

## Final Report 2018: Oikonos Ecosystem Knowledge

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### Necropsy findings from Seabird Bycatch in Hawai'i and Alaska Longline Fisheries: Examinations conducted September 2017 – August 2018

Jessie Beck<sup>1</sup> and Michelle Hester<sup>1</sup>

<sup>1</sup>Oikonos Ecosystem Knowledge, P.O. Box 2570, Santa Cruz, CA 95062

#### Summary

Seabird bycatch carcasses from fishery operations provide valuable sources of population-level information on demographics, distribution patterns, food habits, and pollution loads. The objectives of this study are to understand demographics of seabirds incidentally caught in U.S.-based commercial fisheries and maximize scientific sampling from these collections. From September 2017 through August 2018, we examined 206 carcasses collected by the NOAA North Pacific Groundfish and Halibut Observer Program in Alaska, the Pacific Islands Regional Office Observer Program in Hawai'i, and the West Coast At-Sea Hake Observer Program out of Washington and Oregon.

To describe the demographic patterns in mortality of Black-footed (*Phoebastria nigripes*) and Laysan Albatrosses (*Phoebastria immutabilis*), and other seabirds collected in longline fisheries, we summarize necropsy findings from the period of performance. Appendices include all samples examined since the beginning of the current collaboration with NOAA Fisheries (September 2007-August 2018; 3173 carcasses total; Table 5, Appendices A and B.)



Supervised volunteers conducting Northern Fulmar and Black-footed Albatross necropsies

#### Methods

##### Facility

Necropsies were conducted by Oikonos at the California Department of Fish and Wildlife Office of Spill Prevention and Response Marine Wildlife Veterinary Care and Research Center (MWVCRC) in Santa Cruz, CA, which provides a regional center to study mortality trends in marine wildlife. The program integrates wildlife and pathology experts from MWVCRC with specialists from rehabilitation centers and beach survey programs to quantify the demographics of marine wildlife affected by disease, oil spills, fisheries interactions, and other mortality events. To better understand population-level trends for migratory species, the center works in collaboration with researchers from outside California.

### ***Samples Examined***

From September 2017 through August 2018, we examined 206 carcasses provided by NOAA fisheries observers that were collected throughout the North Pacific Ocean (174 birds with NOAA funds, plus an additional 32 birds with in-kind funding). All the specimens with available data were collected in 2015-2017 (n = 64). We necropsied 142 carcasses from NOAA whose collection years are in the process of being confirmed via NOAA Observer Database queries.

### ***Methods and Data Collected***

Seabirds were identified to species and necropsied to obtain demographic data including morphometrics (bill, tarsus, and wing length), molt, body condition, age, and sex. Skeletal muscle and stomachs were collected from each carcass. For a subset of albatross specimens, we collected



bone, fat, and feather samples. All samples were stored frozen at -20°C. Body condition was quantified by assessing muscle and fat using a scoring system of 0 to 3 per van Franeker et al. (2004). The *pectoralis-supracoracoideus* muscle complex was scored from 0 - severely emaciated (muscle significantly below keel-line) to 3 - excellent body condition (muscle at or above keel-line). We scored subcutaneous fat and internal fat from 0 (no fat) to 3 (obese). We determined sexual maturity by quantifying gonad characteristics (length and width, teste color, diameter of largest follicle, and oviduct score) and assessed the presence of the Bursa of Fabricius (present [immature] or absent [adult], Broughton 1994). Since the bursa is thought to atrophy with age and sexual development, we considered birds without bursae to be adult and birds with residual bursae to be immature.

For Pacific northern fulmar (*Fulmarus glacialis rogersii*), we scored molt and assigned one of four color morphs: light (L), double light (LL), dark (D) and double dark (DD) following Hatch (1984) and van Franeker (2004). Albatross primary feather molt patterns were scored following Edwards and Rohwer (2005) and van Franeker (2004).

Entire stomachs (proventriculus and ventriculus) were frozen until processed. We examined and sorted stomach contents to determine the incidence of plastics, natural prey, and fishery discards. Plastics and non-natural items were sorted and categorized following van Franeker (2004). Cephalopod beaks were stored in glass vials in 70% isopropyl alcohol for storage. Beaks and prey items were sorted and later shipped to William Walker at Alaska Fisheries Science Center - Marine Mammal Laboratory (MML) for species identification.

### **Results of Bycatch Examinations**

#### ***Species***

From September 2017 through August 2018, we examined 189 seabirds collected in Alaska and Hawai'i (Table 1). For the first time, we also received 17 specimens from the West Coast At-Sea Hake Observer Program. We examined 5 species collected in Alaskan waters: Black-footed

(*Phoebastria nigripes*) and Laysan Albatross (*P. immutabilis*), Sooty-Shearwater (*Ardenna grisea*) Short-tailed Shearwater (*Ardenna tenuirostris*), and Pacific Northern Fulmar (*Fulmarus glacialis rogersii*). From the Hawaiian fisheries, 2 species were examined: the Black-footed and Laysan Albatrosses. The West Coast Hake fishery samples were comprised of 3 species: Black-footed Albatross, Pacific Northern Fulmar, and Sooty Shearwater.

### **Demographics**

Age and sex patterns of 2017-18 Alaska and Hawai'i samples were mostly consistent with trends from the complete dataset across years (Nevins et al. 2018, Beck et al. 2017). Adults dominated the seabird bycatch in both Alaska and Hawai'i (Tables 2 and 3). These samples were consistent with the male bias of Laysan and Black-footed Albatrosses, and Northern Fulmars in Alaska observed in the full dataset (Tables 3, 4 and 6). One species that was inconsistent with the age trend was the Short-tailed Shearwater specimens from Alaska, which had a strong bias towards immature individuals (13 of 16 birds examined, Table 4). In past years, the bycatch of this species exhibited a strong mature trend similar to other procellariids from the area. Since fishery data still needs to be queried for the majority of specimens from 2017-18, we are unable to further investigate possible factors contributing to the immature trend of Short-tailed Shearwaters in this cycle.



Volunteer Angie Reed examining molt on a Northern Fulmar

Samples originating from Hawai'i showed a strong female bias in Black-footed Albatross but sample sizes were more limiting for Laysan Albatross. We were unable to examine all birds from Hawai'i collected in 2017 and 2018, although we did finish examinations for all albatross from 2016. Thus, more data are needed before trends from these years can be discussed. Of the 45 albatross examined from Hawaii in 2017-18, 10 originated from the shallow-set longline fishery and 35 originated from the deep-set longline fishery.

### **Laysan Albatross**

Laysan Albatross collected in Hawai'i and examined in 2017-18 were collected from January through June of 2017. Laysan Albatross examined during 2017-18 from Alaskan fisheries are in the process of having their fishery data queried.

In both Alaska and Hawai'i, Laysan Albatross examined in 2017-18 were predominately adults (4 years or older; Tables 2, 3). These results were consistent with previous findings across all years with sufficient sample sizes (2005, 2010-2017) and in both fisheries.

Within the Laysan samples from the Hawaiian fisheries, there was a male bias (64% male) although sample sizes were lacking (n = 11, Table 2). Male biases were recorded in all years with sufficient samples sizes, with the exception of 2010, when a female bias occurred (41% male). In Alaskan fisheries, the majority of birds examined were male although sample sizes were low (83%

male, n = 11, Table 3). In fact, over the nine years of this program, only 4 of the 114 Alaskan Laysan Albatross with sex data were female. This represents a highly significant bias towards males as discussed in (Nevins et al. 2018).

#### *Black-footed Albatross*

We examined Black-footed Albatross that were collected from Hawaiian fisheries in January through June of 2017 (n = 34). Of the 10 birds examined from Alaskan fisheries, one specimen had available data and was collected in August of 2017. The remainder of the specimens will have their data queried from fishery databases.

A high percentage of Black-footed Albatross samples were adult stage in both Hawaiian (85%, n = 34; Table 2) and Alaskan fisheries (100%, n = 10; Table 3). In our entire dataset, we have recorded only three immature Black-footed Albatross from Alaskan fisheries between 2007 and 2018, illustrating the strong bias towards incidentally catching adults in these fisheries.

In Hawai'i, we found a female bias in adults examined (34% male, n = 34, Table 2), in line with an overall female bias found cumulatively from 2008-2017. There was a slight male bias in 2015-16, although not all birds from those years were examined at that time. Immature birds from Hawai'i did not follow this pattern (60% male) although sample sizes were limited (n = 5; Table 2). Adult Black-footed Albatross from Alaskan fisheries tended to be male (80% male, n = 10, Table 3).

#### *Northern Fulmars*

Northern Fulmars examined in 2017-18 were collected from the West Coast At-Sea Hake Fishery, and in Alaskan fisheries. Specimens in the West Coast fishery were collected between 2015 and 2017, while the two birds from Alaska with available collection dates were from 2016 (102 fulmars from Alaska are in the process of having their collection data queried). In the 2017-18 samples, Northern Fulmars from Alaska were predominately adult ( $\geq 3$  years, Tables 4). In the West Coast fishery, the specimens were almost evenly split between mature and immature birds (7 mature: 6 immature; Table 5). Although there has been a male-bias in Northern Fulmars across all collection years, the strength of the ratios varied inter-annually (Table 6) and seasonally within years (Beck et al. 2018 *in prep*).

#### *Short-tailed Shearwaters*

We received 16 Short-tailed Shearwaters from Alaska, with one confirmed collected in 2016. Collection data for the remaining 15 specimens are pending. All birds were collected in Alaska.

The majority of Short-tailed Shearwaters were immature (80% immature, n = 16, Table 4), reversing a trend towards adults seen throughout the previous years. In both the adult and immature samples, there was a slight bias towards males (67% male in mature samples, 53% male in immature samples, Table 4), although sample sizes were limited.

#### *Sooty Shearwaters*

Two Sooty Shearwaters were collected in Alaska fisheries, and another collected in the West Coast fishery. In the Alaska sample, there was one adult male and one adult female. The bird collected in the West Coast fishery was an adult male.

#### *Stomach Content Analysis*

We processed 181 procellariid stomachs during the period of performance (2017-2018). We were unable to collect 23 stomachs due to extensive scavenging. The fishery discards, fleshy prey parts, and prey hard parts from these stomachs are in the process of being shipped to William Walker at MML for identification and will be reported separately by NOAA. Plastics and other debris are currently being sorted, quantified, and weighed with support from Oikonos matching funds to investigate trends in seabird plastic ingestion.

#### *Database*

Data were stored and protected as required under the Magnuson-Stevens Fisheries Management Act. The Seabird Coordinated Studies Group of the Alaska Fisheries Science Center will confirm date of collection and other fields with original NOAA observer data for this study period.

#### **Conclusions**

Seabird specimens from fisheries bycatch in Alaska and Hawai'i waters provide unique samples to examine regional differences among age classes and sexes of albatross, shearwaters, fulmars and other migratory seabirds throughout the North Pacific. Our results identify biases in age and sex important for understanding demographic vulnerabilities to fisheries bycatch. Although some sample sizes were limited, we found all procellariid species displayed demographic biases. Age- and sex- biases were most apparent in Laysan and Black-footed Albatrosses, with trends varying by species and fishery region.

Since 2007, both fisheries caught predominately adult seabirds of all species, with some annual variability in the strength of the biases. This information will be useful for improving models of population-level consequences of mortality from fisheries bycatch. For example, due to the long-lived, low fecundity life history employed by procellariid species, mortality of adults have a greater negative effect on population growth than the removal of an equal number of pre-breeding individuals (Crouse et al. 1987, Croxall et al. 1991, Doak et al. 1994). Among different species, variability in sex ratios was more complex and dependent on fishery and season of capture (seasonal results are not summarized in this report). These findings warrant more extensive analyses of demographics and other metrics by year, season, and fishery region.

#### **Outreach and Career Training**

We continued our public awareness and youth education efforts focused on seabirds as bio-indicators of the level of plastic trash in the North Pacific, informed by fishery bycatch samples and other colony and beached bird program sources. With the help of matching funds, 2017-18 highlights included:

- We trained 4 undergraduate students on necropsy techniques and another 5 on prey sorting techniques and data management through university internships. Additionally, three aviculturists from the Monterey Bay Aquarium trained with us. We also continued to provide trainings to local and international students and biologists, including from UCSC, Chilean institutions, and Stanford researchers.
- We provided protocol support to a NOAA collaboration with the National Institute of Standards and Technology and the Korea Institute of Ocean Science and Technology
- Thanks to NOAA funds and other in-kind support, we were able to prioritize writing 2 peer-reviewed publications this contract. An additional two manuscripts using contributed samples from this program are submitted for publication.

- We are in the second year of a North Pacific Research Board Grant to investigate Northern Fulmar genetics using samples from this necropsy program. In year 1, samples from colonies were successfully used to determine population structure of Northern Fulmars at Alaska colonies and create baseline data for genetic stock identification. In year 2, bycatch samples will be analyzed for the markers delineated from the colony samples to determine colony of origin. Blogs and curriculum produced for the project in partnership with the Seabird Youth Network can be found at:

SYN Northern Fulmar Blog 1: <http://seabirdyouth.org/northern-fulmars/>

SYN Northern Fulmar Blog 2: <http://seabirdyouth.org/tracing-northern-fulmars-back-to-their-colonies-part-2/>

Seabird curriculum: <http://seabirdyouth.org/seabirds/>

A SYN Blog about the curriculum being used in the Commander Islands:

<http://seabirdyouth.org/commander-islands-nature-and-biosphere-reserve/>

- In November 2018, we participated in the Workshop on the Factors Influencing Albatross Interactions in the Hawaii Longline, hosted by the Western Pacific Regional Fishery Management Council. Demographic data from albatross originating in the deep-set longline fishery in Hawaii was presented to the workshop, and will additionally be included in a technical memo of the workshop's findings.
- School teachers across the country and globe continued to use our free curriculum package called "Winged Ambassadors - ocean literacy through the eyes of albatross". The lessons feature the best available science on the ingestion of marine debris and albatross migration tracking. The teaching package has been used by more than 6,000 teachers and 261,000 students from 36 states in the U.S. and 28 countries.

These teaching materials are available free at Oikonos and two NOAA websites:

[oikonos.org/education](http://oikonos.org/education)

[papahanaumokuakea.gov/education/wa.html](http://papahanaumokuakea.gov/education/wa.html)

[cordellbank.noaa.gov/education/teachers.html](http://cordellbank.noaa.gov/education/teachers.html)

### **Scientific Presentations**

- Baetscher, D., J. Beck, E.C. Anderson, K. Ruegg, A. Ramey, S. Hatch, and J.C. Garza. 2018. Alaskan breeding colonies of Northern Fulmars exhibit extensive gene flow and limited population structure. Poster presentation by D. Baetscher, Jan. 21-26, Anchorage, AK.

### **Scientific Papers**

With additional funding this year for publishing our findings, along with in-kind funding, we were able to make significant progress on 4 papers that we plan to have submitted to journals by early Oct. To help us accomplish this, we hired Pamela Michael and re-hired Erica Donnelly-Greenan to lead demography and plastic paper completion.

### **Published**

- Nevins, H.M., J. Beck, P.E. Michael, M. Hester, J. Peschon, E. Donnelly-Greenan, and S. Fitzgerald. 2018. Demographics of Laysan *Phoebastria immutabilis* and Black-footed *P.*

*nigripes* Albatross caught as bycatch in Alaskan groundfish and Hawaiian longline fisheries. *Marine Ornithology* 46(2): 187-199.

- Donnelly-Greenan, E., D. Hyrenbach, J. Beck, S. Fitzgerald, H. Nevins, and M. Hester. 2018. First quantification of plastic ingestion by Short-tailed Albatross *Phoebastria albatrus*. *Marine Ornithology* 46(1): 79-84.

#### *Submitted for AFSC review*

- Beck, J., P.E. Michael, M. Hester, H. Nevins, E. Donnelly-Greenan, C. Gible, E. Phillips, C. Young, and S. Fitzgerald. 2018. Skewed bycatch of adult male Northern Fulmars varies seasonally, implies sex-specific bycatch risk. *To be submitted to: Fisheries Oceanography*

#### *Additional papers using samples from this program*

- Vokshoori, N.L., M. McCarthy, P. Collins, M. Etnier, T. Rick, M. Eda, J. Beck, and S.D. Newsome. 2018. Expanded foraging range of ancient short-tailed albatross populations into California coastal waters based on bulk tissue and amino acid isotope analysis. *Submitted to Marine Ecology Progress Series – accepted with minor revisions.*
- Morra, K., Y. Chikaraishi, H. Gandhi, H. James, S. Rossman, A. Wiley, A. Raine, J. Beck, and P. Ostrom. 2018. Trophic Declines and Decadal-Scale Foraging Segregation in Three Pelagic Seabirds. *Submitted to Oecologia – accepted with minor revisions.*

### **Additional Projects**

#### *Northern Fulmar Genetics*

In an effort to further the impact of this necropsy program, Oikonos partnered with the University of California Santa Cruz (UCSC), USGS, and NOAA to successfully apply for a North Pacific Research Board (NPRB) grant to investigate the genetic structure of North Pacific Fulmars, and attempt to link Northern Fulmar bycatch back to their natal colonies. UCSC will be leading the genetic work, with Oikonos, USGS, and NOAA supplying samples and expertise.

In addition, Oikonos received a supplemental NPRB outreach to help distribute the project's knowledge and findings to various stakeholders, including remote Bering Sea and Aleutian Island communities, neighboring Russian communities in the Commander Islands, and Alaska groundfish fisherman. Oikonos will be partnering with Thalassa Education, the Seabird Youth Network, and the Northern Research Technical Assistance Center, and UCSC.

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& Game Office of Oil Spill Prevention and Response, Oikonos Ecosystem Knowledge, Moss Landing Marine Laboratories, Hawai'i Pacific University, National Fish and Wildlife Foundation, Wildlife Health Center, University of California at Davis and an Anonymous Foundation Grant.

**Recommended Citation:**

Beck, J. and M. Hester. 2018. Necropsy Findings from Seabird Bycatch in Hawai'i and Alaska Longline Fisheries: Examinations conducted in 2017-18. Unpublished Report to NOAA Alaska Fisheries Science Center.

**Literature Cited**

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**Table 1.** Summary of seabird bycatch specimens examined from September 2017 to August 2018, by fishery region.

Species	Alaska	Hawaii	West Coast	Total
Laysan Albatross	6	11	0	17
Black-footed Albatross	10	34	3	47
Northern Fulmar	106	0	13	119
Sooty Shearwater	6	0	1	7
Short-tailed Shearwater	16	0	0	16
<b>Grand Total</b>	<b>144</b>	<b>45</b>	<b>17</b>	<b>206</b>

**Table 2.** Sex and age (based on presence of bursa) of bycatch in the Hawaiian fisheries examined between September 2017 and August 2018. Age estimates are based on bursa assessment (Absent = adult, Present = immature).

Species	Presence of Bursa	Female	Male	Total
Black-footed Albatross	Absent	19	10	29
	Present	2	3	5
Laysan Albatross	Absent	3	7	10
	Present	1	0	1
<b>Grand Total</b>		<b>25</b>	<b>20</b>	<b>45</b>

**Table 3.** Sex and age of albatross bycatch in the Alaskan fisheries, examined between September 2017 and August 2018. Age estimates are based on bursa assessment (Absent = adult, Present = immature).

Species	Presence of Bursa	Female	Male	Total
Laysan Albatross	Absent	1	5	6
	Present	0	0	0
Black-footed Albatross	Absent	2	8	10
	Present	0	0	0
<b>Grand Total</b>		<b>3</b>	<b>13</b>	<b>16</b>

**Table 4.** Age differences in small procellariids collected in Alaska, examined between September 2017 and August 2018. Age estimates are based on bursa assessment (Absent = adult, Present = immature. Specimens with unknown sexes or bursal status were not included here (n = 3).

Species	Presence of Bursa	Female	Male	Total
Short-tailed Shearwater	Absent	1	2	3
	Present	6	7	13
Sooty Shearwater	Absent	1	1	2
	Present	3	0	3
Northern Fulmar	Absent	28	69	97
	Present	5	2	7
<b>Grand Total</b>		<b>44</b>	<b>81</b>	<b>125</b>

**Table 5.** Age differences by sex in specimens collected in the West Coast At-Sea Hake Fishery, examined between September 2017 and August 2018. Age estimates are based on bursa assessment (Absent = adult, Present = immature).

Species	Presence of Bursa	Female	Male	Total
Black-footed Albatross	Absent	3	0	3
	Present	0	0	0
Sooty Shearwater	Absent	0	1	1
	Present	0	0	0
Northern Fulmar	Absent	6	1	7
	Present	3	3	6
<b>Grand Total</b>		<b>12</b>	<b>5</b>	<b>17</b>

**Table 6.** Percentage of males in known-sex Northern Fulmars, and number of individuals included in NPRB-funded genetics study by collection year and sample size. All birds were examined 2007-2018. Specimens without sex information were excluded (n=53).

Year	n	% Male	Included in genetics study
2006	50	64	9
2007	120	58	87
2008	53	63	49
2009	109	72	105
2010	106	73	105
2011	227	66	219
2012	56	77	53
2013	151	63	144
2014	50	70	49
2015	89	71	80
2016	16	73	15
TBD	620	64	606

*\*\*Note: Date of collection needs to be crossed checked with original observer data for a number of records before these analyses are finalized. For unrecorded dates, specimen collection notes are being used to query the Observer Database for this information, which will be available for most specimens. This work is currently underway.*

## Appendix A.

Number of seabird samples of known sex examined from **Alaska** between September 2007 and August 2018 by collection year (n = 2473). Birds without available collection data are in the process of being queried in the Observer Database to fill in the missing information. Species are referred to by their AOU codes, with the exception of UNGU which indicates unidentified gulls.

Species	1995	1996	2000	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TBD	Total
BFAL	1						4	3	2	3	8	7	4	6	11	1	1	1	36	88
BLKI							1	2		5	1	3							2	14
CANV										1										1
COEI							1													1
COMU						6				3	2	4							6	21
CRAU										1										1
FTSP										1										1
GLGU						2		5	2		2	4							4	19
GWGU			1			7	5	11	10	13	34	11	3						16	111
HERG								1												1
HOPU											1									1
KIEI								4												4
LAAL			4				1	14	5	12	21	14	3	15	6	1	2	1	41	140
LHSP						2		1		1										4
NOFU					1	2	50	127	55	109	106	227	56	151	50	89	16		643	1682
RLKI								2		1									1	4
SBGU							1			1										2
SOSH							1												9	10
STSH			1		3	21	16	44	14	17	17	11	9	13		2	6		171	345
TBMU		1		1		1	2				2									7
TUPU										1										1
WEGU								2												2
UNGU					2	2	1	5	1		1								1	13

## Appendix B.

Number of seabird samples of known sex examined from **Hawai'i** between September 2007 and August 2018 by collection year (n = 683).

Species	2001	2003	2005	2006	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TBD	Total
BFAL			7	5	8	6	25	14	43	49	36	77	80	39	2	391
LAAL	2	2	13		6	4	39	36	36	37	9	23	23	14	8	252
LHSP					1											1
NESH							1									1
SOSH				2	11		1	3	5	7	1	3	2		1	36
WISP							1									1
WTSH					1											1