Pilot Project: Assessing the Effectiveness of the SOS Rehabilitation Program

YEAR 3

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EXECUTIVE SUMMARY

- This report presents data from all three years of a pilot study to assess the effectiveness of the Save Our Shearwaters Program. The Save Our Shearwaters (SOS) program is a public conservation effort to recover and rehabilitate fallout Newell's Shearwater fledglings and downed adults that was initiated by DOFAW in the late 1970s.
- Since its inception in 1979, the SOS has processed 31,812 Newell's Shearwaters (of which 30,552 [96%] were fledglings). To date there has been no information available to determine survival rates of birds released by SOS. To assess survival rates of SOS birds we tracked SOS birds and wild fledging birds using satellite tags and compared the number of days that the tags transmitted.
- Save Our Shearwaters birds were considered in three different groups; birds that were collected and released immediately without any rehabilitation (Same Day Release), birds that had spent one day in rehabilitation and birds that had been rehabilitated for 2 or more days. Between 2014 and 2017, Microwave Technology Solar PTT tags (Microwave Technology) were attached to 17 Same Day Release Newell's Shearwaters, 7 One Day rehabilitation, 11 2+ Day rehabilitation, 7 wild fledglings and 2 adults (the latter as a control group). A single Hawaiian Petrel fledgling was also tagged.
- Fledgling Newell's Shearwaters in all years headed to the same general area immediately after dispersing and appear to spend at least the first few months of their first winter in this area. This area is bounded by 4°–13°N, 165°–178°W and is presumably an area of elevated relative oceanic productivity and food availability. All of the birds headed to this area very rapidly after release, without spending significant amounts of time in the waters around Kaua'i prior to heading south.
- The two adult Newell's Shearwaters had a very different post-breeding dispersal pattern from fledglings. Of the two adults tracked in 2016, one went north and east and the other went south and west (spending its time around the Line Islands). Neither dispersed to the area where the fledglings were.
- Considering the fledgling groups only (SOS same day, SOS one day, SOS two+ day, and wild), wild fledglings had significantly longer average transmission periods, while birds in SOS two+ day had the shortest average transmission period (Kruskal Wallis Test, χ^2=8.35, df=3, p=0.039) (Figure 7). All of the SOS groups were then combined together and compared with wild fledglings. Wild fledglings transmitted significantly longer than SOS birds (wild: 42.3 ± 14.1 days, SOS: 19.9 ± 2.0days; Mann-Whitney U-test, U=57.5, p=0.028).
- When considering the potential for negative impact from rehabilitation, we assumed any negative impacts from fledglings being grounded, recovered, and released would manifest in a change in behavior or presumed mortality within two weeks and very conservatively after three weeks. This was thought to be particularly true when considering the fact that all of the fledglings immediately flew on average 2022 km upon release or fledging - if the birds were seriously compromised upon departure, this would likely be impossible.
- The majority of birds in this study were still transmitting after two weeks from release; 87.5% of wild chicks were still transmitting, compared with 76.4% same day release, 85.6% one day and 81.2% two plus day birds. Considering all 35 SOS birds together, 28 were still transmitting after 2 weeks. This indicates that at least 80.0% survived beyond the period where it is reasonable to assume that any impacts of grounding followed by rescue and/or rehabilitation

would have manifested. By comparison, 7 of 8 (87.5%) wild fledglings were still transmitting after two weeks.

- If one wanted to be conservative and use three weeks as the cut-off point, then after three weeks, 62.5% of wild chicks were still transmitting, compared to 29.4% of Same Day, 28.6% of One Day and 9.1% of 2+ day. While the numbers are lower for the SOS cohorts than the wild fledglings, just under a third of the same day and one day cohort were still transmitting after this period. Considering all 35 SOS birds together, 8 (22.9%) were still transmitting beyond 3wks, compared to 62.5% (5 of 8) of wild fledglings. All of these results need to be considered in the context of small sample sizes and potential year effects.
- As expected, adults performed well, with one transmitting up to 71 days and the other to 100 days. Both individuals were re-sighted in the following year at their colony, indicating that, as expected, their tags stopped transmitting because they fell off.
- Our tracking results have shown that the hard work of the rehabilitation team at SOS is an absolutely vital conservation effort to help Newell's Shearwater fledglings (and other native and endangered seabirds) that have been grounded by light attraction. Birds do indeed survive after being collected and rehabilitated by the SOS program and fly to their first wintering grounds along with birds that have fledged naturally from the wild. Without the SOS program they would almost certainly die.
- The need for future research is discussed.

1.0 INTRODUCTION

This report describes the results of three years of a pilot study to assess the effectiveness of the Save Our Shearwaters Recovery Program (SOS) in terms of the survival of newly fledged Newell's Shearwater *Puffinus newelli* that were grounded by light attraction, rescued by SOS, and subsequently released and/or rehabilitated and then released. This work was carried out by staff from the Kaua'i Endangered Seabird Recovery Project (KESRP) and SOS, with input from staff of the US Geological Survey, Western Ecological Research Center (USGS). Funding for the first year of the project came from the Kauai Island Utility Co-operative (KIUC). Funding for the second and third years of the project came from the St. Regis via Earth Justice. To allow for the most in-depth analysis of the data set this report presents the results of the work of all three years combined and outlines any further steps needed to assess the effectiveness of the Save Our Shearwaters rehabilitation program.

The Save Our Shearwaters (SOS) program is a public conservation effort to recover fallout fledglings and downed adults that was initiated by DOFAW in the late 1970s. It is currently housed at the Kaua'i Humane Society (KHS) and is currently funded by the Kaua'i Island Utility Co-operative (KIUC) with additional funds from USFWS. SOS focuses primarily on threatened and endangered seabirds, although all native birds are rehabilitated by the program. For endangered seabirds, SOS deals primarily with fledglings of Newell's Shearwater which are seriously affected by light attraction and fall-out on the island of Kaua'i (Reed et al 1985, Ainley et al 2001, Troy et al 2011, Raine et al 2017). Hawaiian Petrels *Pterodroma sandwichensis* and Band-rumped Storm-petrels *Oceanodroma castro* are also recovered by the SOS, though in much smaller numbers.

The SOS program relies heavily on public participation, with the public encouraged to pick up downed seabirds and place them in aid stations located around the island. During the fallout season (approximately September – December) these aid stations are checked every morning by SOS staff who collect all the birds. SOS personnel examine the fledglings and then either release them immediately or take them to KHS to rehabilitate them prior to release. All released birds are fitted with an identifying metal band. Since its inception in 1979, the SOS has processed 31,812 Newell's Shearwaters (of which 30,552 [96%] were fledglings).

Although there is no information to determine survival rates of birds released by SOS, post-release survival rates may be lower than survival rates for wild fledglings (which go from burrow to ocean without incident) because downed birds could be compromised by a range of additional factors not experienced by non-grounded fledglings, including undetected injuries, decreased health values (weight, hydration), or secondary complications acquired during fallout (exposure to disease, parasites, or compromised waterproofing). However, it is likely that SOS does confer an important benefit on downed birds, resulting in the long-term survival of some birds that would otherwise die – in other words, the assumption that all fallout fledglings released through the SOS program die before reaching breeding age (i.e. 0% SOS effectiveness) is unlikely. The SOS program has been getting progressively more sophisticated in its evaluation, treatment, release criteria, and captive care protocols; between 2010 and present day these protocols were significantly improved with assistance from professional rehabilitation experts. These improvements were designed to increase post-release survival for seabirds released immediately and for birds taken into rehabilitation that are subsequently held in captivity briefly for stabilization, then released.

Understanding the impacts of grounding on shearwater survival is thus vital to help guide and maximise the efficacy of rescue and rehabilitation efforts. Therefore, understanding what proportion of grounded and recovered and/or rehabilitated birds survive after release is paramount to assessing the SOS program's utility as a conservation tool. This is, however, extremely challenging because birds are released out to sea as fledglings and ultimately return to remote montane colonies, most of which are not monitored. This renders band recoveries to assess survival almost impossible. For example, from 1979–2017, there have been only 24 adult and sub-adult recoveries collected by SOS which were banded in a previous year by SOS staff (most of these being mortalities). Ainley et al. (1995) reported no previously banded SOS birds from 42 and 33 nests monitored at the Kalaheo colony in 1992 and 1993, despite the Kahaleo area being a fallout hotspot. Similarly, of 113 Newell's Shearwater burrows monitored by the Kaua'i Endangered Seabird Recovery Project (KESRP) in Upper Limahuli Preserve, only one bird rehabilitated from the SOS program has ever been found (KESRP, *unpublished data*).

Although band returns are very low, these results need to be evaluated considering: (i) few colonies are actively monitored at the individual burrow level and thus effort to find SOS banded birds is very low (moreover intensive monitoring without attendant predator control would be detrimental to the birds) (ii) most monitored colonies are in areas in the north-west that are presumably less likely to be affected by fall out (this is important because seabirds such as shearwaters are especially philopatric and tend to recruit to their natal colonies), (iii) bird banding and handling in colonies is not a primary facet of monitoring work, and (iv) most band recoveries are from mortalities collected opportunistically under powerlines, and these mortalities are rarely found (Travers et al 2016, 2017). Therefore, band recoveries are not an effective way of assessing the impact of grounding and effectiveness of rehabilitation and release of this species on Kauai.

After careful consideration, it was therefore decided by KESRP and SOS that the optimum way to assess survival rates of SOS birds would be to track SOS birds and wild fledging birds using satellite tags and compare their survival rates over time after leaving SOS and natural burrows, respectively. Work was undertaken in 2014, 2016 and 2017, with the number of birds being tagged each year being dependent upon what funding was available.

It should be noted that due to the uncertain nature of the funding (funding was never assured in the following year) and the high monetary cost of the tags themselves (meaning only a small number of tags could be purchased each year) – there were multiple constraints on creating an appropriate study design. In 2014 only 12 tags were available via funding from KIUC and the study was clearly identified as a pilot study, with only SOS birds considered to be of the highest release category (i.e. healthy birds with a good release weight, plumage, body condition, normal mentation and lack of physical injuries) tagged. In 2016, funding was available from St Regis (via Earth Justice) for 14 tags and so 6 SOS birds (again from the highest release categories), 6 wild birds and 2 adults were tagged. In 2017, again with funding from St Regis 17 tags were available and these were mainly split between the three SOS rehabilitation and release groups. Considering the many variables that could be considered in any rehabilitation project, small sample sizes in different groups increase the difficulty in analysis.

2.0 METHODS

Microwave Technology Solar PTT tags (Microwave Technology) were attached to 35 fledgling Newell's Shearwater collected by the Save Our Shearwaters program and 7 fledglings from the Upper Limahuli Preserve. The Upper Limahuli Preserve is located in the north of Kauaʻi and consists of a 378-acre (153ha) area (Figure 1) owned and managed in perpetuity as a Conservation Area by the National Tropical Botanical Gardens. The site holds significant breeding populations of Newell's Shearwater and is actively managed for this species as well as the endangered Hawaiian Petrel. Lastly, one tag was also available in 2017 for Hawaiian Petrels and so was attached to a fledgling Hawaiian Petrel collected by the SOS program.

Tags were attached using the same suture attachment technique in all three years. This non-surgical, external PTT attachment technique used previously-established suture methods for seabirds (Newman et al. 1999), modified for petrels and shearwaters by J. Adams following Klomp and Schultz (2000) and Ristow et al. (2000) (see Macleod et al. 2008, Adams et al. 2008, Adams et al. 2012). Similar attachment techniques (i.e., subcutaneous anchor-suture-glue) were adapted from use on ducklings and employed successfully on Federally listed (Threatened) Marbled Murrelet (*Brachyramphus marmoratus*; Hébert et al. 2003, Bradley et al. 2004, Peery et al. 2004). Unlike the attachment method developed for murrelets, only sutures were used for petrels and shearwaters (including Newell's Shearwater in this study); as the additional application of a small, subcutaneous stainless-steel anchor was considered more invasive and unnecessary. All tags were supposed to be on a continuous transmission cycle. However, the 2016 ones were mistakenly built by Microwave Telemetry using a 10-48hr on-off cycle.

All birds were weighed and a series of morphometric measurements (wing chord, tarsus, head-bill length, bill width at proximal end of nares and bill depth at proximal end of nares) were recorded. A blood sample was also drawn from the medial tarsal vein and the bird banded with a metal band (size 4 or 4A, depending on tarsus width).

After measuring and banding, each bird was then covered partially to shield them from light and restrained by experienced seabird handlers. All tagging was undertaken by Dr. André Raine from KESRP or Josh Adams from USGS, and birds were held by Tracy Anderson, Megan Vynne or Helen Raine. Several feathers on the central, dorsal surface between the scapulae were lifted and 1 strip (0.5 × 2.0 cm) of waterproof tape (Tesa® Beirersdorff, Germany) was inserted adhesive-side-up and wrapped over on itself to entrap the feathers inside. Four sterile surgical sutures (2-0 Prolene™ monofilament, non-absorbable sutures, Ethicon™)[1] were then used to attach the transmitter to the skin (Macleod et al. 2008, Adams et al. 2008, Adams et al. 2012). For each suture, the skin below the PTT suture channel was pinched using the thumb and forefinger, a sterile 21 gauge × 1.5 in hypodermic

[1] Prior to use of polydioxanone monofilament absorbable sutures on Hawaiian Petrel, Adams et al. used 2-0 Prolene™ monofilament, non-absorbable sutures (Ethicon™). For Hawaiian Petrel, the choice to switch to absorbable type reflected the desire to minimize the total effective attachment duration for satellite transmitters to approximately 40 days (approximately 50% of the expected duration using non-absorbable suture).

needle inserted through the pinched skin, and the suture then threaded through the needle[2]. When the needle was removed, the suture was retained under a 17-mm wide section of skin.

Once the middle two sutures were in place, a small amount (~3 drops) of Loctite 422®, 1-min cyanoacrilate adhesive was applied to the base of the PTT which was then affixed to the taped feathers. The two sutures were then threaded back through the channels at the base of the PTT and secured snug to the skin and feathers with four surgical square knots. Once the two sutures were secured, the remaining two sutures were placed in the same manner, starting with the posterior one and ending with the anterior one. Care was taken to ensure that each suture was snug and posed no risk for entanglement.

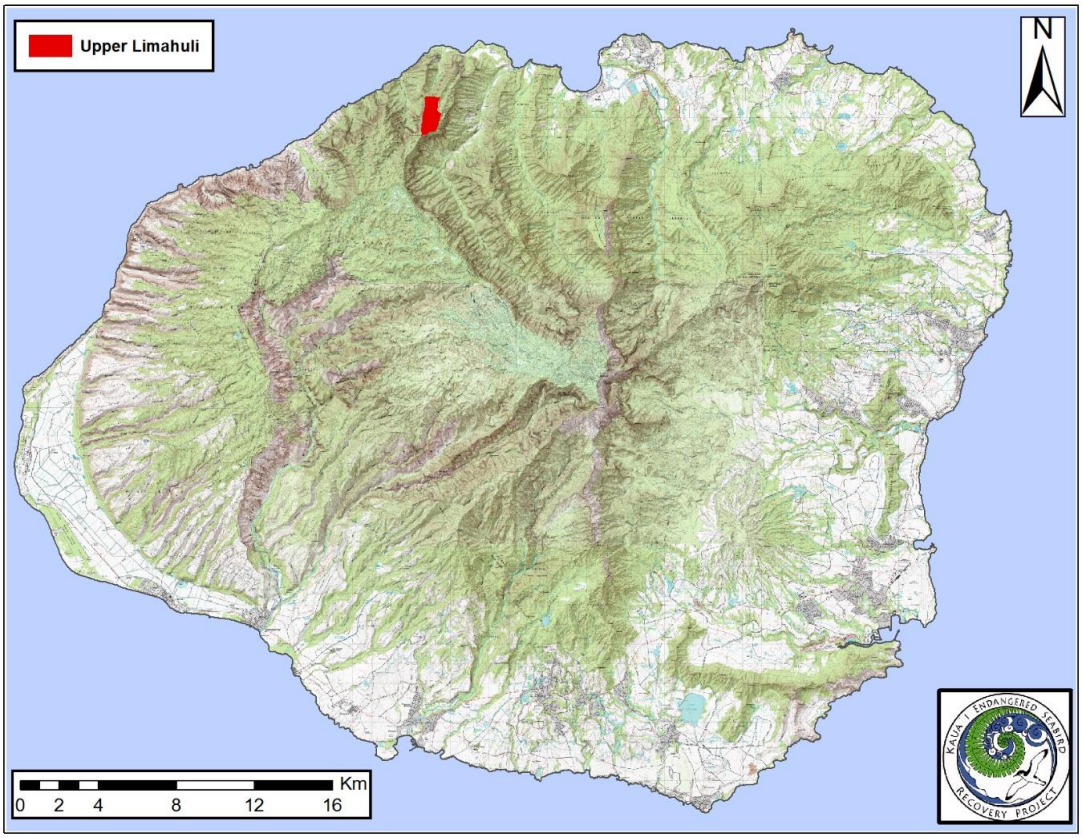

Figure 1. Map showing location of Upper Limahuli Preserve on the island of Kaua'i, Hawaii.

2.1 SOS groups

Birds that pass through the SOS program are classed as either "same-day release (no rehabilitation)" or those that experience a varying number of days of rehabilitation. Same-day release birds are not typically brought back to the SOS facility but are released by SOS staff at one of two release sites at the end of their morning rounds of the SOS boxes. For the purposes of this study, SOS birds were

[2] Topical anesthetic was not used for this procedure as previous work using this technique has shown that the birds do not tend to react to the process. Furthermore, the application of anesthetic would prolong handling and could cause unforeseen/unanticipated effects (e.g., skin reaction, compromised waterproofing, unintentional numbing of dorsal muscles).

therefore chosen from three groups – (i) same day release, (ii) one day in rehabilitation and (iii) 2 or more days in rehabilitation – and compared with a cohort of wild fledglings. 2 adult birds were also tagged in 2016 as a control to assess whether the birds were still alive after the tags stopped transmitting (as they were tagged at known burrows and could be recaptured the following year).

Birds from the SOS groups were chosen for the study as long as they met standard release requirements; no apparent injuries, good body condition (at least a '2' on a 3-point scale), normal mentation, good "flap test"[3] and non-damaged/non-contaminated plumage. If the bird spent time in rehabilitation it also had to demonstrate that it was waterproof (testing done on the conditioning pools), be able to regulate its body temperature and have blood values within normal range for the species. Birds that were heavily compromised (i.e. due to injuries or heavily compromised feathers) were not tagged as part of this study as it was assumed that the additional stress of adding tags would make their survival even more unlikely. Therefore, it needs to be clear that the results of this study relate to birds that meet standard release requirements, and that there are some birds released by SOS each year that are considered marginal. The results of this study would not necessarily be reflective of the fate of that particular group of birds.

In total, 17 same day release birds, 7 one day and 11 two+ day birds were tagged from the SOS program, for a total of 35 birds (see Appendix 1 for photographs of the tagging work in 2017 and Appendix 2 for details on all birds tagged in this pilot project). After the attachment procedure, PTT-marked birds were then introduced to the SOS rehabilitation pool if staff felt there was additional need to assess attachment placement and to ensure that the birds were properly waterproofed. Birds were all released at one of the two standard SOS release sites: Makauhena Point (south shore of Kaua'i) and Lydgate Beach (east shore of Kaua'i). Release site was chosen based on weather and prevailing wind as per standard SOS release protocols.

2.2 Upper Limahuli Preserve group

A total of 7 fledglings in Upper Limahuli Preserve (ULP) were tagged using the same attachment method as outlined above – all but one was tagged in 2016 with the 7th bird tagged in 2017 (see Appendix 1 for details on all birds tagged in this pilot project). The reason for this was again because of the uncertainty of funding and the small number of tags available in any given year; over the course of the three years an attempt was made to ensure that sufficient birds were tagged within the four main groups.

Fledglings were chosen from wide-mouthed burrows (to prevent the satellite tags from snagging on the burrow entrance) and were tagged as close to fledging as possible to reduce the amount of time the bird was likely to spend sitting in the burrow with the tag. Birds chosen for the tagging work were also monitored using Reconyx Hyperfire PC900 cameras that were already in place under colony monitoring work funded via KIUC. This allowed the tagging team to assess whether the bird was exercising regularly and how many days the bird had previously been outside its burrow exercising (which allowed for an assessment of likely fledging date). The tagging team consisted of Dr. Andre

[3] The body of the bird is held gently and firmly with both hands with the wings free. Taking care so that the wings will not hit anything, the bird is allowed to flap. Strength and symmetry is assessed.

Raine (who again did all of the tagging), Megan Vynne, Mike McFarlin and Nathan Banfield (who held the birds during the tagging process) and Scott Driskill. Chicks were tagged in early October as close to fledging as possible (Newell's Shearwaters on Kaua'i typically fledge from late September to mid-November, with a peak in mid-October).

All banding and tagging work undertaken for this study was carried out under **Federal Bird Banding Permit 08487-I.**

3.0 RESULTS

3.1 Initial Release (Save Our Shearwaters – all groups)

Birds in all years were tagged in the month of October, with the earliest tagged on October 4th and the latest on October 26th. This is typically the peak fallout period for this species on Kauai. Of the 35 SOS birds tagged for this pilot project, 32 flew off strongly and headed out to sea immediately after release. The remaining three were all from the 2014 cohort. Two of these ended up in the water, with one of the two being blown by the wind over the edge of the release site and landing in the water after a very short glide. Neither were seen flying after landing in the water but were last observed with binoculars swimming out to sea. The final bird, released at Lydgate Beach, initially flew strongly out to sea but was attacked by a Great Frigatebird (*Fregata minor*) which, after a series of diving attacks by the frigatebird, resulted in it landing in an area of high surf. It was not seen regaining flight after disappearing from view in the surf. Despite this all birds were subsequently recorded transmitting the day after release indicating that all 35 (100.0%) survived immediate release and were free-ranging at sea.

Two other birds are worth noting in this section. One bird tagged on the 15 October 2017 did not fly on release, and so was brought back to the SOS facility and the tag was removed. It was released a week later without the tag, so its fate was not known. A second bird – also tagged in 2017 – was re-assessed by a senior SOS staff member after tag attachment and a head injury was discovered that had been previously missed. The tag was removed, and the bird was later euthanised as it did not recover from its injuries and was also found to be blind in one eye.

The 35 tagged birds consisted of the following: 17 same day release birds, 7 one day and 11 two+ day birds (Table 1). Of those that spent 2 or more days in rehabilitation, the average number of days spent at the facility was 5.3 days (range 2–14 days). One of the birds in the 2+ day group was originally released by SOS (banded but untagged) and subsequently found two days later back on land. It was then rehabilitated for 2 more days, after which it was tagged as part of this project and released.

3.2 Initial Release (Upper Limahuli group)

6 wild chicks were tagged in Upper Limahuli in 2016 and a 7th bird in 2017. After fledging, all birds subsequently transmitting at sea indicating that all (100%) survived initial fledging and were free-ranging at sea.

3.3 Initial Release (Hawaiian Petrel)

One Hawaiian Petrel was tagged on 12 November 2017, after two days in rehabilitation. It had been collected in front of the Dolphin Restaurant in Hanalei. After release, it subsequently transmitted at sea indicating that it had survived initial release and was free-ranging at sea.

3.4 Reliability of Data

Over the course of the pilot study a total of 55,806 location fixes were received (consisting of 32,594 in 2017, 17,279 in 2016 and 5,213 in 2014) with the majority (94.1%) representing data within the 4,3,2,1 or 0 quality categories indicating that they were of high accuracy quality (i.e., the location fixes had an accuracy of <100m for a 4 category to >1.5km for a 0 category).

3.5 Movement of tagged birds

3.5.1 Newell's Shearwater fledglings

All fledglings (from all groups) travelled to a region of the Pacific to the south-west of the Hawaiian islands (bounded by 5°S–10°N, 164°E–162°W) influenced by the Inter-Tropical Convergence Zone (ITCZ, approximately 5°–15°N) and the frontal zone that separates the westward-flowing North Equatorial Current (NEC) from the eastward-flowing North Equatorial Counter Current (NECC; Figures 2 and 3). The same area was used in all three years.

The maximum straight-line distance from Kaua'i for each trip was considered for all SOS birds (all groups combined). Of the 35 tags on SOS fledglings, the average maximum straight-line distance reached was 2,022.5 km (min = 147.8 km, max = 4,360.4 km, median = 2,108.8 km). There was no significant difference between the three groups for straight-line distance (Kruskal Wallis Test, χ^2=4.142, df=2, p>0.05) nor between year (Kruskal Wallis Test, χ^2=2.748, df=2, p>0.05). Additionally, there were no significant differences (Kruskal Wallis Test, χ^2=.180, df=2, p>0.05) between SOS bird groups for straight-line distance recorded at the 14-day threshold (for those SOS birds that reached this threshold), nor the 21-day threshold[4] (Kruskal Wallis Test, χ^2=1.900, df=2, p>0.05)

The maximum straight-line distance reached was also considered for all wild fledglings (both years combined). Of the 7 tags on wild fledglings, the average straight-line distance travelled was 2,596.9 km (min = 1441.8 km, max = 3,981.5 km, median = 2,008.6 km). There was no significant difference between the wild and SOS fledglings for straight-line distance (Mann-Whitney U-test, U=108.00, p> 0.05). Similarly, there was no significant difference between straight line distances recorded for wild vs. SOS fledglings at the 14-day threshold (Mann-Whitney U-test, U=58.00, p> 0.05) nor the 21-day threshold distance (Mann-Whitney U-test, U=26.0, p> 0.05).

[4] See Section 3.6 below for an explanation of these thresholds and their significance to the study,

3.5.2 Newell's Shearwater adults (2016 only)

Tracks of the two Newell's Shearwater adults tagged in 2016 were markedly different from the fledglings (Figure 4). One adult went north, moving first towards the North-western Hawaiian islands and then eastwards. Its final location on the last transmission was -159.58 W/ 25.57 N, 71 days after release. Its straight-line distance from Kauai was 521.4 km and the total distance the bird had traveled was 5,150.0 km.

The second adult went south, but concentrated its foraging time around the Line Islands, 2,500km to the south-east of Kauai. The final transmission of the bird occurred at -152.75 W/ 4.02 N, 100 days after release. Its straight-line distance from Kauai at this point was 2,102.2 km and the total distance the bird has traveled to date is 7,104.9 km.

3.5.3 Hawaiian Petrel fledgling

The straight-line distance between Kauai and the last transmission location was considered for the single Hawaiian Petrel tagged from SOS in 2017. Between time of release on 12th November to the final transmission 46 days later on 27 December the bird travelled a straight-line distance of 3,243.3 km. It also transited to the same area as the Newell's Shearwater fledglings (Figure 5).

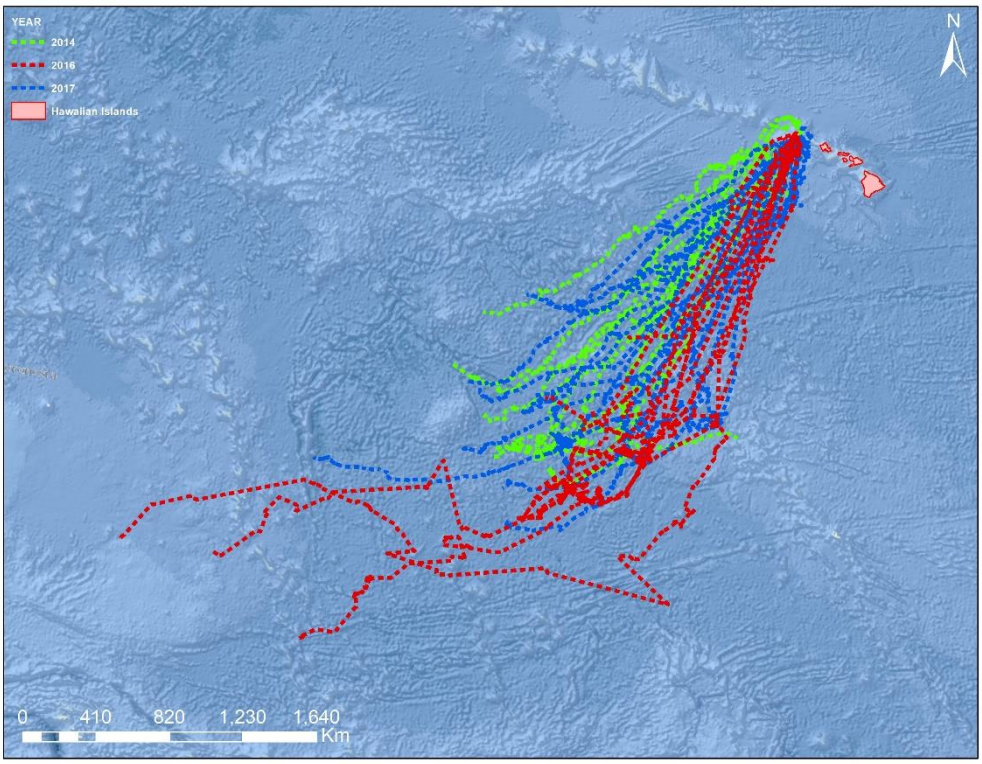

Figure 2. Overview of tracks for all 35 Newell's Shearwater fledglings tracked during this pilot study (all years combined).

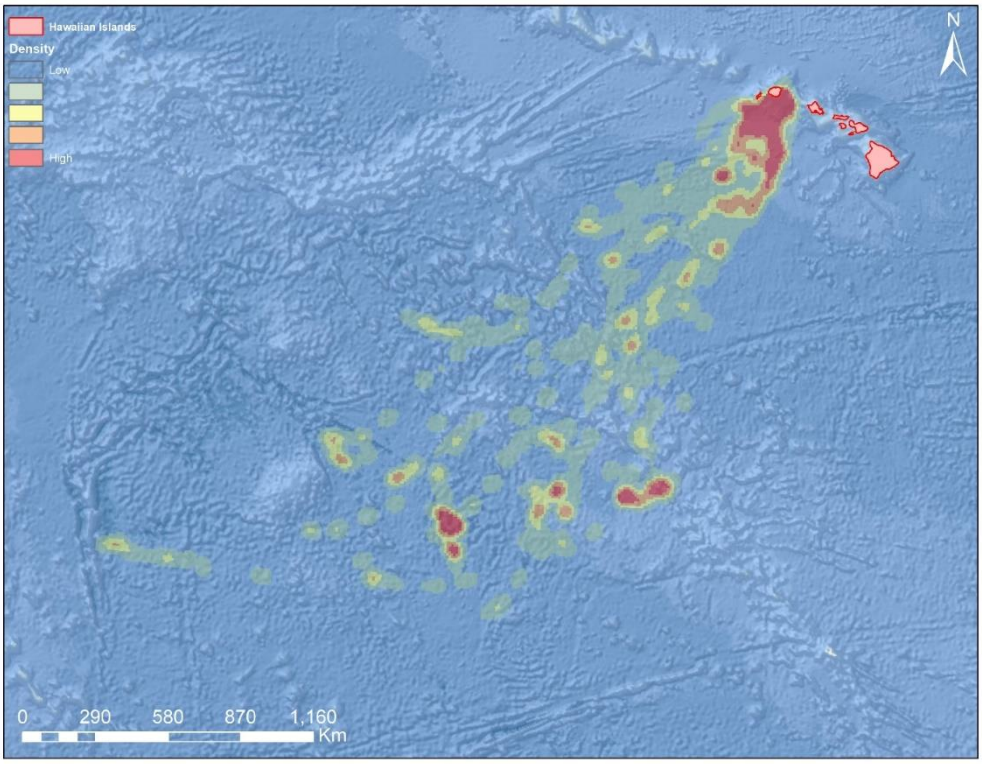

Figure 3. Heat map indicating area of high density of tracking points recorded for all Newell's Shearwater fledglings tracked in 2017.

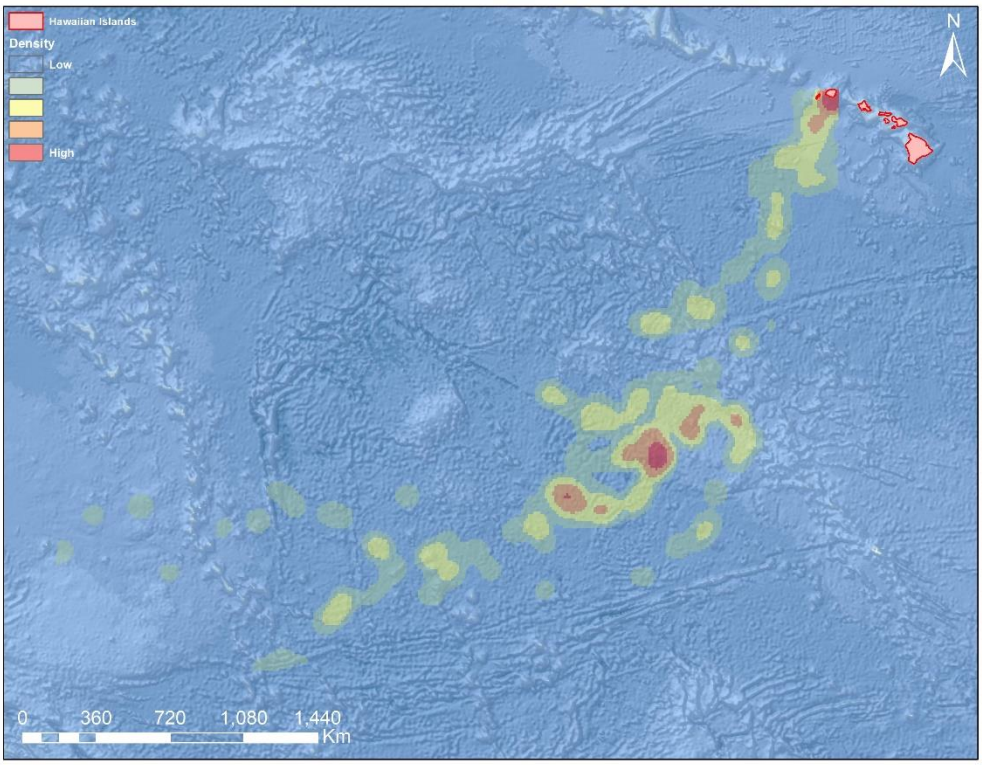

Figure 4. Heat map indicating area of high density of tracking points recorded for all Newell's Shearwater fledglings tracked in 2016.

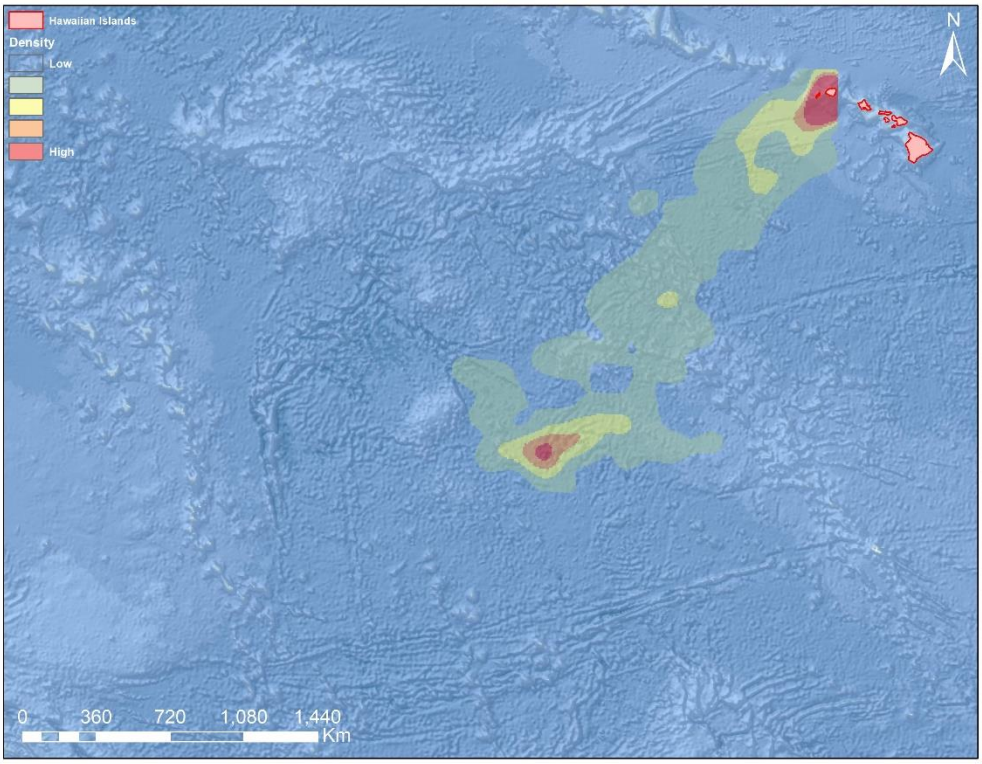

Figure 5. Heat map indicating area of high density of tracking points recorded for all Newell's Shearwater fledglings tracked in 2014.

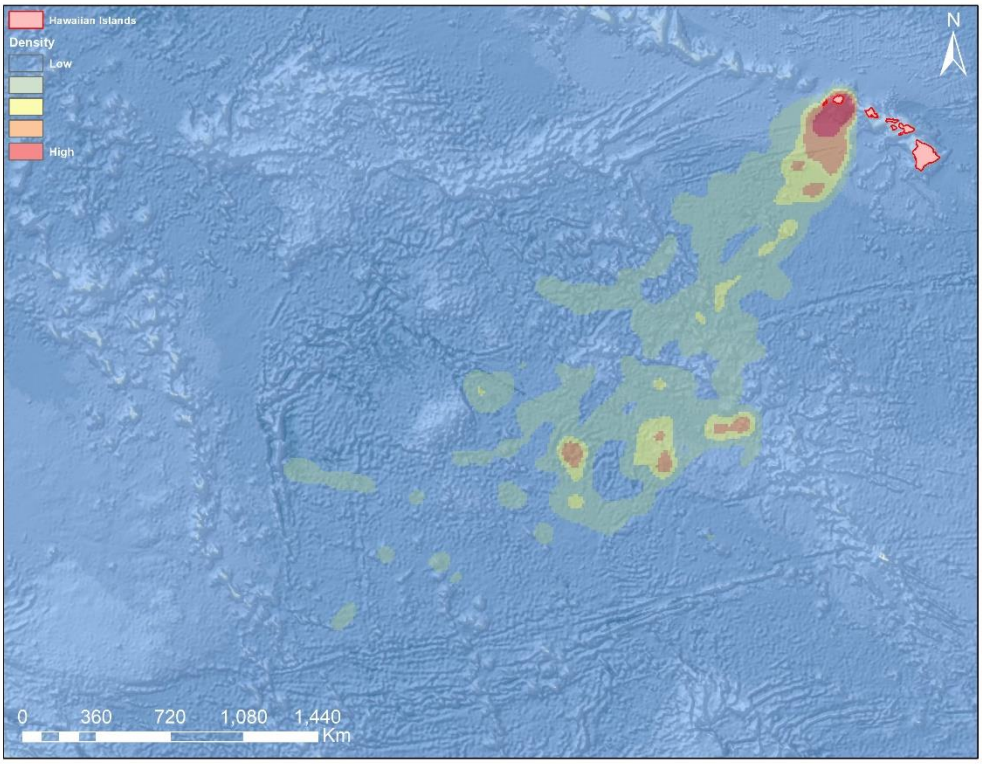

Figure 6. Heat map indicating area of high density of tracking points recorded for all Newell's Shearwater fledglings tracked in all years combined.

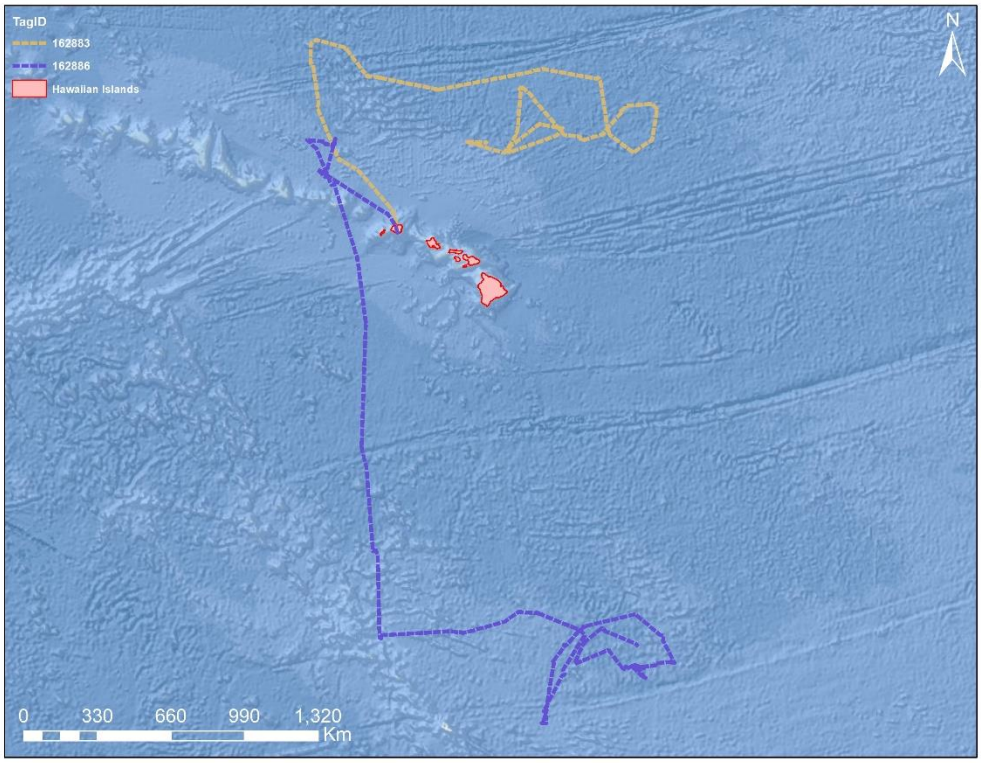

Figure 7. Overview of tracks for two adult Newell's Shearwaters tracked in 2016.

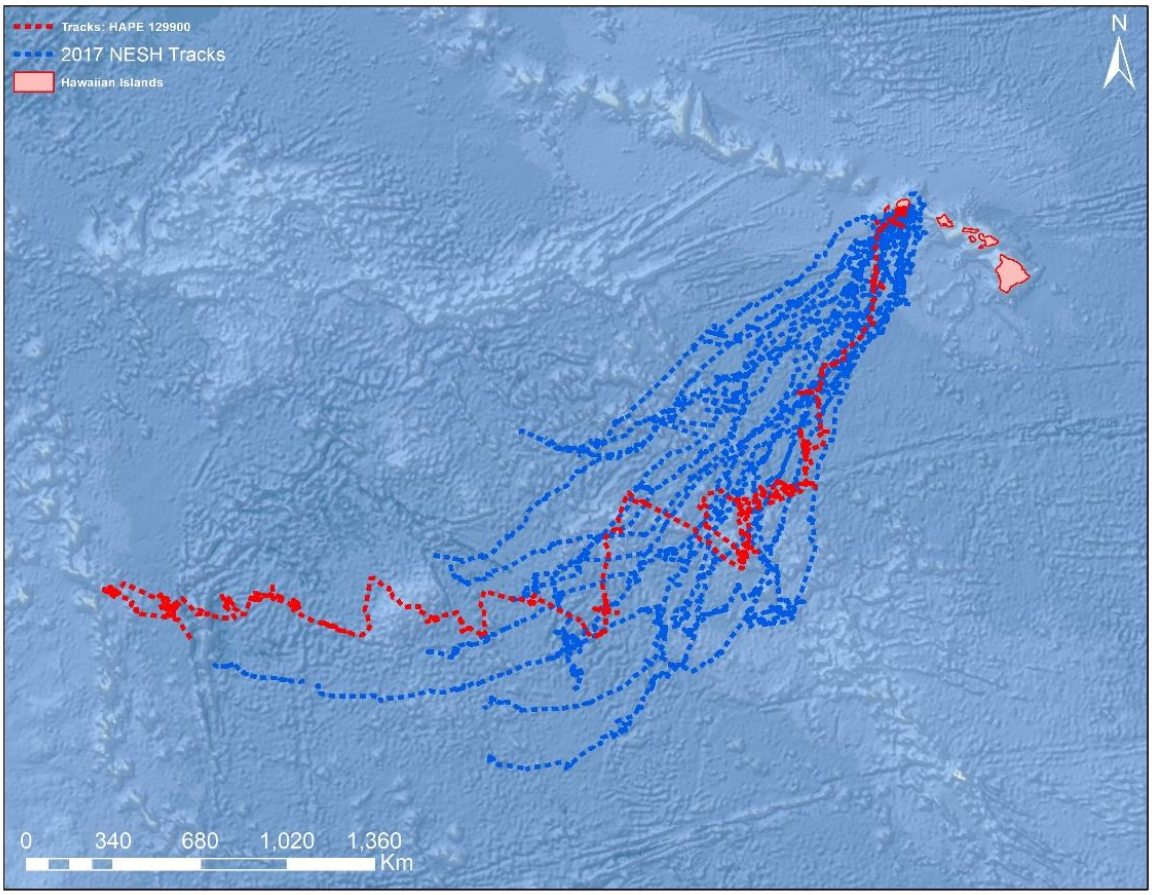

Figure 8. Overview of the single Hawaiian Petrel fledgling track for 2017, overlaid on all Newell's Shearwater tracks.

3.6 Apparent survival rates of grounded birds

Shearwaters and petrels are known to have a low survival rate in the first year of their lives, followed by relatively high survival rates once they reach adulthood (e.g. Perrins et al 1973, Serventy & Curry 1984, Brooke 1990, Chastel et al 1993). For this study however, we were interested in understanding the survival rates of fledglings in their first few *weeks* at sea. This was considered the best way of assessing any impact of grounding on the SOS group of birds – the rationale being that if the bird was negatively impacted by grounding, then (i) any unidentified serious internal injuries the bird may have sustained by being grounded would cause mortality very quickly after release (probably within a few days) and (ii) any negative effects by grounding and handling would result in the bird having reduced capabilities for foraging, resulting in death by starvation and / or inability to fly long distances. A literature search was therefore undertaken to assess how long a seabird would be likely to survive after release if it could not properly feed itself (i.e. number of days to starvation).

Despite an extensive literature review, only two studies were found that explicitly dealt with this issue. A study by Mougin et al (2000) on Cory's Shearwater *Calonectris diomedea* found that fledglings on land lose approximately 40 g d^{-1} when they are not being fed and would thus have less than 10 days to learn how to feed before they starved to death. A study by Oka & Okuyama (2000) on oiled Rhinoceros Auklets (*Cerorhinca monocerata*) found that oiled birds starved to death in 1–2 days (although in this case, one would also need to factor in the case that an oiled bird consumes body energy rapidly due to loss of thermoregulatory capability due to oiled plumage). Also, perhaps relevant to this work – albeit from sea ducks - in a study of the effects of different radio transmitter configurations, Iverson et al. (2006) reported that 8 of 12 scoter mortalities occurred within the first 14 days after handling and release

From the above three studies, it would be expected that negative impacts should become apparent relatively soon after release. Therefore, we compared groups throughout the three years of study to the number still transmitting after 1wk, 2wks and 3wks (Table 4, Figure 6). We assumed any negative impacts from fledglings being grounded, recovered, and released would manifest in a change in behavior or presumed mortality within two weeks and, very conservatively, after three weeks. This should also be taken in the context that all of the fledglings in this pilot study immediately flew on average 2,022 km upon release (or, for the wild birds, from fledging). The ensuing energetic cost that this long journey requires would likely exacerbate any negative effects of grounding and rehabilitation, further strengthening our consideration of the time taken for negative impacts to become apparent.

3.6.1 Tag duration

For the SOS birds, tag duration was considered based on group (Figure 9).

- For the 17 same-day release birds, average tag transmission was 22.6 ± 3.8d (range: 3-71d).
- For the 7 one-day rehabilitation birds, average tag transmission was 20.4 ± 2.4d (range: 12-31d).
- For the 11 birds in rehabilitation for 2+ days, average tag transmission was 15.6 ± 1.1d (range: 7–22d).
- For the single Hawaiian Petrel fledgling tagged in 2017, the tag transmitted for 46 days.

In comparison, tag duration for wild birds was as follows;

- For the 7 wild fledglings, average tag transmission was 42.3 ± 14.1d (range: 12-111d).
- For the 2 wild adults, tag transmission was 71 and 100d respectively.

Considering the fledgling groups only (SOS same day, SOS one day, SOS two+ day, and wild), wild fledglings had significantly longer average transmission periods, while birds in SOS two+ day had the shortest average transmission period (Kruskal Wallis Test, χ^2=8.35, df=3, p=0.039) (Figure 7). All of the SOS groups were then combined into a single group and compared with wild fledglings. Wild fledglings transmitted significantly longer than SOS birds (wild: 42.3 ± 14.1 days, SOS: 19.9 ± 2.0 days; Mann-Whitney U-test, U=57.5, p=0.028).

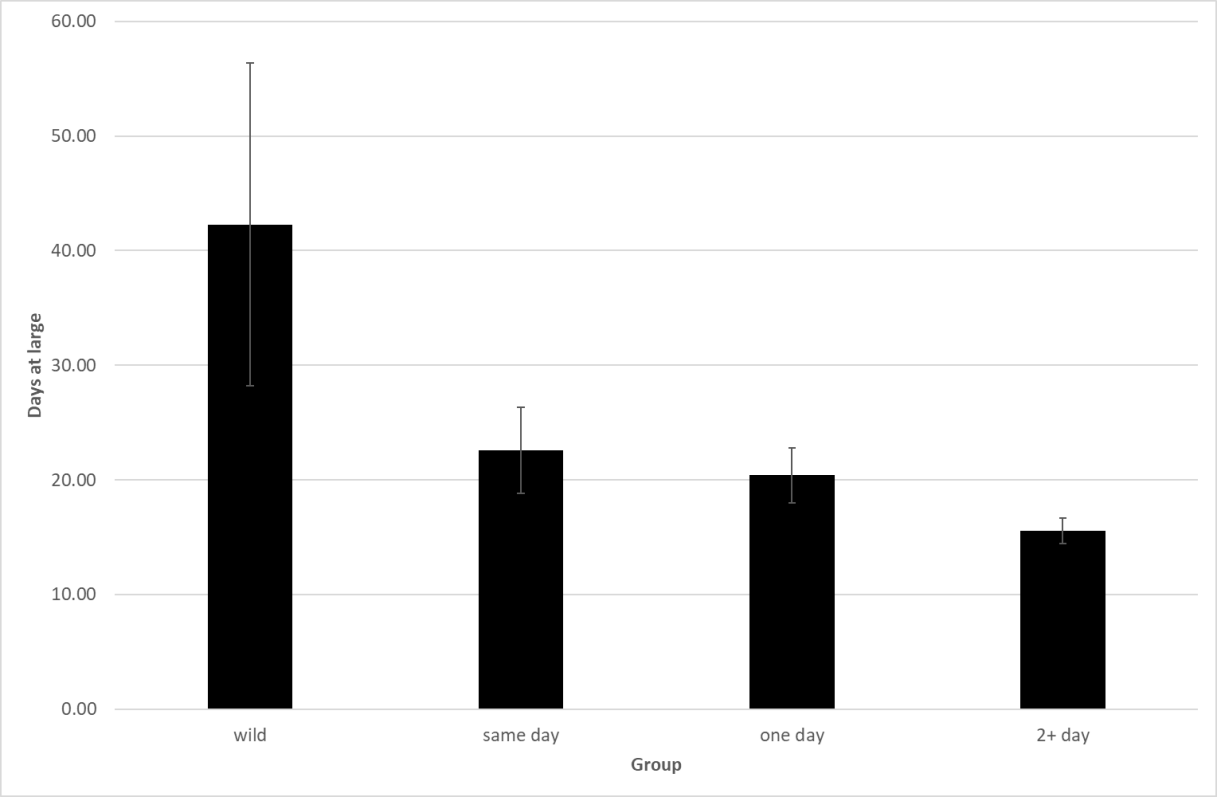

Figure 9. Average tag duration of the three SOS fledgling groups and the wild fledgling group included in this pilot study.

Year	Date	Cohort	TagNum	Days at Large
2014	10/20/2014	Same day release	141874	14
2014	10/16/2014	Same day release	141875	18
2014	10/17/2014	Rehab - One day	141877	18
2014	10/15/2014	Same day release	138434	19
2014	10/20/2014	Rehab - One day	141873	19
2014	10/13/2014	Rehab - One day	141880	26
2014	10/16/2014	Rehab - One day	141879	31
2014	10/16/2014	Same day release	141881	11
2014	10/17/2014	Same day release	141876	14
2014	10/20/2014	Rehab - Two day	141878	18
2014	10/16/2014	Same day release	141882	26
2014	10/17/2014	Same day release	141883	31
2016	18/10/2016	Same day release	162884	3
2016	10/10/2016	Wild - Chick	162894	12
2016	04/10/2016	Same day release	162885	16
2016	10/10/2016	Wild - Chick	162890	20
2016	05/10/2016	Same day release	162887	20
2016	10/10/2016	Wild - Chick	162889	22
2016	05/10/2016	Same day release	162881	22
2016	10/10/2016	Wild - Chick	162892	27
2016	05/10/2016	Same day release	162888	47
2016	10/10/2016	Wild - Adult	162883	71
2016	04/10/2016	Same day release	162891	71
2016	20/10/2016	Wild - Chick	162882	78
2016	11/10/2016	Wild - Adult	162886	100
2016	11/10/2016	Wild - Chick	162893	111
2017	10/23/2017	Rehab - 4 nights	171113	7
2017	10/15/2017	Rehab - One day	171112	12
2017	10/13/2017	Rehab - Four day	171114	15
2017	10/16/2017	Rehab - Four day	171123	15
2017	10/19/2017	Rehab - six days	171118	15
2017	10/18/2017	Released, found 2 days later, re-released 2 days after that	171125	22
2017	10/24/2017	Wild - Chick	171110	26
2017	10/10/2017	Rehab - 14 days	171127	17
2017	10/21/2017	Rehab - 7 nights	171120	16
2017	10/17/2017	Same day release	171117	18
2017	10/26/2017	Rehab - 8 nights	173279	15
2017	10/21/2017	Rehab - 4 nights	171124	13
2017	10/23/2017	Rehab - One day	171122	16
2017	10/16/2017	Same day release	171119	17
2017	10/18/2017	Rehab - Two day	171115	18
2017	10/22/2017	Same day release	171121	20
2017	10/17/2017	Rehab - One day	171116	21
2017	10/12/2017	Same day release	171126	17

Table 3. Summary data for all satellite tags deployed on Newell's Shearwaters in 2014, 2016 and 2017.

After *one week,* **all** birds from all groups were still transmitting apart from those in the 'Same Day' group (**94%)** and the 2+ day group (**90.1%)** (Table 4). After *two weeks*, **>75.0%** of birds from all groups were still transmitting. Numbers dropped after *three weeks*, with **29.4%** of Same Day, **28.6%** of One Day, **9.1%** of 2+ day, and **62.5%** of wild chicks still transmitting. The two adults tagged in 2016 both transmitted beyond two months (71 d and 100 d respectively) and both were re-sighted at nesting burrows in the following year (2017) indicating that the tags had fallen off and the birds had survived to return and attempt breeding (in both cases they also successfully fledged chicks).

	Week		
Cohort	**1+**	**2+**	**3+**
Same Day	94	76.4	29.4
One Day	100	85.6	28.6
2+ Day	90.1	81.2	9.1
Wild Chick	100	87.5	62.5
Wild Adult	100	100	100

Table 4. Percentage of each group still transmitting <u>after</u> 1wk, 2wks and 3wks.

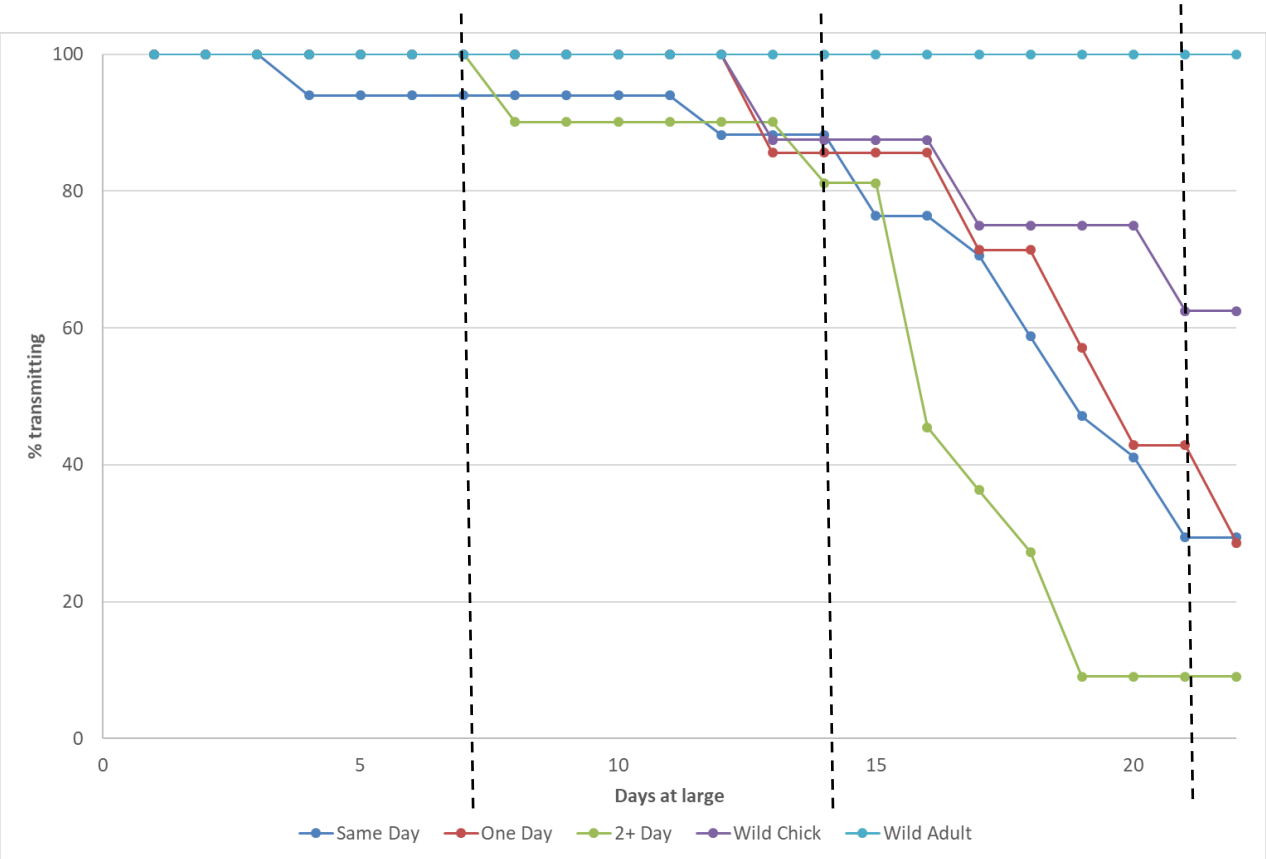

Figure 7. Percentage of tags still transmitting in each of five groups; (i) SOS same day, (ii) SOS one day rehabilitation, (iii) SOS 2+ day rehabilitation, (iv) ULP fledglings and (iv) ULP adults. Black dotted lines represent 1wks, 2wks and 3wks respectively.

The effect of the weight of a bird on release was also considered to see if that had an impact on days at large. Considering only birds within the SOS groups, there was no relationship between weight of bird at tagging and days at large ($y = 0.0034x + 18.324$, $R^2 = 0.00$, $F=0.002$, $df=1$, $p>0.05$, Figure 8). The size of the bird was also taken into account by dividing weight by wing chord and then assessing whether there was a relationship with days at large. Again, there was no relationship between weight/wing chord and days at large (large ($y = -4.23x + 27.30$, $R^2 = 0.002$, $F=0.060$, $df=1$, $p>0.05$).

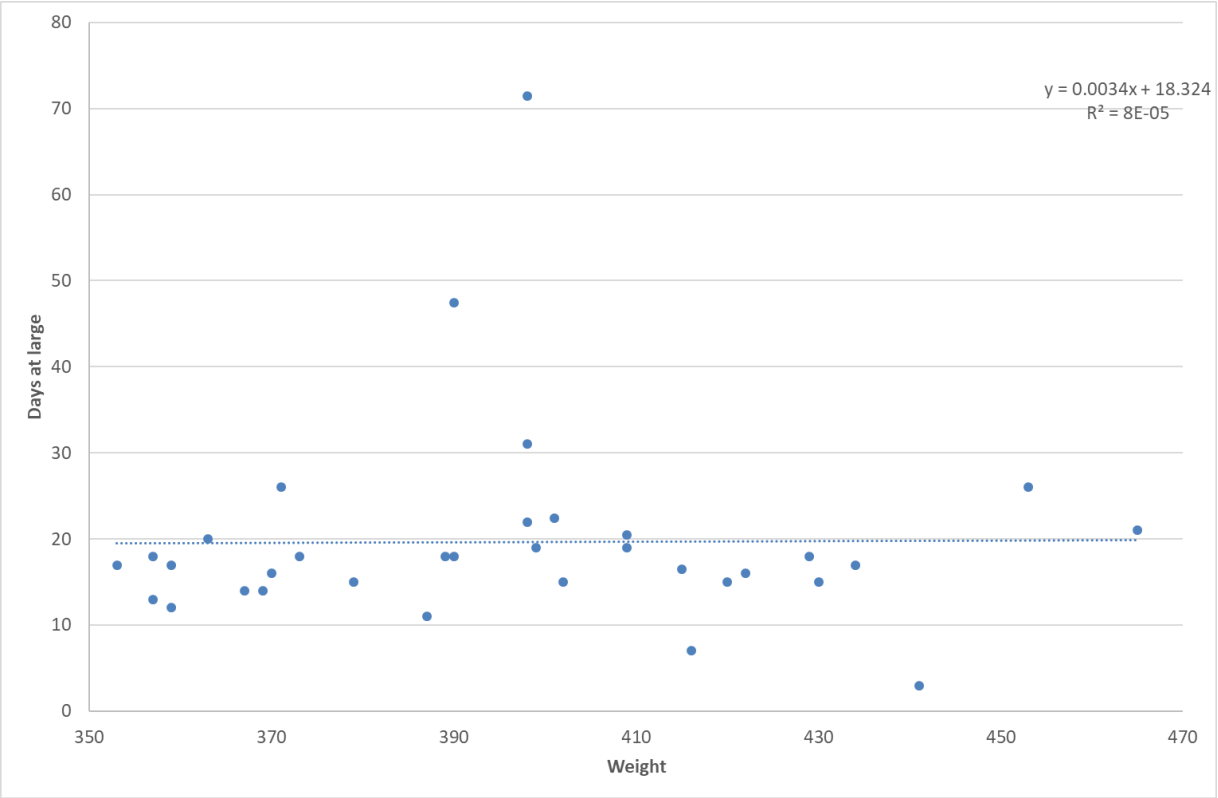

Figure 8. Weight of birds at the time of tagging against total days at large, with one outlier removed.

4.0 DISCUSSION

The primary aim of this pilot study was to assess the effectiveness of SOS to maximize the survival rate of Newell's Shearwaters after recovery, rehabilitation, and release. Considering the many variables that could be considered in any rehabilitation project, small sample sizes in different groups increase the difficulty in analysis. However due to the uncertainty in funding availability each year and the cost of satellite tags compared to the available annual funding, small sample sizes were unavoidable.

Furthermore, during the three years of study, we observed differences in PTT transmission duration after release; birds tagged in 2014 and 2017 apparently experienced greater mortality within a month, whereas those in 2016 transmitted for much longer. 2014 birds in particular may have experienced difficulties in their first wintering grounds due to two reasons. The latter part of 2014 constituted a transition to El Niño oceanographic conditions with resultant shifts in warmer waters away from the central Pacific towards the west coast of North America. Warm water conditions associated with El Niño conditions and an anomalous oceanographic "warm blob" throughout the north-eastern Pacific altered prey availability and restructured zooplankton communities (Peterson et al. 2017) and were associated with large mortalities of seabirds reported along the west coast (including tens of thousands of mostly juvenile Cassin's Auklets *Ptychoramphus aleuticus* washed up on beaches of California) (National Geographic 2014), as well as unusually large numbers of starving California Sealion *Zalophus californianus* pups in the early part of 2015 (NPR 2015). Although far from the central Pacific, where we have little ecological information, these anomalous events highlight linked ecosystem impacts to diving predators in other regions of the Pacific. Sufficient ecological information is lacking to evaluate the potential impacts of the 2014-15 central Pacific warm anomaly on changing conditions in the area where the tagged Newell's Shearwater aggregated, but it is possible that there was reduced prey availability in this area due to these effects. Secondly, anomalous storm effects locally off Hawaii during fledging in 2014 may also have contributed to unexpected mortality in the weeks after they were released to sea. Tagging and release of birds in that year occurred just prior to the passage of Hurricane Ana (a Category 1 hurricane which passed 85 km SW of Kaua'i) which most of the tagged birds flew through – this may also have compromised their survival chances, although all flew out the other side of the hurricane and continued their onward flights.

It is possible that one or both of these factors contributed to the presumed complete mortality among released birds in 2014. Poor breeding success among seabirds has been linked to large-scale ENSO and other climatic events (Hodder and Greybill 1985, Chastel et al. 1993, Guinet, et al. 1998, Jenouvrier et al. 2003). Among seabirds, survival and foraging behavior during the first few weeks after fledging has rarely been studied (but see, Grissac et al. [2016] who compared juvenile vs. adult movement behaviors among 9 procellariform species). Daunt et al. (2007) found post-fledging mortality among European Shag juveniles was 5× greater than adults during the winter and attributed this difference to poor foraging proficiency among juveniles.

Due to the environmental variability and variation in rehabilitation strategies, a multi-year study is required to fully evaluate SOS efficacy, using greater numbers of tags for each of the main SOS groups (see Section 5 below). Nonetheless, the data gathered from this pilot study have produced interesting and relevant results which will be helpful in considering the effectiveness of SOS and the post-fledging dispersal of the Newell's Shearwater in particular. These are discussed below.

4.1 Post-fledging dispersal

Fledgling Newell's Shearwaters in all years headed to the same general area immediately after dispersing and appear to spend at least the first few months of their first winter in this area. This area is bounded by 4°–13°N, 165°–178°W and is presumably an area of elevated relative oceanic productivity and food availability. All of the birds headed to this area very rapidly after, without spending significant amounts of time in the waters around Kaua'i prior to heading south. This highlights how vulnerable this species is to changes in oceanic conditions, with all birds fledging from Kaua'i apparently concentrating in this single geographic area at a critical period of time for survival. If conditions are poor there, then there is a greater chance that a large proportion of the year's fledglings will not survive past the first few months.

Adult Newell's Shearwaters had a very different post-breeding dispersal pattern from fledglings. Of the two adults tracked in 2016, one went north and east and the other went south and west (spending its time around the Line Islands). Neither dispersed to the area where the fledglings were. Previous tracking work using geolocators revealed that five adult birds tagged at Kilauea Point NWR spent the non-breeding season south and east of Hawai'i in the tropical North Pacific between 0° and 15°N and spanning 60° longitude from 105° to 165°W (Joyce et al. 2010) – an area where the two birds tracked during this study also went. The same was true for Newell's Shearwater adults tagged during additional geolocator work undertaken by KESRP in 2017 (unpub. data).

4.2 Save Our Shearwaters (SOS) Effectiveness

Due to the constraints of the study design, it is difficult to fully evaluate the effectiveness of SOS, particularly because of the high apparent mortality in 2014 and 2017. However, several interesting results are worth discussing.

- The majority of SOS birds tracked during this study transmitted beyond the first week after tag attachment and release; of 42 chicks (SOS and wild) tracked only 2 (4.7%) stopped transmitting during the first week (a same day release bird at day 3, and a 4-day rehab bird at day 7).
- Likewise, the majority of birds were still transmitting after two weeks from release; 87.5% of wild chicks were still transmitting, compared with 76.4% same day release, 85.6% one day and 81.2% two plus day birds. If one considers two weeks to be the cut-off point for birds to succumb to injuries or issues associated with grounding, this indicates that the majority of birds did not appear to suffer from immediate ill effects of grounding and release (with the proviso that all of the SOS birds used in this pilot study met the standard release requirements, and marginal release birds were not considered).
- If one wanted to be conservative and use three weeks as the cut-off point, then after three weeks, 29.4% of Same Day, 28.6% of One Day, 9.1% of 2+ day, and 62.5% of wild chicks were still transmitting. While the numbers are lower for the SOS cohorts than the wild fledglings, just under a third of the same day and one day cohort were still transmitting after this period.
- As expected, adults performed well, with one transmitting up to 71 days and the other to 100 days. Both individuals were re-sighted in the following year at their colony, indicating that, as

expected, their tags stopped transmitting because they fell off rather than because the bird died.

- Due to the duty cycle of the tags in 2016 (they were mistakenly pre-programmed by MWT to have a '10hr on / 48hr off' duty cycle rather than our preferred continuous duty cycle), it was not possible to assess whether tags during that year stopped transmitting because of bird mortality (as suspected in 2014) or because they dropped off. This is because we could not review the activity sensors like we could in 2014. However, among tracked Hawaiian Petrels *Pterodroma sandwichensis* on Maui, when tags were not removed by researchers, tag attachment with absorbable sutures lasted on average 54 days (range: 30–87 days, n=7) and 144 and 97 days using non-absorbable sutures (J. Adams, *unpublished data*). For Hawaiian Petrels on Kauai, tag attachment has lasted up to 159 days (Raine et al 2017b). Using non-absorbable polypropylene sutures and similar MWT solar PTTs, tag attachment among Pink-footed Shearwater (*Puffinus creatopus*) in three separate years averaged 142 (n=7), 116 (n=6), and 158 days (n=9) (range: 26–249 days; J. Adams, *unpublished data*). Furthermore, the Newell's Shearwater is a more energetic flyer than the Hawaiian Petrel and can achieve deep dives in pursuit of prey (up to 50 m, Troy 2011); such diving behaviour would presumably put additional strain (hydrodynamic drag) on the tag attachment points, likely causing the tag to dislodge earlier. Therefore, we suspect it is likely that tags that stopped transmitting after 45 days of transmissions (i.e. two same day release birds from the SOS group, two birds from the ULP group and both of the adults) were lost at sea after falling off (an assumption supported by the re-sighting of the two adults tagged in 2016 back at their burrows in 2017). Tags that stopped transmitting before this were likely to be mortalities (and indeed many of the birds that ceased transmitting before this had flat-line activity patterns indicative of a moribund or dead bird).
- Lastly, there was a pattern of survival among the SOS groups; (i) wild fledglings transmitted for longer than SOS birds, (ii) birds that were released on the same day transmitted for longer than those that underwent rehabilitation and (iii) birds at SOS that underwent longer rehabilitation transmitted for shorter periods of time than those that were immediately released or rehabilitated for only one day. This indicated a potential effect related to the length of rehabilitation; indeed, some birds that enter SOS die while in care due to their injuries (i.e. in 2016, 6.2% of Newell's Shearwaters died or were euthanised and an additional 6.2% were received DOA [Anderson 2017]). Furthermore, as can be seen from one of the birds initially tagged in 2017 that was subsequently found to have an undiagnosed head injury from which it perished at SOS, some birds that are released by SOS do have injuries that can compromise their survival chances. This was also seen during tagging work of three adults rehabilitated by SOS after collision with powerlines; one (a marginal release Newell's Shearwater) died after only 5 days at sea while the other two birds (both standard release Hawaiian Petrels) transmitted for 121 and 159 days suggesting they both survived (Raine et al 2018).

In conclusion, it appears the majority of birds rescued and rehabilitated by SOS (especially those considered to be standard release birds) have only a slightly lower chance of surviving their first 2 weeks at sea during their dispersal to initial wintering grounds when compared with wild birds and just under a third of birds in the same day and 1-day rehabilitation groups were still transmitting after three weeks. However, duration of time in care and/or nature of injury may negatively impact survival

longevity. Considering the 35 SOS birds that were tagged, 28 were still transmitting after 2 weeks. This indicates that at least 80.0% survived beyond the period where it is reasonable to assume that any impacts of grounding followed by rescue and/or rehabilitation would have manifested. By comparison, 7 of 8 (87.5%) wild fledglings were still transmitting after two weeks. If one wanted to be conservative and use 3 weeks as a benchmark then 8 of 35 (22.9%) birds were still transmitting beyond that period, compared to 62.5% of wild fledglings. All of these results need to be considered in the context of small sample sizes and potential year effects (particularly the weather conditions and El Nino effects of 2014).

Despite the logistical challenge which make it impossible to locate banded and released birds from SOS when they return to Kauai in future years, our tracking results have shown that the hard work of the rehabilitation team at SOS is an absolutely vital conservation effort to help Newell's Shearwater fledglings (and other native and endangered seabirds) that have been grounded by light attraction. Some birds do indeed survive after being collected and cared for by the SOS program and fly to their first wintering grounds along with birds that have fledged naturally from the wild. Likewise, it should be noted that where grounded birds are not turned in by the public and businesses, they stand a very high chance of mortality resulting from exposure to abundant introduced predators (such as cats or dogs), being run over, or death by exposure and starvation due to an inability to reach the sea.

5.0 FUTURE WORK

It is important to consider what future work is necessary to improve our ability to measure the efficacy of the SOS program. Due to the multiple variables present in rehabilitation and recovery and large predicted variation in natural survival in any given year, a multi-year project with larger numbers of tags would be necessary. At a minimum, a consecutive two-year study, with at least 80 satellite tags per year could be allocated as follows:

- **20 – SOS immediate release group.**
- **20 – one day rehabilitation group.**
- **20 - 2+ day rehabilitation group.**
- **20 – wild birds fledging without fallout issues.**

Alternatively, other tracking options could be considered and – if nothing with an appropriate weight (<14 g) exists – waiting until new technology becomes available before continuing with this work.

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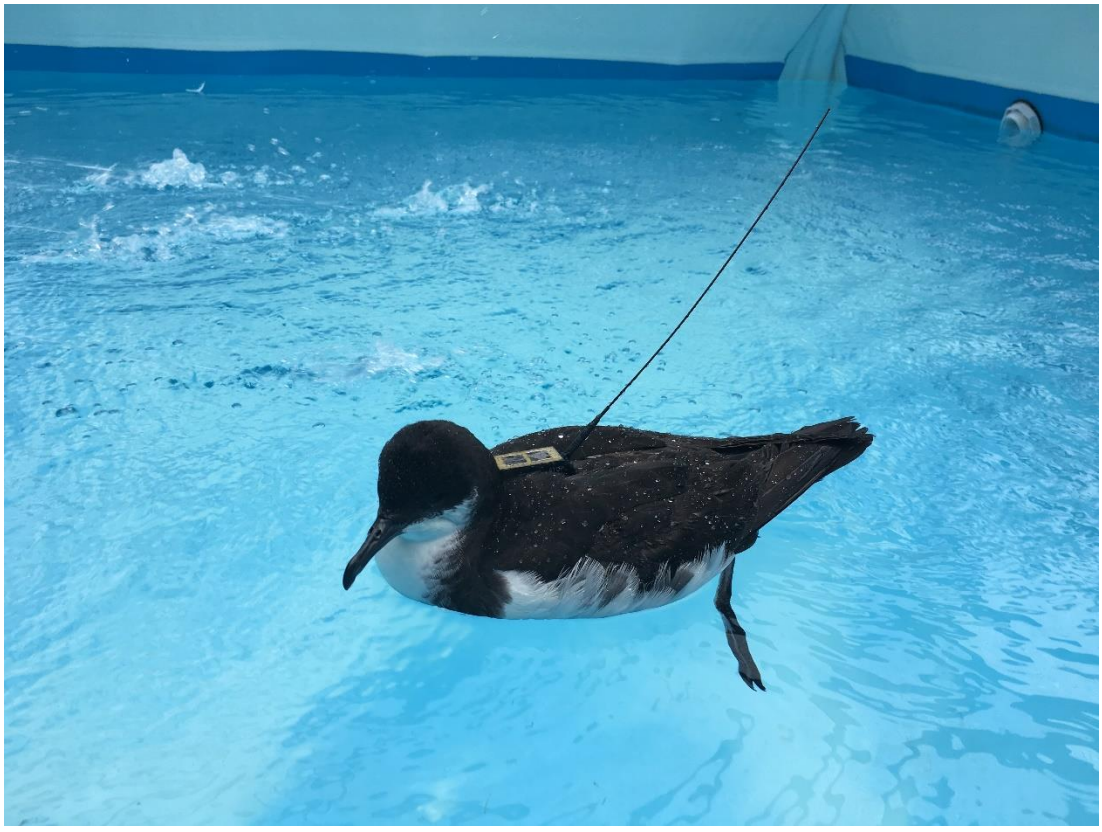
Appendix 1. Photos from the third year of this pilot project.

Newell's Shearwater being held for satellite tag attachment.

Newell’s Shearwater with satellite tag being attached.

Newell’s Shearwater with satellite tag fully attached.

Newell’s Shearwater with satellite tag fully attached.



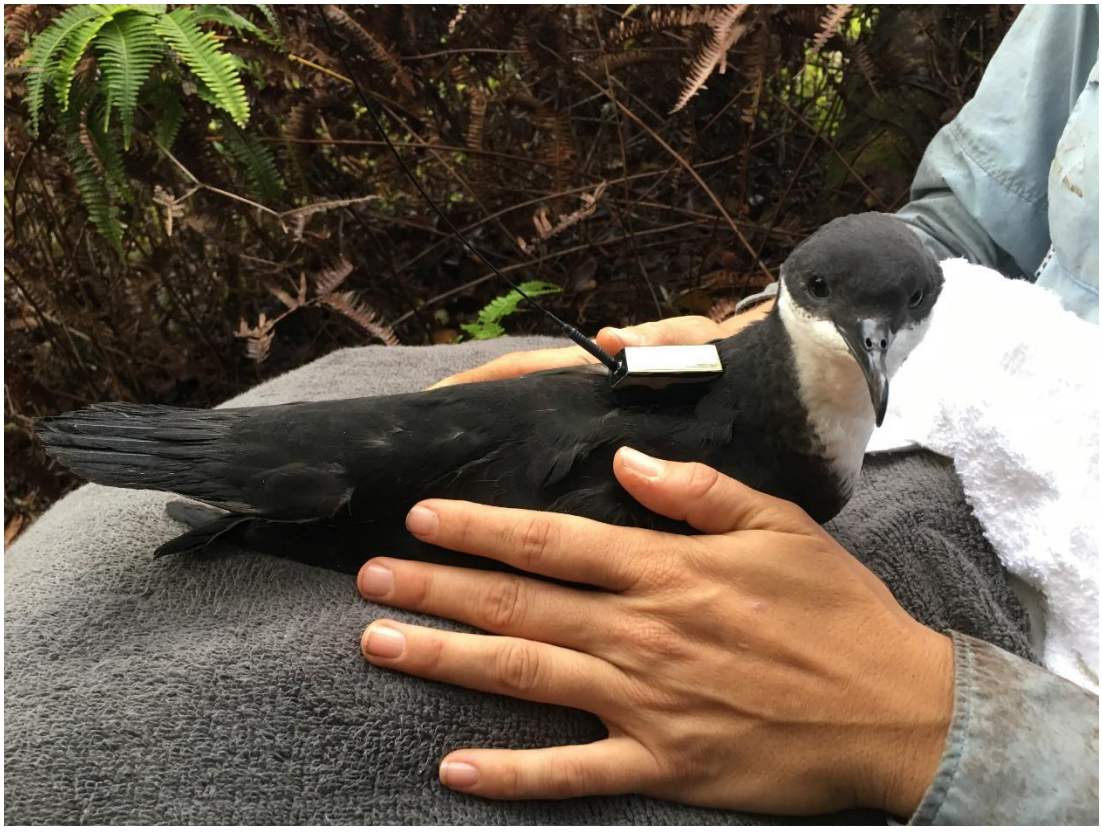
Tagged Newell’s Shearwater in pool to check for water proofing.

Tagged Newell’s Shearwater at Makauhena Point release location.

Tagged Newell’s Shearwater at Makauhena Point release location.

View of Upper Limauhli Preserve.

View of Upper Limauhli Preserve.



Newell’s Shearwater chick tagged at Upper Limahuli Preserve.

The only Hawaiian Petrel tagged as part of this study.

The only Hawaiian Petrel tagged as part of this study.

Appendix 2. All Newell's Shearwater tagged between 2014 and 2017.

Date	Cohort	Group	General Location	Band #	Age	Weight	Sat Tag #	Tag/Body
10/13/2014	SOS	Rehab - One day		1064-00668	HY	371	141880	3.23%
10/15/2014	SOS	Same day release	Waimea	1064-00669	HY	399	138434	3.01%
10/16/2014	SOS	Same day release	PMRF	1064-00754	HY	373	141875	3.22%
10/16/2014	SOS	Same day release	PA Pier	1064-00757	HY	387	141881	3.10%
10/16/2014	SOS	Rehab - One day	St Regis	1064-00756	HY	*na*	141879	*na*
10/16/2014	SOS	Same day release	PAGS	1064-00755	HY	453	141882	2.65%
10/17/2014	SOS	Rehab - One day	Waimea FS	1054-27470	HY	357	141877	3.36%
10/17/2014	SOS	Same day release	Costco/Kmart	1064-00759	HY	398	141883	3.02%
10/17/2014	SOS	Same day release		1064-00760	HY	367	141876	3.27%
10/20/2014	SOS	Rehab - One day	Sheraton Tennis Courts	1064-00903	HY	409	141873	3.18%
10/20/2014	SOS	Rehab - Two day	Lihue FS	1064-00904	HY	389	141878	3.08%
10/20/2014	SOS	Same day release	St Regis	1064-00901	HY	369	141874	3.25%
11/10/2016	Upper Limahuli	Wild Adult	ORA089	1064-00074	AHY	420	162886	2.86%
10/10/2016	Upper Limahuli	Wild Adult	ORA084	0944-08584	AHY	370	162883	3.24%
20/10/2016	Upper Limahuli	Wild fledgling	ORA197	0944-08589	L	*na*	162882	*na*
11/10/2016	Upper Limahuli	Wild fledgling	ORA085	1064-00075	L	545	162893	2.20%
10/10/2016	Upper Limahuli	Wild fledgling	ORA253	1064-00073	L	420	162894	2.86%
10/10/2016	Upper Limahuli	Wild fledgling	ORA084	0944-08587	L	430	162892	2.79%
10/10/2016	Upper Limahuli	Wild fledgling	ORA110	1064-00072	L	435	162890	2.76%
10/10/2016	Upper Limahuli	Wild fledgling	ORA089	0944-08586	L	400	162889	3.00%
18/10/2016	SOS	Same day release	PAGS	1064-02112	HY	441	162884	2.72%
05/10/2016	SOS	Same day release	St Regis	1064-02107	HY	401	162881	2.99%
05/10/2016	SOS	Same day release	St Regis	1064-02106	HY	390	162888	3.08%
05/10/2016	SOS	Same day release	Koa Kea Resort	1064-02105	HY	409	162887	2.93%
04/10/2016	SOS	Same day release	PAGS	1064-02103	HY	398	162891	3.02%
04/10/2016	SOS	Same day release	Hanalei FS	1064-02102	HY	415	162885	2.89%
10/12/2017	SOS	Same day release	Port Allen	1064-02209	HY	359	171126	3.34%
10/15/2017	SOS	Rehab - One day	St Regis	1064-02349	HY	359	171112	3.34%
10/16/2017	SOS	Same day release	7311 Alealea Rd, Haena	1064-02348	HY	353	171119	3.40%
10/17/2017	SOS	Same day release	Hanalei	1064-02285	HY	390	171117	3.08%
10/13/2017	SOS	Rehab - Four day	Koloa FS	1064-02344	HY	402	171114	2.99%
10/17/2017	SOS	Rehab - One day	Kauai Brewery	1064-02352	HY	465	171116	2.58%
10/18/2017	SOS	Rehab - Two day	Waimea Pier	1064-02291	HY	429	171115	2.80%
10/16/2017	SOS	Rehab - Four day	Port Allen	1064-02292	HY	430	171123	2.79%
10/18/2017	SOS	Released, found 2 days later, re-released 2 days after that	1st - Port Allen. 2nd - Waimea Tennis Courts	1064-02259	HY	398	171125	3.02%
10/22/2017	SOS	Same day release	St Regis	1054-81846	HY	363	171121	3.31%
10/23/2017	SOS	Rehab - One day	Kaua'i Beach Resort	1064-02354	HY	370	171122	3.24%
10/10/2017	SOS	Rehab - 14 days	front of Sunset Bar and Grill	1054-31986	HY	434	171127	2.76%
10/24/2017	Upper Limahuli	ORA085	ULP	0944-08641	L	*na*	171110	*na*
10/19/2017	SOS	Rehab - six days	Waimea	1064-02358	HY	420	171118	2.86%
10/21/2017	SOS	Rehab - 4 nights	Waimea	1064-31987	HY	357	171124	3.36%
10/23/2017	SOS	Rehab - 4 nights	Uncles Shave Ice, Lihue	1064-02297	HY	416	171113	2.88%
10/21/2017	SOS	Rehab - 7 nights	4458 Hokulele Place, Kekaha	1064-02359	HY	422	171120	2.84%
10/26/2017	SOS	Rehab - 8 nights	PAGS	1064-02303	HY	379	173279	3.17%