accessible by probe or access hole. Eight of the 9 had a chick. In one nest an adult was present but we were unable to determine if it had an egg or chick.

We arrived after most Juan Fernández petrel chicks had already hatched, although we recorded 3 chicks hatching between 9-13 March. Based on the size and

development of the chicks, it appears that hatching begins during the last week of February and continues until mid-March. Chicks were left unattended 1-3 days after hatching, and adults were almost never found in the burrows during the day after this initial, brief brooding period. At the time of our departure, none of the primary feathers on any of the chicks had emerged yet.

We have day 0-1 measurements for two Juan Fernández petrel chicks:

| MASS | WING LENGTH | TARSUS LENGTH | CULMEN LENGTH |
|---|---|---|---|
| 57 g | 24 mm | 18.7 mm | 19.7 mm |
| 71 g | 23 mm | 19.1 mm | 19.1 mm |

Additionally, we have measurements on 12 other Juan Fernández petrel chicks whose hatch date is not known. These data will be available once they are compiled.

Description of Juan Fernández petrel downy nestlings:

- slaty gray down on head, neck, back, and wings; gray extends to sides of throat
- white down on chest and belly extending to rump
- white chin and throat
- bill and eyes black
- legs pale pink with pale pink webbing and gray toes
- white patches on proximal underwing
- bill is relatively deeper than the bill of Stejneger's petrel nestlings
- at 2-3 weeks of age, the foot develops the characteristic two-tone coloring of the adult foot with pink coloring on the proximal half of the webbing and gray on the distal half

We measured 8 eggs and the results are in the following table:

Measurements of Juan Fernández petrel eggs

| Egg # | Egg length (mm) | Egg width (mm) |
|---|---|---|
| 1 | 67.1 | 47.8 |
| 2 | 69.8 | 47.7 |
| 3 | 71.9 | 46.8 |
| 4 | 65.3 | 47.4 |
| 5 | 70.9 | 46.6 |
| 6 | 66.0 | 46.3 |
| 7 | 66.5 | 47.1 |
| 8 | 66.8 | 47.2 |
| MEAN | 68.0 | 47.1 |
| S.D. | 2.5 | 0.5 |

We measured 15 adult Juan Fernández petrels. We were unable to determine the breeding status of these individuals, although most were probably non-breeders because they were captured while sitting on the surface of the colony.

Measurements of adult Juan Fernández petrels (breeding status unknown)

| Bird # | Mass (g) | Wing length (mm) | Tarsus length (mm) | Culmen length (mm) |
|---|---|---|---|---|
| 1 | 456 | 318 | 40.1 | 36.6 |
| 2 | 465 | 320 | 39.3 | 37.2 |
| 3 | 455 | - | - | - |
| 4 | 533 | - | - | - |
| 5 | 510 | 320 | - | - |
| 6 | 480 | 318 | - | - |
| 7 | 478 | 321 | - | - |
| 8 | 463 | 319 | 40.9 | 38.7 |
| 9 | 445 | 305 | 40.4 | 38.1 |
| 10 | 435 | 325 | 40.6 | 38.3 |
| 11 | 458 | 320 | 40.5 | 38.8 |
| 12 | 490 | 321 | 41.0 | 37.6 |
| 13 | 470 | 313 | 40.8 | 39.9 |
| 14 | 463 | 315 | 43.6 | 36.6 |
| 15 | 473 | 316 | 41.0 | 36.5 |
| MEAN | 472 | 318 | 40.8 | 37.8 |
| S.D. | 25 | 5 | 1.1 | 1.1 |

*Stejneger's petrels*

We marked 10 burrows along the top of Cordón de los Inocentes Bajos, all of which were accessible by either burrow probe or access holes that we excavated. Of the 10, 8 had chicks present when first examined and the other 2 had unattended eggs that never hatched, yielding a hatching rate of 80%.

We arrived after hatching had concluded for the season and thus we did not have any known-age nestlings. Based on their stage of development when we arrived, it appears that the peak of hatching occurs during the first half of February. Stejneger's petrel chicks apparently hatch 1-2 weeks prior to Juan Fernández petrel chicks. At the time of our departure primary feathers on the oldest chicks were beginning to emerge. We have preliminary chick growth data for 7 nestlings and these will be available once they are compiled.

Description of Stejneger's petrel downy nestlings:

- slaty gray down on head, neck, back, and wings
- white down on chest and flanks of belly with gray chevron extending from the underside of the rump to the central belly (contrast with pure white belly of Juan Fernández petrel chicks)
- bill and eyes black
- legs lavender/gray with pale webbing between toes; toes gray with outer toe darker
- no white patch on underside of wing, as in Juan Fernández petrel chicks

- hook on bill is shallower
- tarsus is relatively thinner for a given size chick

We were able to measure the dimensions of 1 Stejneger's petrel egg: length = 53.5 mm, width = 38.3 mm.

We measured 5 adult Stejneger's petrels. We were unable to determine the breeding status of these individuals, although most were probably non-breeders because they were captured while sitting on the surface of the colony.

Measurements of adult Stejneger's petrels (breeding status unknown)

| Bird # | Mass (g) | Wing length (mm) | Tarsus length (mm) | Culmen length (mm) |
|---|---|---|---|---|
| 1 | 141 | 218 | 29.2 | 25.3 |
| 2 | 197 | 221 | - | - |
| 3 | 217 | 221 | - | - |
| 4 | 140 | 215 | - | - |
| 5 | 153 | 223 | 29.0 | 25.5 |
| MEAN | 170 | 220 | 29.1 | 25.4 |
| S.D. | 35 | 3 | 0.1 | 0.1 |

*Adult behavior and activity patterns in colonies (both species)*

Adults of both species exhibited similar behavior and activity patterns in the colonies and we are therefore presenting them together. Adults began to return to the colonies about sunset. Typically, the first vocalizations in the vicinity of the colony were heard between 2015-2030 h (adjusted to standard time), which coincided with the first observations of birds flying over the colony. A peak of aerial activity and vocalizations occurred within the first hour. Breeding birds appeared to spend little time on the surface before entering their burrow, typically landing within several meters of the burrow, walking to the entrance, and entering directly. In contrast, non-breeding birds spent up to several hours on the surface. During this time they exhibited a variety of behaviors including sitting, sleeping, interacting with other individuals, and exploring burrows. These non-breeding individuals appear to be at greatest risk from predation by cats in the colonies.

Adults departed the colony throughout the night with the last individuals leaving immediately prior to sunrise (as late as 0655 h standard time; 15 March).

**Foraging ecology**

As part of our study investigating trophic relationships and diet of the seabird community, we will use stable isotope analyses to acquire information about diet and trophic structure from blood samples that we collected from adult and nestling petrels of both species. Unfortunately, many of these samples, including all of the adult petrel samples, were lost in the storm and flooding of 17-18 March (see section below). The samples that survived (6 Juan Fernández and 5 Stejneger's petrel chicks) will be analyzed in the coming months. Using some of our data on burrow visitations, we will also be able to acquire preliminary information on foraging trip lengths for both species. This information will be combined with complementary data collected from pink-footed

shearwaters and Kermadec petrels to begin to develop a better understanding of the trophic role that these seabirds play in the surrounding marine environment.

**Predation**

We used several different techniques to begin to address our research objectives regarding the impact of introduced mammalian predators on the breeding seabird population. We have begun a systematic survey of quadrants within the colonies to quantify the number of petrel carcasses found. From this we will eventually be better able to calculate the predation rate on these two species. Our preliminary data suggest that the smaller species, the Stejneger's petrel, is disproportionately preyed upon. Although we do not have total breeding population estimates for either species yet, it is apparent that Juan Fernández petrels are significantly more abundant. In 1986, de La Brooke estimated that there were approximately 7x as many breeding pairs of Juan Fernández petrels as Stejneger's petrels. In our preliminary survey this season we found 27 carcasses in total, 17 Juan Fernández (63%) and 10 Stejneger's (37%) petrels. If the species were being preyed upon relative to de La Brooke's estimates of abundances, we would expect 88% of carcasses to be Juan Fernández petrels, and only 12% to be Stejneger's petrels. Our observations demonstrate a higher rate for Stejneger's, suggesting that they are relatively more vulnerable to predation.

Some of the carcasses showed definite evidence of cat predation, although most were not in sufficiently good condition to determine predation status.

We established three baited track pad stations along Cordón de los Inocentes Bajos, using canned tuna as bait. At two of the three stations, on multiple nights, we recorded cat tracks.

We also opportunistically conducted observations for predators while we worked in the colonies at night. We used a dive light to scan the colonies for cats and rats. We observed cats on four separate occasions, twice along the edge of the ferns immediately north of the camp at Tres Torres and twice on the central ridge of the Cordón. All four locations were within the colonies.

To determine whether or not rats and mice were present in the colonies we set up a trap line of 10 Victor snap traps baited with peanut butter. The trap line ran along the edge of the fern-grassy plain transition north of the Tres Torres camp and through active petrel colonies. In 7 nights of trapping we caught 11 Norway rats (*Rattus norvegicus*) and 8 house mice (*Mus musculus*). We took muscle and bone samples from trapped animals to use in stable isotope analyses. With this information we can begin to address the issue of whether or not rats and mice prey on petrel eggs and/or chicks.

In the future we would also like to collect regurgitated pellets from the endemic subspecies of red-backed hawk (*Buteo polyosoma exsul*). It is apparent that hawks do kill petrels and it would be interesting to determine the frequency with which they prey upon petrels. Obviously, predation by native hawks is something that breeding petrels have had to confront historically. This contrasts strongly with the predation pressure of relatively recently introduced mammals such as feral cats and rodents.

**The storm**

As a result of the storm on 17-18 March 2002 and the destruction of part of the CONAF house, we unfortunately lost a considerable amount of data and samples. These

include samples collected for stable isotope analyses: blood samples from adult petrels of both species, feather and bones from predated adult petrels, and muscle and bone samples from trapped Norway rats and mice. However, some of the samples survived the storm and will be used for analyses.

Additionally, we had collected wings and skulls of predated petrels for donation to the CONAF Information Center. All but a Juan Fernández petrel foot and a Stejneger's petrel wing were lost in the disaster.

There were also significant ecological impacts from the storm. The tremendous amount of rainfall resulted in flooding, massive amounts of erosion in streambeds, and landslides, and the storm also directly affected breeding petrels. Of the 14 Juan Fernández petrel nests with chicks in the grassy plain study area, 7 died during the storm (50% mortality). All of these nests were quite wet when checked on the afternoon of 19 March, and all of the dead chicks were completely wet with their down matted. Interestingly, all 8 of the Stejneger's petrel chicks survived the storm, and all were completely dry when checked the afternoon of 19 March. In addition, several sizable landslides occurred within parts of the petrel colonies on the slopes on both sides of Cordón de los Inocentes Bajos. Although we will never know how many burrows were destroyed in this natural catastrophe, it would certainly be in the thousands.

## RESEARCH ON THE KERMADEC PETREL (*Pterodroma neglecta*)

Kermadec petrels (*Pterodroma neglecta*) appear to be the least common of the seabird species breeding in the archipelago. Breeding is currently confirmed only from Morro Juanango and El Verdugo although isolated breeding pairs may yet remain undiscovered. Although the species is not currently listed by the International Union for the Conservation of Nature (IUCN), their small, isolated breeding populations across the temperate Pacific suggest that they may be a species of concern and, thus, may warrant listing. Because of their small population in the archipelago and their potentially vulnerable status globally, we feel that a long-term monitoring program for the species should be established in the Juan Fernández.

We made two visits to Morro Juanango, 6 February and 27 March 2002, to begin our research program on the Kermadec petrel population that breeds at that location. The purpose of the first visit was to conduct an informal survey and assess the possibility of establishing a monitoring program for the population breeding on Morro Juanango. On 6 February most active nests already had a chick present, but we also found a pipped egg in the process of hatching. Although we lack hatch dates for the chicks, all of them appeared to be no more than one week of age. Thus, the timing of breeding for Kermadec petrels appears to be similar to that of pink-footed shearwaters.

Following this initial visit and conversations with Ramón Schiller and other park officials, we submitted a proposal to CONAF and the park rangers to develop a collaborative monitoring program on Morro Juanango (see Appendix A). On 27 March 2002 we revisited Morro Juanango with the following objectives:

-establish a monitoring quadrant for Kermadec petrels
-mark Kermadec petrel nests within the quadrant
-determine the status of each marked nest within the quadrant
-take measurements of, and blood samples from, Kermadec petrel chicks

We marked 23 Kermadec petrel nests and established the status of each (empty, failed egg, chick). Of the 23 nests, 10 had chicks, 4 had failed eggs, and 9 nests were empty. We measured 4 of the chicks and collected blood samples from 6 chicks. These blood samples will be used for stable isotope analyses of diet composition. We also found 2 white-bellied storm-petrel (*Fregetta grallaria)* eggs and 1 Defilippe's petrel (*Pterodroma defilippiana)* egg which provided the first evidence that these two species breed (or attempt to breed) on Morro Juanango.

Because we had limited time during the second visit, the monitoring quadrant is currently incomplete. At the beginning of the next field season (mid- to late December 2002) we intend to revisit Morro Juanango and expand the size of the quadrant, as well as to check for evidence of additional nests that may be more obvious early in the breeding season.

## COMMUNITY INVOLVEMENT

### Public lectures

On 1 February, 2002, we held our first public seminar at the CONAF Information Center, which approximately 45 people attended. The majority of attendees were high-school or college youths and adults. Our presentation covered an introduction to the distribution and importance of the seabird community in the archipelago, and outlined our objectives for the research season.

On 25 March, 2002, we held a second public seminar at the CONAF Information Center, which approximately 25 people attended. The majority of attendees were parents with primary school-aged children. High-school and college students had completed their summer break on the islands and were back on the Chilean mainland for school. Our presentation briefly reviewed our objectives, and then presented the basic findings from our field season. In addition, we awarded small prizes to all the children who entered the seabird t-shirt drawing contest (see below), as well as 1$^{st}$, 2$^{nd}$, and 3$^{rd}$ place prizes to contest winners. These latter prizes were generously provided by the CONAF Environmental Education Program.

### Seabird drawing contest

Visits to local artisan and tourist shops revealed a paucity of art, souvenirs, and presumably general recognition of the native seabirds. In contrast, the endemic hummingbird, fur seal, and lobster were prominent themes for crafts and tourist products. To increase visibility and knowledge of seabirds, we collaborated with CONAF to sponsor a drawing contest in which the winners would have their design printed on t-shirts. The contest was broken into adult (>14 yrs) and child (≤ 14 yrs) categories. Materials were generously provided by the CONAF Environmental Education Program. Approximately 30 adult entries and 20 child entries were received. A panel composed of Peter Hodum, Michelle Wainstein, Erin Hagen, Marcelo Rossi (president of the fisherman's syndicate), and Hernán Gonzales (Assistant Park Administrator) judged the entries, and winners were chosen by ballot on 22 March.

On 25-26 March, all entered drawings were displayed on billboards (kindly constructed by CONAF staff) in the town plaza (San Juan Bautista). We were present at

the plaza on 25 March during most of the day, and interest in the drawings and seabirds in general appeared high. Prizes were awarded after the second public seminar on 25 March. We are currently researching options for the design and printing of t-shirts with the winning drawings.

**Radio show**

On 25 March, we were guests on the local radio program Zona Verde (The Green Zone), hosted by CONAF Environmental Education Coordinator Susan López. We responded to questions regarding our research efforts, our findings, our plans for a long term program on the islands, and the value of fauna to the archipelago's ecosystems. In addition, we announced the winners of the seabird drawing competition.

**Materials for CONAF Information Center**

We collected a variety of natural history samples during our time in the field and left them with the CONAF Information Center for educational purposes. These ranged from short-eared owl (*Asio flammeus*) pellets containing white-bellied storm petrel skulls and wings, to skulls, other bones, wings, and eggs from a range of species. A complete listing of items left with the center, as well as the interpretive information provided to accompany those samples, is provided in Appendix B. In subsequent seasons we hope to more fully develop exhibits in collaboration with the CONAF Information Center in order to make natural history information more available to a wide range of ages and audiences.

**Local pink-footed shearwater reserve**

Perhaps our most rewarding endeavor with the community was to begin the process of establishing a pink-footed shearwater reserve on Labrador Ridge, immediately southeast of the current urban area. Officials from CONAF initially pointed out the presence of a small remnant group of burrows, and asked that we assess the area to determine if it was an active colony. Using the infrared burrow camera and other indicators, we found that a proportion were definitely (5 of 15) or likely (5 of 15) being currently used. This information prompted several meetings with CONAF and the creation of a proposal to the municipality to set aside the area for a shearwater reserve. The full proposal is provided in Appendix C.

On 25 March, our research group and CONAF representatives met with the town mayor, Leopoldo Charpentier, and other municipality officials, and the proposal was discussed. The municipality agreed to set aside the reserve area defined in the proposal, such that it would not be available for future urban construction. The mayor's office is currently generating the official paperwork to this effect. Meanwhile, we scheduled two community visits to the Labrador colony, with the intention of using the burrow camera to show the resident shearwaters to anyone interested. Six people attended the first visit, and approximately 8 children expressed interest in the second visit; however, this outing was cancelled due to heavy rain. Local CONAF officers have also expressed interest in investing in the reserve, and we hope to continue collaborating in our efforts to maximize the environmental and conservation education potential that this nearby colony offers (see Appendix C for educational ideas).

## CONSERVATION CONCERNS

### Streetlights

In our meeting with the municipality regarding the local shearwater reserve, we also discussed the predicament caused by the recent installment of streetlights along Labrador Ridge, as well as the general streetlighting in town. These streetlights cause disorientation of seabirds, especially when fledglings are dispersing from the colonies. Though uninjured, these disoriented birds generally land in the streets of town and fall easy prey to cats, dogs, and rats. In order to provide an immediate, short-term remedy to the situation at the newly designated reserve, the mayor's office had the new streetlights turned off, and agreed to keep them off through the fledging season. We subsequently went to the power plant to get dimensions on the streetlights being installed in town, in order to pursue long-term solutions involving the addition of shades or tinted panels to minimize light pollution and direct lighting downward. These methods have been proven successful in drastically diminishing the attraction of seabirds to urban lighting in other parts of the world (e.g. Hawaii). Finally, we have received information from the mayor's office on the cost of burying streetlight cables in the vicinity of the shearwater reserve, and are searching for funding for this project.

### Eradication and restoration

There is no question that introduced mammals and vegetation have had a devastating impact on organisms native and endemic to the archipelago. The Juan Fernández-Dutch Cooperative Project (JF-DCP) implemented control programs for several exotic plant species, goats, and rabbits; however, we feel strongly that these measures will provide only a temporary stop-gap and that complete eradication efforts are necessary. With direct regard to seabirds, many researchers, park officers, and locals have commented on predation by rats, coatis, and feral cats, and our preliminary field studies suggest that these are threats worth considering. This is a particularly dangerous situation because, due to the life-history strategy of these birds (long lifespan, delayed reproduction, etc), even a small increase in adult mortality can have a disproportionately large impact on population stability.

In addition, cattle have visibly damaged colony areas on Robinson Crusoe due to grazing and trampling of burrows, while cattle fencing occasionally entangles and kills seabirds. The direct competition between rabbits and shearwaters for burrows on Santa Clara was noted above, and the potential indirect effects of increased erosion due to rabbit herbivory were also noted in the context of the storm that the islands suffered in mid-March. Finally, even the rabbit control program utilizing snares results in the unintentional snaring of shearwaters, and so a long-term effort to simply maintain low rabbit populations is a sub-optimal solution. We therefore would like to see, and are eager to assist, any efforts to begin concerted eradication efforts on the islands.

We also feel that restoration efforts are warranted, but we encourage the implementation of eradication efforts prior to investment in large-scale restoration. Without the elimination of threats from invasive species, restoration efforts run the risk of being undermined by their effects. An alternative may be to establish large, well-maintained ecological exclosures to study restoration processes. Such a project would not

only provide extremely valuable experimental, ecological data, but would also provide a template upon which to plan future restoration efforts. We again would be eager to assist with a well-planned, scientifically robust project of this nature.

Brad Keitt and Josh Donlan of Island Conservation, and Karl Campbell of Fundación Charles Darwin (Galapagos Islands), in their 3 week assessment of Robinson Crusoe and Santa Clara, also feel that eradication efforts are warranted and feasible. They are currently collaborating with other eradication experts from New Zealand on a large US island, and feel that this experience may set the stage for generating an eradication proposal for the Juan Fernández Islands. In the long-term, we hope to discuss the possibility of such an effort with local islanders, local, regional, and national CONAF officials, other Chilean agencies, Chilean ecologists, and eventually implement such an effort.

**Other fauna**

We were fortunate to have the opportunity to communicate regularly with locals and CONAF officers, and had several meetings in order to discuss conservation priorities for the islands. In particular, the rangers represent a cumulative source of biological knowledge that cannot be matched by even the most intensive academic research efforts. We agree with these rangers that the endemic hummingbird, the Juan Fernández Firecrown *(Sephanoides fernandensis)* is of primary conservation concern. Its population appears to have dwindled from 800 to 400 individuals in just the past three years (G. Araya, personal communication), and cats and rats have been implicated in the decline. We are currently searching for funds to develop a collaborative conservation effort between F. Johow (CODEFF), Javiera Meza (CONAF), and other local and regional CONAF officials.

The impacts of introduced species clearly have wide-ranging effects on the entire ecosystem of the islands. We again emphasize that we believe that all flora and fauna, including the firecrown and other endemic birdlife, will ultimately benefit from the eradication and restoration efforts discussed above.

## ACKNOWLEDGEMENTS

We are indebted to the Wallis Foundation for their financial support and enthusiasm for this project. We also thank Wildlife Conservation Society for administrative assistance. These efforts would not have been possible without the assistance and permits provided by Leonardo Moder, Mario Galvez, and Javiera Meza of CONAF, and Agustín Iriarte and Horacio Merlet of SAG (Servicio Agrícola y Ganadero). We appreciate the collaborative efforts of Dr. Roberto Schlatter and his student Ronnie Reyes. We cannot express sufficient gratitude to the local CONAF personnel, who are too numerous to list individually. We are particularly indebted to Gastón Correa, Christian Díaz, Hernán Gonzales and their families, Gart Van Leersum, the entire corps of park rangers and the JF-DCP staff, and the CONAF administrative officers. The successes of our project were due to the continuous and enthusiastic logistic, programmatic, and conceptual support from CONAF, and we consider our time in the field with rangers and hunters invaluable. We thank everyone at CONAF for their willingness to assist our efforts and to share their knowledge, impressions, and skills with

us. Finally, we wish to extend this gratitude to the local population as a whole, and in particular to Marcelo Rossi, Leopoldo Charpentier and the mayor's office, Maria Mar, Lilian Reina de Pansitos, Drina Schiller and family, and numerous other shop owners, fishermen, and their families. We are grateful for the sense of welcome and enthusiasm with which we were treated. Our efforts to return and continue working on the islands are fueled as much by the unique ecosystem as by the enormously rewarding experience of working with our above-mentioned colleagues.

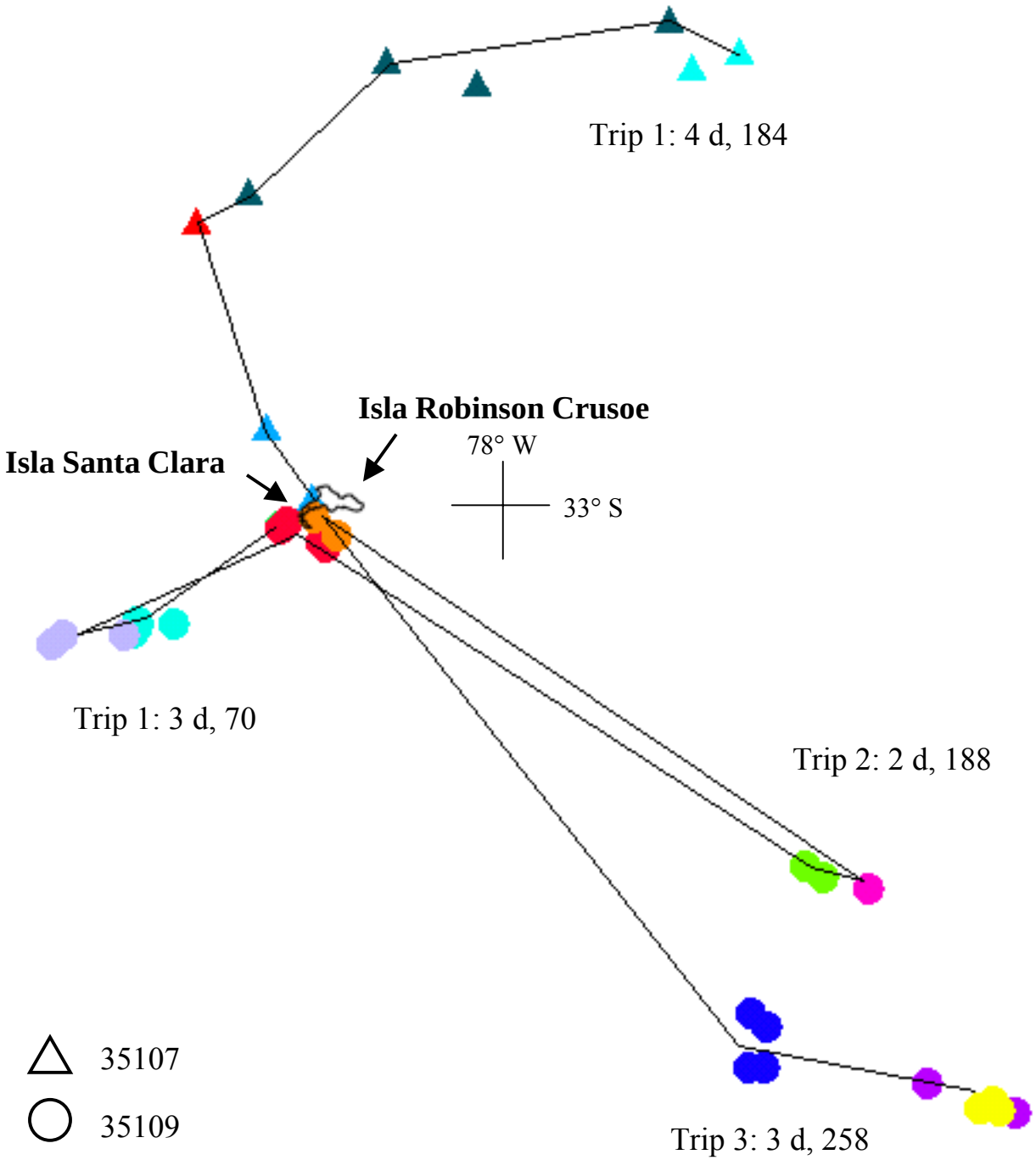


Figure 1. Preliminary satellite tracking data for two adult pink-footed shearwaters (*Puffinus creatopus*) breeding on Isla Santa Clara, Juan Fernández Archipelago, Chile. Trip notations represent duration of recorded portion of trip (days, different colors representing different days), and approximate maximum linear distance from colony (km). Partial trip coverage due to duty cycling of instruments.

APPENDIX A

**Propuesta para realizar un programa de monitoreo de fárdelas negras (*Pterodroma neglecta*) en Morro Juanango**

una colaboración entre el Proyecto Fardela (Michelle Wainstein y Peter Hodum) y CONAF/Parque Nacional de Juan Fernández

**OBJETIVOS:**

1. Establecer el tamaño de la población nidificando en Morro Juanango (hacer un censo tan completo como es posible)
2. Establecer un cuadrante de monitoreo con nidos marcados
3. Cada año monitorear los nidos marcados adentro del quadrante (actividad; huevo; polluelo)
4. En largo plazo anillar a los adultos y polluelos para determinar sobrevivencia, parejas, etc.
5. Medir polluelos para detectar diferencias en alimentación entre años

**METODOS:**

1. En el primer viaje: (¿posiblemente en marzo 2002?)
    a. establecer el quadrante
    b. marcar los nidos
    c. dibujar un mapa
2. Tres viajes cada temporada
    a. mitad de diciembre (después de la postura de los huevos)
    b. mitad de febrero (después de la eclosión de los huevos)
    c. fin de marzo/comienzo de abril (antes de la salida de los volantones)
    d. en cada viaje recordar el estado de cada nido en el quadrante
    e. en los viajes de febrero y/o marzo medir los polluelos (peso y posiblemente otras medidas como ala, etc.)
3. Para los Guardaparques que tienen interés en este proyecto podemos enseñarles sobre las técnicas relevantes:
    a. como chequear los nidos
    b. como mover y acercarse cerca de las aves
    c. como hacer medidas (especialmente el peso)
4. El Proyecto Fardela proveerá los materiales para el programa
5. En largo plazo podemos empezar con un programa para anillar adultos y polluelos

**PARA ESTA TEMPORADA** (febrero/marzo 2002)
si es posible realizar un viaje a Morro Juanango:

1. Establecer el cuadrante
2. Marcar los nidos adentro del cuadrante
3. Dibujar un mapa
4. Recordar el estado de cada nido

APPENDIX B

**Exposición para el Centro de Información**
Muestras recogidas para una exposición sobre la historia natural del Archipiélago

- mandíbula de tiburón
- pata de fardela de Juan Fernández (*Pterodroma externa*)
- ala de golondrina de mar de vientre blanco (*Fregetta grallaria*)
- 2 cráneos de conejo (*Oryctolagus cuniculus*)
- huevo de fardela blanca (*Puffinus creatopus*)
- huevo de fardela blanca de Más a Tierra (*Pterodroma defilippiana*)
- regurgitaciones de neques (*Asio flammeus*)
  con plumas y cráneos de golondrinas de mar
- cráneos de fardela blanca (*Puffinus creatopus*)
- cráneo del polluelo de fardela blanca (*Puffinus creatopus*)
- ala de fardela blanca (*Puffinus creatopus*)
- ala de fardela de Más Afuera (*Pterodroma longirostris*)

# Mandíbula de tiburón (Especie no clarificado)

Los dientes de tiburones están reemplazados durante todo la vida

# Pata de fardela de Juan Fernández (*Pterodroma externa*)

Note las garras que se usan para excavar las cuevas y subir arboles de helecho, canelo, y otros helechos para alzar el vuelo. También hay membranas entre los dedos para nadar.

# Ala de golondrina de mar de vientre blanco (*Fregetta grallaria*)

La golondrina de mar es la especie que tiene el tamaño más pequeño de todas las aves marinas del Archipiélago. Nidifica abajo de rocas pero no excava cuevas como las fardelas. Note la diferencia en la forma del ala entre esta especie y las alas de fardelas.

# Cráneo de conejo (*Oryctolagus cuniculus*)

El conejo es una especie introducida al Archipiélago. Los conejos hacen mucho daño a la flora a las islas y contribuyen mucho a los problemas de erosión. Note las dientes adaptados para comer plantas.

# Huevo de fardela blanca (*Puffinus creatopus*)

Como otras especies de fardelas, la fardela blanca se pone solamente un huevo cada año. Si se pierde el huevo o el polluelo no se puede reemplazar.

## Huevo de fardela blanca de Más a Tierra (*Pterodroma defilippiana*)

Por lo general fardelas se ponen huevos que son aproximadamente 20% del peso de la hembra. Esta proporción sería igual como si una mujer (de 55 kg) tuviera un bebe de 11 kg.

## Regurgitaciones de neques (*Asio flammeus*)

El neque es una especie de lechuza. Como otras especies de rapaces, el neque vomita regurgitaciones de partes indiregibles de su presa. Estas regurgitaciones proveen una indicación de la dieta de los neques. Note las plumas y cráneos de golondrinas de mar en unas de las regurgitaciones.

## Cráneos de fardela blanca (*Puffinus creatopus*)

La fardela blanca es endémica, una palabra que significa única, a Chile, nidificando solamente en las islas de Robinson Crusoe y Santa Clara acá en el Archipiélago y en Isla Mocha. Note algunas características sobre los picos: el largo y el anzuelo a la punta para cazar pescado y calamares. También note las narices y el tubo que son características únicas a todas las fardelas, albatroses, petreles, y golondrinas de mar. Tienen un buen sentido de oler que se usa para encontrar su nido y probablemente para forrajear.

## Cráneo de polluelo de fardela blanca (*Puffinus creatopus*)

Note el tamaño más pequeño que el cráneo de los adultos.

## Ala de fardela blanca (*Puffinus creatopus*)

La fardela blanca usa sus alas no solo para volar pero sino también para nadar abajo que la superficie del agua. Por eso, el ala es un compromiso entre los requirimientos para volar y nadar.

## Ala de fardela de Más Afuera (*Pterodroma longirostris*)

Esta fardela es una de las dos especies de fardelas endémicas que nidifican en Isla Alejandro Selkirk.

APPENDIX C

# Propuesta para una reserva local de fardelas en Isla Robinson Crusoe

**Responsables**
**Hernán Gonzales**
**Michelle Wainstein**
**Peter Hodum**

**Marzo 2002**

## Introducción

Existe un claro desconocimiento de la biología y de la situación actual de las aves presentes en el Archipiélago Juan Fernández. Sin embargo, está claro que la actividad antrópica desarrollada desde el descubrimiento del archipiélago ha traído consigo alteraciones de los hábitats de estas especies, que sumado a la introducción de animales dañinos las estarían afectando insospechadamente.

Para remediar esta situación se requiere de investigaciones permanentes y censos a lo largo del año. Esta necesidad de realizar estudios que revelen los aspectos más trascendentes de la biología de las especies y el conocimiento de los factores que estén poniendo en peligro su preservación, generalmente están asociados a investigaciones que realizan universidades y entidades extranjeras. Este es el caso de los investigadores Michelle Wainstein y Peter Hodum, que actualmente se encuentran realizando estudios en el archipiélago destinados aclarar la situación particular de las fardelas, especies muy poco estudiadas y que sin embargo están en categorías de conservación delicadas básicamente por ser especies muy sensibles a factores negativos.

Dentro de sus actividades estos investigadores se han preocupado fuertemente por el traspaso de conocimiento que pueden entregar a través de diferentes actividades de difusión. A este respecto es importante dar la posibilidad a la comunidad de conocer a estas especies en un ámbito de acercamiento científico, esto permitiría la valoración de las especies, además de ser un apoyo fundamental para la educación ambiental a nivel Insular. Es importante destacar que durante su ejercicio han ubicado una colonia de fardelas inserta en el área de la población que reviste gran importancia. Este tema pasa a dar origen a una propuesta (adjunta) que dadas las consideraciones previas reviste gran importancia para toda la comunidad en términos educacionales, turísticos y principalmente de investigación.

**Propuesta para una reserva local de fardelas**
**Ilustre Municipalidad de Juan Fernández,**
**Isla Robinson Crusoe**

**Estado de la Fardelería** (inspeccionada el 4 y 5 febrero de 2002)

La fardelería es una colonia de la fardela blanca (*Puffinus creatopus*). El lugar se ubica en el cordón "El Labrador". Tiene una superficie de aproximadamente 2400 $m^2$ y está ubicado entre los 53 y 81a msnm . En el lugar hay por lo menos 15 cuevas ubicadas a menos de 15 metros del camino que va al Pangal. Hay 8 ubicadas arriba del camino y 7 abajo. Examinamos todas las cuevas con una cámara de infra-rojo y encontramos 4 cuevas activas. En estas cuevas pudimos ver:

i. una cueva con un adulto (presumidamente sentado sobre un huevo o polluelo muy chico),
ii. una con adulto y polluelo,
iii. una con polluelo sólo, y
iv. una con una pareja de adultos.

Hay 2 que están vacías y el estado del resto no se ha clarificado porque el largo de la cueva es demasiado para la cámara. De este grupo final quienes estado no es conocido, por lo menos hay 5 cuevas que parecen estar activas basado en evidencia directa como: guano fresco, plumas, y olor fuerte de fardela

**Significación Histórica**

En el pasado esta fardelería debió ser de tamaño más grande, pero ha sido disminuida debido al desarrollo de la población en torno ella. Esta fardelería nos provee de una oportunidad para mantener un aspecto histórico del pueblo, particularmente la presencia de fardelas nidificando junto a la comunidad.

**Importancia de esta Fardeleria**

Educación, como se puede convivir con especies de importancia en el patio de nuestra casa, tratando de minimizar nuestro impacto (recordemos que ellas estaban antes que el hombre llegara), interacción entre los seres humanos y estas aves. Objetivo: obtener respeto por el entorno y por el hábitat de animales y plantas nativos. Entregar las herramientas a través de la ciencia para que la comunidad se sienta inmersa en la tarea de conservar los recursos naturales del Archipiélago.

Además de las oportunidades educativas la colonia nos proveería con oportunidades científicas para mejorar nuestro conocimiento sobre la biología de la fardela blanca, una especie casi desconocida. Un programa de monitoreo comunal, junto con las investigaciones de Michelle Wainstein y Peter Hodum, sería muy útil a determinar las fechas de la postura, la eclosión, la salida de los volantones, y el éxito reproductivo de una colonia urbana.

**Reunión Comunal**

Ante la oportunidad única del establecer una reserva en el área urbana, coordinamos una reunión para conversar con la comunidad a través de su representante, el Alcalde, y sus colaboradores; para así conocer su posición sobre esta propuesta y algunos aspectos asociados.

**Establecimiento de una Reserva**

Proponemos a establecer una reserva local para las fardelas. La reserva incluiría la colonia y el área circundante. Esta reserva se quedaría abierta y accesible al público y serviría como un recurso educativo para la comunidad. También sería una oportunidad de desarrollar una reserva al interior de la comuna, que sus habitantes pueden adoptar, involucrarse, y cuidar.

Un letrero sería una idea buena. Este letrero puede incluir no solamente la designación como reserva sino también materiales educacional. Además un letrero también puede servir como notificación visual.

Para mejorar el acceso de la gente se puede construir unos escalones en la piedra/tierra y establecer senderos cortos.

**Mitigación de impactos**

Los impactos ambientales más importantes sobre las fardelas dicen relación con los factores que ponen en peligro la subsistencia de la colonia. Al respecto , eventualmente un cerco ubicado en el perímetro de la colonia sería muy útil para impedir la entrada de perros y gatos, además de demarcar el límite de la reserva.

Por otro lado existe el problema que genera la luz y los cables del tendido eléctrico del lugar. En el caso de iluminación nocturna, esta genera una señal equivoca que produce que las fardelas se extravíen por perdida de orientación. Por otra parte los cables que el tendido tiene en el lugar pasan por frente del área de las cuevas, las fardelas muy probablemente chocaran contra ellos con el consiguiente daño. Las medidas de mitigación de estos aspectos tendría que ver con regular la iluminación del lugar permitiendo el uso de lamparas más bajas y con cubiertas que permitan optimizar el uso de la luz al concentrarla en los lugares que efectivamente lo requieran. Por otra parte los cables del alumbrado público podría ser dispuesto bajo tierra de manera de no interferir con el normal desarrollo de la colonia. Estas dos propuestas conllevan el compromiso de buscar los fondos necesarios para su realización.

**Monitoreando por la Comunidad**

Michelle Wainstein y Peter Hodum (el Proyecto Fardela) están dispuestos a enseñar a algunas personas sobre la biología e historia natural de las fardelas, así como el uso de la cámara de infra-rojo. Posiblemente un guardaparque puede ser encargado de supervisar la reserva y a coordinar el trabajo con las personas que quieran involucrarse en la reserva.

Michelle Wainstein y Peter Hodum (el Proyecto Fardela) donarían una cámara de infra-rojo para continuar con un seguimiento hasta el final de la temporada de reproducción (hasta la mitad o finales de abril 2002) y el inicio de la próxima temporada (empezando en noviembre 2002). También se pueden usar otros métodos para determinar la ocupación o actividad, como el uso de palitos en la boca de cada cueva y un colador para cernir tierra en frente de la boca de las cuevas y así conseguir huellas.

Estas personas pueden chequear los nidos con regularidad y continuar con una busca meticulosa de las áreas circundantes en busca de otras cuevas.

Cada nido/polluelo podría ser identificado con un nombre; quizás grupos de jóvenes de nivel básico podrían individualizar los nidos/polluelos que están siguiendo?

Por la radio de la comunidad se puede anunciar con regularidad del estado de cada nido

Antes del inicio de próximas temporadas de reproducción, los involucrados pueden realizar una limpieza del área de la fardelería, incluyendo el sacar hojas y ramas de las entradas de las cuevas.

**Visitantes**

Para la comunidad: las visitas pueden desarrollarse con regularidad y en ciertas oportunidades, principalmente para observar al interior de las cuevas con la cámara de infra-rojo

(anuncios con la fecha y horario de cuando habrá en el lugar de una de las personas entrenadas en el uso de la cámara)

Para los turistas: Al igual que para los residentes se puede programar, de existir capacidad, la visita al lugar de turistas.

Para minimizar el impacto de las visitas se debe realizar una determinada cantidad de visitas de manera de no alterar el medio ni la actividad de las fardelas. Estas limitas tienen que ver solamente con las visitas utilizando la cámara de infra-rojo. Otros visitantes a la colonia no tienen que ser regulado. Visitas programadas cada dos semanas de una larga de no más que 15 a 20 minutos a cada nido sería apropiada.

**Programas Relacionados y Educativos**

*Hay fardelas en el patio de tu casa?*

Un programa de búsqueda para otras fardelerías chicas en la cercanía del pueblo. Si se encuentran cuevas se puede ir con la cámara a ver si están activas (esto es lo que hay que pensar con el tema de la construcción – queremos que la comunidad vea el encuentro de una fardelería como algo positivo, no negativo, ya que quizás después no se podría construir en esa zona).

*Adoptar-una-fardela*

Jóvenes pueden "adoptar" a un nido/polluelo. los jóvenes que demuestren interés pueden "adoptar" a un nido/polluelo. Al elegir uno recibirían un paquete informativo sobre el crecimiento del polluelo, materiales educativos, etc. Esto se realizaría en conjunto con los programas de monitoreo y por medio de anuncios de radio se informaría a la comunidad del estado de los nidos, etc..

**Ideas de Largo Plazo**

Construcción de cuevas artificiales para estimular el uso de la fardelería.

Técnicas de atracción (por ejemplo, emitir vocalizaciones grabadas) para también estimular el uso de las fardelerías

Instalación de tecnología con una cámara permanente, donde cualquier persona pueda ver los nidos, y, quizás llegar a poder transmitir las imágenes a los televisores o computadoras en casas en tiempo actual (estilo "web-cam"?).

20 febrero 2002

**Reserva de la comunidad**
**Fechas propuestas para el período de los volantones**

La mayoría de los huevos eclosionan durante la primera semana de febrero pero todavía nos faltan datos sobre el largo del período del crecimiento de los polluelos. Basado en información de otras especies semejantes nosotros estimamos un período de crecimiento de 68-75 días.

Cuando chequeamos las cuevas en el 4 y 5 de febrero encontramos dos polluelos de una edad estimada por unos días (menos que una semana de edad). Uno fue acompañado por adulto y el otro se quedó solo. Entonces probablemente nacieron aproximadamente en el 1 o 2 de febrero.

Basado en esta información hay varias posibilidades sobre la ventana de tiempo cuando sea mejor a mantener las luces apagadas. Los que siguen son sugerencias sobre el rango de fechas cuando sería mejor a mantener las luces apagadas durante la noche.

Si podemos realizar un período de dos semanas, sugerimos un período del 8 de abril hasta el 22 de abril cuando las luces deben ser apagadas.

Si podemos realizar un período de tres semanas, sugerimos un período de 3 abril hasta 24 abril.

Si podemos realizar un período de cuatro semanas, sugerimos un período de 1 abrel hasta 28 abril.

También Michelle Wainstein y Peter Hodum van a dejar una camara infra-roja con CONAF para que los guardaparques (Alfonso Andaur va a estar encarga) puedan monitorear las cuevas cada unos días. Cuando los polluelos se van el puede notificar a la municipalidad.

Hay dos luces adentro del perimetro de la reserva propuesta. Hay una tercer luz al costado de la reserva. Idealmente las tres luces se pueden estar apagadas durante este período antes de la salida de los volantones. Por lo menos sugerimos que las dos luces adentro de la reserva se queda apagado durante el período propuesto.

Preparado por
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APPENDIX D

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