DEVELOPMENT OF A BANDING DATABASE FOR NORTH PACIFIC ALBATROSS: IMPLICATIONS FOR FUTURE DATA COLLECTION

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ABSTRACT

The effects of fishery practices on black-footed (*Phoebastria nigripes*) and Laysan albatross (*Phoebastria immutabilis*) continue to be a source of contention and uncertainty. Some of this uncertainty is a result of a lack of estimates of albatross demographic parameters such as survival. To begin to address these informational needs, a database of albatross banding and encounter records was constructed. Due to uncertainty concerning data collection and validity of assumptions required for mark-recapture analyses, these data should be used with caution. Although demographic parameter estimates are of interest to many, band loss rates, temporary emigration rates, and discontinuous banding effort can confound these estimates. We suggest a number of improvements in data collection that can help ameliorate problems, including the use of double banding and collecting data using a 'robust' design. Additionally, sustained banding and encounter efforts are needed to maximize the value of these data. With these modifications, the usefulness of the banding data could be improved markedly.

INTRODUCTION

Although there is much recent concern over the status and trends of north Pacific albatross species (American Bird Conservancy, 2002; Lewison and Crowder, 2003; EarthJustice, 2004), there are few demographic data to address these concerns, or to assess the effectiveness of possible mitigation measures. Generally, for long-lived species such as albatross, the demographic rate to which population change is most sensitive is adult survival (Cairns, 1992; Pfister, 1998; Doherty et al., 2004), and survival is arguably the demographic parameter of most current interest. Although other demographic parameters are of significance and needed for population models (e.g., Caswell, 2001) the interest in survival stems from the possible effects of historic and current fishery practices on albatross species (e.g., Lewison and Crowder, 2003). Although there is concern for all north Pacific albatross species, focus has been on the

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black-footed (*Phoebastria nigripes*) and Laysan (*Phoebastria immutabilis*) albatross, since short-tailed (*Phoebastria albatru*) and waved (*Phoebastria irrorata*) albatross populations have not been suggested as declining steeply.

Data to estimate survival can come from banding and subsequent encounter data. Fortunately, over the last ~70 years much albatross banding activity has taken place. Unfortunately, many of these albatross records have not been readily accessible. Even when accessible, there are many possible problems associated with using these data, including problems with identifying specific areas where banding took place, accounting for band loss, identifying birds with double and replaced bands, and tracking such bands over time.

Our overall goals were to: (1) gather and vet albatross banding and encounter data to construct a database, (2) assess the usefulness of the database for providing estimates of vital demographic rates, and (3) provide recommendations for future study design and data collection.

METHODS AND MATERIALS

To address data needs for a demographic analysis of black-footed (BFAL) and Laysan (LAAL) albatross, with a focus on estimating survival, a database consisting of banding (first capture) and subsequent encounter (dead or alive) records was needed. A previous effort was made at constructing such a database, however this effort had shortcomings. The previous effort focused on BFAL and ostensibly included 114,884 banding and 24,324 encounter records. When these records were examined more closely, problems due to tracking replaced bands (i.e., albatross can outlive a band, and often more than one band is associated with a particular bird), errors in data entry (e.g., band numbers that did not correspond to albatross), and unfamiliarity with banding data, led to this database being unusable. We undertook a data entry and vetting initiative to construct a usable database for both BFAL and LAAL using this previous database as a starting point. Since the U.S. Geological Survey (USGS) Bird Banding Laboratory (BBL), in cooperation with the Canadian Wildlife Service, governs all U.S. and Canadian banding activities, and maintains a large database of banding data, we worked within the BBL with a goal of conforming to BBL database structure and data standards.

We first located as many of the albatross banding records as possible. Only banding data collected since 1960 were available in an electronic format at the BBL. Data previous to ~1950 were on microfiche, and data from the period ~1950 to 1960 were on paper. Finding all the older (pre-1960) albatross banding data was particularly challenging. We entered or re-entered all banding data previous to ~1970, with the earliest recorded bandings dating to 1936. Until recently, only locations to the nearest 10-minute block were stored by the BBL. When we re-entered data, we also entered exact location information if such information was available.

We then identified band associations (i.e., replaced bands and double bandings that would artificially increase the number of bandings if not recognized as a single bird). All such band associations were electronically available from ~1988. Records previous to this date were available on paper only, unless such associations had been noted upon an encounter event. We searched for all band associations and re-entered these along with exact location data if it were available.

We then located and entered encounter data. Local encounter data (i.e., within the same 10-minute block of banding) has not been stored traditionally by the BBL, and few local encounter records were available directly from the BBL. The BBL is currently in the process of re-evaluating this policy and will most likely routinely store such information in the future. We obtained encounter data from many sources including the first albatross database, the BBL databases, paper records at the BBL, U.S. Fish and Wildlife Service (USFWS) personnel in Hawaii (including the banding records from a number of banders working on French Frigate Shoals), and directly from banders' personal records.

In constructing the database, data were entered once, as resources were not available to enter data more than once. However, many records were entered multiple times due to duplicate records from different data sources. Whenever an error or inconsistency was discovered, we went back to the primary source (i.e., paper records) and verified the data. In vetting these records, we made sure that every banding was indeed an albatross and that every encounter record had a matching banding record. We also checked for internal inconsistencies between bandings and encounters (e.g., species, sex, age, dates of encounters being later than banding date).

Our database was formatted to conform to BBL procedures and codes. These formats/codes are available online (http://www.pwrc.usgs.gov/). The BBL is currently in the process of updating its databases (from a mainframe system to an Oracle-based client-server system). When this process is complete, our albatross database will be imported into the BBL databases, with additional vetting related to importing procedures happening at that time, and access will be the same as for any other BBL banding data.

RESULTS

Database Records

We identified 109,372 BFAL, 252,540 LAAL, 16 hybrid, and 1 unidentified albatross bandings (total = 361,929). With long-lived species such as albatross, double banding and replaced bands are common. Tracking such band associations is crucial for data to be usable, or biased estimates will result. Previously to our efforts we were aware of ~9,600 band associations (both species inclusive). We now recognize 25,404 band associations (5,305 BFAL; 20,097 LAAL; 2 hybrids).

We recognize a total of 163,455 encounters (39,762 BFAL, 123,583 LAAL, 6 hybrids, and 104 unknown albatross species). Many banders replaced bands through the years, and there were multiple duplicate records that have now been rectified. One important exception that should be noted is that there were a number of banding schedules that were never submitted to the BBL (and cannot be located by the permit holder) for which there were numerous (110) encounters, but no banding data. These 110 records currently are left in the database.

Potential Analyses

We suggest the database is of limited use. The data are too limited to generate annual survival estimates for both albatross species for the last half century. In preliminary analyses we were able to generate survival estimates for groups of years (i.e., years grouped together in which survival is assumed constant) from dead-encounter data and annual estimates for short series of years from live-encounter data.

Goodness-of-fit is likely to be a problem in using these data, and variance inflation factors will be needed to help adjust for these lack-of-fit problems.

DISCUSSION

With the hundreds of thousands of banding and encounter records known to exist from 1936 (and now available), there are high hopes that much of the informational needs relating to north Pacific albatross species will be met. Unfortunately, due to inadequate record keeping and inconsistency in data collection, these hopes will not be entirely met. However, there is information to be garnered from these data, and these data point to needed improvements in study design and record keeping. We first will discuss the database, and close with comments on the results and study design considerations.

The database was formed to conform to BBL standards and to eventually be imported into the BBL's new database. Thus users of the database should be familiar with the BBL operations. Fortunately, access to BBL data is free and details about BBL operations are available on-line.

Although we identified many errors, there are surely many more that will continue to be detected as the data are used and future records are added. Significant possible sources of errors and/or missing data are:

1) Not all of the old banding data (e.g., microfiche and paper) were located and entered. We are confident we located and entered most of the major banding efforts, but there may be small numbers of very old bands that we did not find.

2) Not all encounter records were located and entered. There are certainly recapture data available that we did not locate. We think we located much of the available data, with an exception of data from individual banders operating during the late 1970s and early 1990s. We had many replaced band records (mandatory submission to the BBL) from these time periods, and we think there may be additional recapture records that were not submitted to the BBL. Additionally, file cabinets on Midway probably contain encounter data that were not entered by staff (volunteer and contractor) before the accessibility to Midway was reduced in the early 2000s.

3) Not all band associations were identified. We scoured the BBL records for band associations and almost tripled the number of known band associations. There are likely others, although few in number, which we did not detect. These few birds would be considered as new bandings and artificially increase the number of birds banded. Most likely, this would negatively bias estimates of survival.

4) Specific banding location data are error-prone or not available. We re-entered banding data previous to ~1970 and captured any specific location (more precise than

a 10-min block) data that were available. Although banding data post- ~1960 were available electronically, these data would not have specific location data associated with the electronic record. It may be useful to go through additional banding records (post-~1970) and enter any specific banding information that may be available on paper.

We think the data fields associated with specific location information are especially prone to error as there was no way to verify or check these fields. For example, data collected at Sand and Eastern islands (Midway Atoll) were sometimes given the same latitude-longitude coordinates and sometimes different coordinates. Extreme care must be taken with the use and interpretation of these data.

5) Any inconsistencies that could not be resolved by examining the original sources were left for the user to decide how to handle. These include species or sex that differs on banding and encounter, as well as an encounter that happens after a dead recovery. There are few of these instances (<1000), but the user must be careful.

This database is viewed as temporary storage until the records can be imported into BBL databases and final vetting is conducted.

Analysis and Implications for Future Study Design

Although we are able to generate estimates of survival from the database, lack of fit for capture data will be a concern, and some estimates will be difficult to judge and interpret. Much care must be taken and many caveats must be recognized when using and interpreting these data. These caveats include:

1) Estimates could be biased due to inadequate design and/or sparse data leading to lack of fit.

2) Little data exists to associate breeding populations with stressors (i.e., fishery activity).

3) There are too many years with inadequate (or no) capture effort.

From our experience in the construction of the database and from preliminary analyses we have many suggestions for future data collection and storage. We are working with the USFWS to construct exact protocols for their surveys on Tern Island and Midway Atoll. Below are some of the suggestions we think could be of value:

1) The BBL is the most logical repository for databases such as this albatross database (Kendall et al., 1998). With the new database developments, as well as developments of band management software (i.e., Band Manager), such storage should be within reason.

2) If annual estimates of survival and other demographic parameters are deemed warranted, then a consistent effort needs to be maintained on the nesting islands. Study plots should be chosen to be representative of the islands and to be able to make inference to the island as a whole. By a consistent effort we mean annual effort in which greater than 2,000 adult albatross are captured per year. Efforts should be made to identify breeding from nonbreeding birds, and if a choice needs to be made, effort should focus on breeding birds. Relying solely on volunteers and opportunistic banding efforts will not provide the information needed.

3) Band loss negatively biases survival estimates from banded birds (in direct proportion to the loss rate). Double-banding a subset of the birds that are banded will

permit estimation of band loss and adjusting of survival estimates for this loss. In this particular situation, we suggest trying for a goal of double banding at least 10% of the birds. This also obviates the need to always record all bands that are on recaptured or resighted birds.

4) By splitting annual capture or resighting effort into at least two full sampling sessions within each breeding season the probability of a breeder skipping a year of breeding can be estimated with some degree of certainty. This would also remove potential bias in estimates of survival rates caused by skipping. We suggest, as a starting point, splitting capture effort into two equally sized sampling intervals. In the first interval, you would capture as many individuals as possible, avoiding recaptures if possible. In the second sampling interval, you would sample individuals randomly, regardless of whether an individual was captured in the first sampling interval. Therefore, a capture history is constructed for an individual within as well as between breeding seasons. For a three-year study, an example capture history would be:

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where a '1' indicates capture in that sampling interval. So this individual was first captured in sampling interval 1 of year 1. It was then recaptured (or the band resighted) in sampling interval 2 of that same year. In year 2, it was not captured/resighted at all, indicating it skipped breeding that year, bred but not in the study plot, or was present and was simply missed. In year 3, it was missed in sampling interval 1 but was captured/resighted in interval 2. This is Pollock's robust design (Pollock, 1982), which permits the estimation of many parameters including temporary emigration (Kendall et al., 1997). Accounting for skipped breeders can be further aided by recording whether the breeding attempt by an albatross in a given year is successful.

5) For study areas defined by plots amid other nesting habitat, the movement of a breeder outside the plot in the following year could be confused with a decision to skip breeding (because in either event the bird is invisible to capture effort within the plot). By establishing a boundary strip around the plot, this edge effect can be neutralized. To accomplish this, the width of the boundary strip should be wide enough to encompass individual breeding pairs that might have been captured and marked in the study plot in the past. A reasonable boundary strip width may be 10 m for these albatross species. Each time field crews capture/resight birds within the plot, they also search the boundary strip. They should not capture unmarked birds, but should search for and record band numbers of previously marked birds.

6) Telemetry and/or data loggers could also be used as direct information on survival and the decision about whether to breed in a given year, as well as the spatial-temporal juxtaposition of the bird's location with longline fishing fleets.

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