Designing and Implementing a Program to Survey and Monitor Spotted Owls at Olympic National Park

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INTRODUCTION

The importance of establishing clearly defined objectives for an inventory or monitoring program cannot be overstated. The size and accessibility of the survey area, the length of time the program is to continue, and specific program objectives determine complexity of a particular program. A relatively simple inventory program involves detecting species presence or absence in a small area. A more complex monitoring program might seek to track species survival and reproduction over time (demographic monitoring) without making statistically valid inferences to the entire population. A very complex program is required if the goal is to inventory and then monitor population density over time in a large, remote landscape.

> ***Inventories*** quantify presence, abundance, distribution and/or habitat relations of species in ***space*** to assess current ***status***. Inventories establish a baseline of information, which may form a foundation for monitoring if they are repeated in the future.

This handbook is intended to assist biologists and natural resource managers in designing an appropriate inventory and monitoring program for the northern spotted owl (*Strix occidentalis caurina*), a territorial raptors. The bulk of the handbook is devoted to a design that is particularly suited to conducting an inventory in large remote areas with limited access where it is impractical if not impossible to survey the entire area. The sampling scheme allows inference to an entire population based on surveys covering only a portion of the area of interest. Some procedures described here require the capture and handling of birds and repeated visits to the sample plots. This handbook will not address monitoring of population density, but the methods for population inventory can be used across time to accomplish that goal. The handbook resulted from an inventory of spotted owls in Olympic National Park (See Seaman et al. 1992, 1996; Seaman 1996, 1998, 1999).

> ***Monitoring*** includes the sequential measurement of ecological systems over ***time*** with the primary purpose of detecting ***trends*** in the characteristics, processes or functions of natural systems. Monitoring identifies ranges of variation in natural resources, establishing the baseline from which changes can be detected. Monitoring plays a critically important role in scientific management of natural areas. After a management action is prescribed, monitoring again plays a pivotal role in assessing the efficacy of implemented actions, necessary adaptations for management, and identifying when management goals have been accomplished.
>
> Monitoring may be confused with related activities involving measurement of natural systems and resources-notably with resource inventories and research. Often, only the design features and study objectives separate those activities; what is measured may be the same. For example, *monitoring* long-term changes in species distribution patterns may require sequential measurements of a species presence or absence using accepted inventory methods. (Extracted from Jenkins et al. 2001).

DETERMINING WHAT IS NEEDED: THE OBJECTIVE

POPULATION ESTIMATION (ESTIMATING POPULATION SIZE)

In some situations it is possible to determine population size by surveying 100% of the potential habitat in a study area and counting all the animals, thus doing a census (Ralph 1981). This approach removes the need for some of the complicated statistical treatment of the data but it still requires that the study area and survey stations be defined.

In large remote areas, population estimates are often obtained using a statistically rigorous design that calls for sampling less than 100% of the potential habitat. This approach is necessary when access and funding are restricted. A sophisticated sampling design is required so that the sample population estimate can be used to infer population size for the entire study area (Nichols 1992, Skalski and Robson 1992). It is ***absolutely imperative*** that a professional statistician review any proposed population estimation projects before beginning fieldwork.

DEMOGRAPHIC MONITORING (MONITORING SURVIVAL AND REPRODUCITIVE STATUS)

The purpose of demographic monitoring is to estimate rates of survival and reproductive status for the population. Survival rate is the proportion of individuals that survive a fixed interval of time such as one year. Some attributes for describing the status of a population include: territory occupancy rate, pairing rate, productivity, and survival rates. These rates are a vital adjunct to an estimate of population size for assessing whether a population will remain stable, increase, or decrease under the current conditions. The basic techniques include: 1) marking and re-sighting individuals to estimate survival rates; and 2) using behavioral observations of individuals to determine territory occupancy, pairing, and 3) estimating juvenile production. Field methods and statistical analyses of demographic monitoring for spotted owls are also described in detail by (Forsman et al. 1996).

PRESENCE/ABSENCE SURVEYS

Presence/absence surveys are often driven by the need for compliance with the Endangered Species Act (ESA) when a management project potentially causes disturbance to, or habitat loss for the species of interest. Determining the sample area will require consultation with the U.S. Fish and Wildlife Service (USFWS), because regulations vary across the range of the species and may change over time. Areas up to a mile or more from the project site may need to be surveyed if the proposed action results in habitat loss. Projects of less magnitude, such as those that cause noise disturbance, will generally require a smaller area to be surveyed. For determining presence/absence, it is generally not necessary to capture and mark individual birds.

Presence/absence surveys may also be conducted as part of a larger species inventory program or a species habitat study. Specific study objectives will determine where and how many sites will be selected. Fore example, in species inventories site selection may be based on a sample grid.

MONITORING POPULATIONS THROUGH TIME

Monitoring populations through time is accomplished by estimating population size during successive periods. In large, remote areas this will be a particularly expensive and time-consuming effort. We do not include a section on population monitoring because the methods are the same as those described for estimating population size except the procedures are repeated across time.

POPULATION ESTIMATION

DEFINING THE STUDY AREA AND SELECTING SAMPLING POINTS

The study area of concern may be all or part of a park or other land-management unit. The size and complexity of an area will determine whether a total count is feasible or whether sampling is required. However, the final decision to complete a total count vs. using a sampling scheme may be based on the available budget. Here, we use the Olympic National Park spotted owl program as a case study to illustrate how to estimate the number of organisms in a large and complicated landscape. The purpose of the study was to estimate the number of spotted owl pairs in Olympic National Park as precisely as possible.

Stratification.

Stratification improves the precision of population estimates by partially accounting for known or expected sources of variation in population density. Preliminary spotted owl survey data (Fredrickson et al. 1990) suggested that owl densities, capture probabilities, or both, varied among east-side, west-side, and high elevation forests of Olympic National Park. Consequently, we used three strata in our sampling scheme (Table 1). Two low elevation strata (east and west) were separated by the 220 cm (~90 in) precipitation isocline (Philips and Donaldson 1972, Fig. 1). West side forests have high precipitation, which leads to extensive forest cover by large trees, whereas east side forests have lower precipitation and more frequent wildfire, which leads to a mosaic of old and younger forest. We also created a single high elevation forest stratum that included the area above 910 m (3,000 ft) on the west side and 1,212 m (4,000ft) on the east side of the park. Different upper elevational limits on the east side vs. west side were necessary because the transition from montane to subalpine forest occurs at different elevations on the two

OLYMPIC NATIONAL PARK (ONP) is located in the northwest corner of the conterminous United States at the heart of the 13,800-km^2 Olympic Peninsula. The Park encompasses 3,530 km^2, most of which is a designated Wilderness Area. The interior of the park is only accessible by 611 miles of trail. The Peninsula is bounded on the west by the Pacific Ocean, on the north by the Strait of Juan de Fuca, and on the east by the Hood Canal, a fjord-like extension of Puget Sound. The Olympic Mountains rise sharply from the surrounding coastal plain and foothills. Mount Olympus is the highest peak at 2,430 m (7,965 ft); 37 other major peaks exceed 2,130 m (7,000 ft). About 266 glaciers cover 46 km^2 (18 mi^2), with the largest ones centered on the Mount Olympus massif. Eleven major rivers radiate from the mountainous core.

Climate The Olympic Mountains block the inland flow of moist air from the Pacific Ocean, producing heavy precipitation on the west side of the Peninsula and a striking rainshadow on the northeastern flanks. Mount Olympus receives more than 600 cm (**20 ft**) of precipitation annually while the community of Sequim, only 55 km (34 mi) distant, receives just 45 cm (**18 in.** Thus, the Olympic Peninsula contains one of the steepest precipitation gradients in the world, with the wettest location in the conterminous U.S. less than 55 km (34 mi) from the driest site on the west coast north of southern California. Eighty percent of the Peninsula's annual precipitation falls between October and March, with only five percent occurring in July and August. Winter precipitation falls mostly as rain below 300 m (984 ft) elevation, as rain and snow between 300-750 m (984-2,461 ft), and as snow at higher elevations. Average January temperatures are near 0º C (32º F). August maxima average about 21º C (70º F).

Vegetation Most of ONP below 1,524 m (5,000 ft) is covered with coniferous forests. Elevational boundaries between vegetation zones vary along the east-west precipitation gradient The low elevation *Tsuga heterophylla* (western hemlock) Zone, often dominated by enormous *Pseudotsuga menziesii* (Douglas-fir) with *Thuja plicata* (western redcedar) and *Tsuga heterophylla*, is the most common forest zone on the Peninsula. Lowland forests of the western Olympic Peninsula lie mainly within the *Picea sitchensis* (Sitka spruce) Zone and typically contain *Picea sitchensis*, *Tsuga heterophylla*, and *Thuja plicata.* The famous rain forests of west-side river valleys of Olympic National Park are distinguished by massive *Picea sitchensis* up to 90 m (295 ft) tall.

Montane forests of the western and southern portions of the Peninsula fall into the *Abies amabilis* (Pacific silver fir) Zone. These cool, relatively moist slopes contain *Abies amabilis* with *Tsuga heterophylla* near lower elevation limits and *Tsuga mertensiana* (mountain hemlock) near upper limits. Dry, south-facing montane forests in the northeastern Olympic Mountains support *Pseudotsuga menziesii* and have been classified either as a separate *Pseudotsuga menziesii* Zone. Most subalpine forests and tree clumps in the Olympics occur in the *Tsuga mertensiana* Zone. *Tsuga mertensiana* with

sides of the park. Greater survey effort was expended in the two low elevation strata to get higher precision where we expected most of the owl population to occur. We considered all forested land within the study area as potential habitat for spotted owls rather than trying to determine suitable habitat vs. non-habitat.

We eliminated two sections of the park (Pacific Coastal Strip, and the Queets River Corridor) because they contain very narrow fragments of forest and are unlike the interior section of the park. Additionally, earlier surveys indicated that there were few spotted owls in these areas. We concluded that eliminating these sites would have minimal effect on the population estimate and that a change in owl numbers there would have inconsequential effects on the population dynamics of the ONP spotted owl population (reference). The resulting study area (Fig. 2) was 3,060 km^2 (755,820 acres). A sampling design

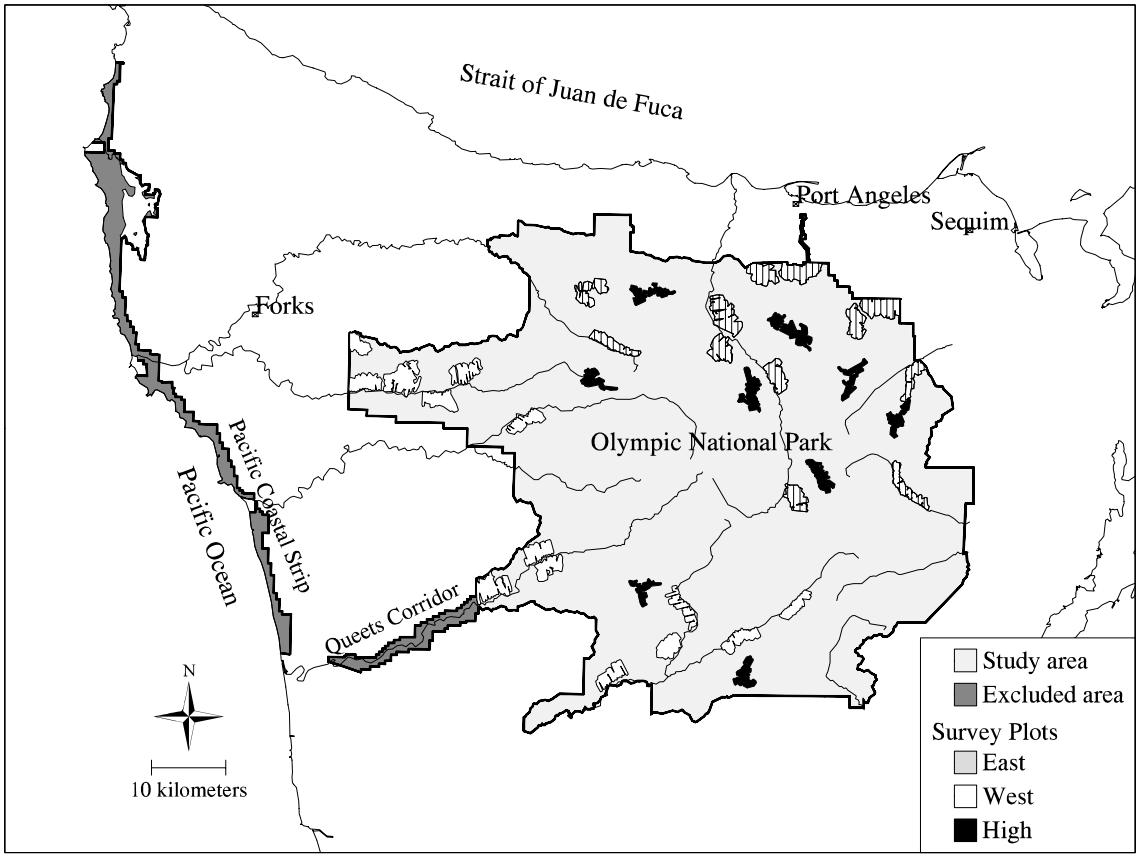

Figure 2. Spotted owl study area and survey plots in Olympic National Park, Washington.

was essential because of the limited road and trail access. We attempted to sample as much area as possible, given our level of funding, and a 4-year time frame for completing the population estimate. We were able to sample about 10% of the study area, which we suggest as a minimum target sample effort. Greater sampling effort will result in more precise estimates.

Plot selection.

Survey plots should be selected either randomly or systematically within the study area to avoid bias created by the researcher's subjective selection process. Our plots were selected at random in the 3 strata. Safety and logistics prevented us from fully implementing the random selection because some potential plots were too dangerous to sample. Plots were eliminated because they were too steep (e.g., cliffs), required dangerous river crossings, or were an unreasonable distance from a road (>18 km). We intentionally sampled more plots in the west- and east-side low elevation strata than in the high elevation stratum. This focused most survey effort in the areas with the highest expected owl densities, which helped us obtain the most precise estimate possible for the population.

> "Any estimate whose average value over all possible random samples is equal to the population parameter being estimated is called **unbiased**." (Snedecor and Cochran 1967:45)

> "**Accuracy** is the closeness of a measure or computed value to its true value; **precision** is the closeness of repeated measurements to the same quantity." (Sokal and Rolf 1981:13)

Plot size.

Plots need to be large enough to potentially include at least one study subject, an owl pair, on average. That is to say, they must be at least as large as the average home range of the species being studied. Plots that are too small will produce estimates with high variance and yield imprecise estimates of population size (Skalski and Robson, 1992)

We used plots averaging about 8.5 km^2 (2,100 acres) in size to sample abundance of spotted owls in Olympic

BIAS AND PLOT SIZE

Accurate density estimates depend on correctly identifying individuals as belonging inside or outside a plot. To sample a given amount of area, many small plots will have more edge than will few large plots, hence there will be more boundary decisions and more chances for error in identifying whether individuals should be counted as belonging inside the plots. The resulting bias will be high if the survey method causes individuals to be incorrectly designated as occurring inside the plot. Conversely, the estimate will be biased low if the survey causes individuals to be incorrectly designated as non-residents (for example, if birds move away from surveyors and out of the plot that they reside in).

Thus, for mobile species (such as birds), it is absolutely critical to define what it means to "belong in the plot". Because individuals can easily move across plot boundaries, their movements may bias the counts. Therefore, it is preferable to base density estimates on counts of some immovable entity. Consequently, in the ONP spotted owl study we used nests and habitual roost sites rather than sightings of individual owls to determine plot occupancy.

National Park. This was considered a minimum; we would have preferred to use larger plots, but were limited by difficult access and logistical considerations. Plots of this size could be surveyed completely by a team of 2 technicians in a 2 week "tour of duty", working 7 consecutive days in the field for approximately 11 hours per day.

Hypothetically, larger plots could reduce the plot-to-plot variance, but this might come at the expense of surveying more plots. The primary disadvantages of fewer, larger plots is that they will be distributed less broadly across the study area and there are fewer degrees of freedom for statistical analyses. The decision about whether to use fewer larger plots vs. more, smaller plots will depend on whether there is likely to be more variation in bird density on a fine scale or coarse scale. If more variation is expected on a fine scale, then fewer, large plots would be indicated; for coarse scale variation, use more small plots. The final decision may rest on a biologist's judgement, but is best determined after a pretest is conducted to determine appropriate plot size. This may seem rather costly, but it is well worth the effort to improve precision, and is highly beneficial if the plots become part of a monitoring program.

Distribution of Calling Stations (Sampling Points)

Calling stations within a sample plot must be spaced sufficiently close together that a person surveying from those points will be likely to elicit a response from an owl that is within the plot. In wilderness areas, it is frequently necessary to conduct daytime surveys because of the rugged and hazardous terrain. For example, calling stations for daytime surveys of spotted owls need to be no more than 400m apart. Calling stations on steep slopes, must account for actual slope distance rather than mapped distance (i.e., planar distance on topographic maps is always less than actual slope distance in the field). Nighttime spotted owl survey sampling points can be up to 800m apart because owls will respond from farther away at night (Eric Forsman, personal communication).

Calling stations should be marked on a map of the plot before going into the field. Sampling points should be located on the topography to maximize the coverage of sound projecting from the surveyor, and to maximize the ability of the surveyor to hear a response. Therefore, they should be located on high points rather than in gullies, and away from noise sources (like creeks) as much as possible. Also, they should be in areas of relatively open vegetation rather than in dense thickets. The objective is to obtain a complete survey of the sample plot.

FIELD SURVEY METHODS AT CALLING STATIONS, BANDING BIRDS

Detailed instructions and data forms for field technicians are included in several Appendices. Basic field methods for spotted owls are based on the work of Forsman (1983, 1995)

Timing of surveys

Territorial birds are most responsive to calling surveys during the active nesting season, therefore surveys should be done only during this period. Surveys outside the nesting season will have a high probability of failing to locate resident individuals. For spotted owls in Washington State, the highest response rates are generally between late March (when nesting is initiated) and late June (when fledglings develop competent flight).

Calling Animals

Calling surveys locate animals by eliciting a response to broadcast territorial calls. For consistency and reliability, it is important to standardize the broadcasting methods as much as possible. All surveyors should use consistent methods among all sampling points and through time. For spotted owls, it has proven simple and reliable to teach surveyors to imitate owl calls with their own voice. It is essential that the following be standardized among surveyors:

1. Length of the calling session at each sampling point.
2. Type of call used (some species produce a variety of territorial calls);
3. Calling frequency or interval
4. Direction the call is “aimed”.

For spotted owls, we have found the following standards work well. Calling sessions last 10 minutes at each sampling point. Only the 2 primary territorial calls (the 4-note location call, and the series hoot) are used. A call is emitted twice per minute for the first 7 minutes, then once per minute for the last 3 minutes (to increase the amount of time listening for a response). Successive calls are given with the surveyor (and the loudspeaker, if used) pointing towards each quadrant of a circle centered on the surveyor, thus broadcasting the calls in all directions around the point.

Active listening for responses is crucial. Surveyors should be tested for hearing impairment before beginning work, and individuals with poor hearing should only conduct field surveys if they have appropriate correction (hearing aids). Surveyors’ ears must be clear while listening at a sampling point, this includes removing hats or other head coverings and tying back long hair that restrict hearing, .

Field capture and data collection methods

To perform the mark-resighting analysis essential for population estimation it is necessary to capture and mark each owl detected so they can be recognized individually. A brief discussion of banding permit requirements is included under "Implementation". Detailed protocols for capture and banding are included in Appendices E and F and Data form and detailed instructions for completing them are included in Appendices G and H.

Once an owl is detected, approach the owl to get the best possible sighting of it. It is generally best not to hoot any more than necessary during a follow-up, because this tends to agitate the owls. Identify species, sex, and age. Use binoculars to observe the legs for bands. Bait the owl with a live mouse as needed to get it to move to a more visible location or reveal its leg bands. If it is unbanded, or you cannot determine whether it is banded, attempt to capture it and band it if necessary. A "Follow-up" data form and detailed instructions are included in Appendices I and J.

Temporal replicates

In estimating population density from sample plots, some measure of detectability is required. Detectability is the probability that an animal present on the sample plot is actually "discovered". We used mark-re-sight (mark re-capture) statistics computed from repeat call surveys conducted on the same sample plot (i.e., temporal replicates), to compute detectability. The number of visits depends on the size of the population being sampled and the individual capture probability (White et al, 1982; Skalski and Robson, 1992). For the Olympic National Park spotted owl study, we settled on 3 visits per year. This is a minimum number of visits for the mark-resight statistics, and it allowed us to survey more of the park than if we had made more visits per plot per year. The high capture probability for spotted owls (0.50) enabled us to use so few visits.

STATISTICAL ANALYSIS

We used two levels of statistical analysis to produce the population estimate. First, we used mark re-sighting statistics to estimate detectability (i.e., the percentage of the true population of resident paired owls we were able to count in the sample plots). Second, we extrapolated density estimates from the sample plots to each stratum, and then added these to estimate the population size for entire park study area (3060 km^2).

We detected only a single pair of owls in the high elevation stratum, therefore we eliminated it from the final analysis. The population estimate was performed with only the two

low elevation strata. It may not seem worthwhile to have included the high elevation stratum in the survey effort, because the expectation of finding owls there was low. However, it should be noted that inclusion of this stratum was the only way to test whether or not this assumption was true. It is critically important to include strata such as this to validate models. It is possible to reduce sampling intensity in such areas and still maintain statistical validity. We reiterate that it is essential that a statistician be consulted to discuss these design features before initiating the survey.

MARK-RESIGHTING

We used closed population models (which assume that no birth, death, immigration or emigration occurs during the sampling period) to estimate the per-visit capture probability ($\hat{p}$) for the paired spotted owls we surveyed (Nichols 1992). This capture probability represents the probability that we will detect (and identify) a resident paired owl on any given survey. We determined the capture history of each marked paired owl that was resident on a survey plot (carefully determining which owls "belong" in a plot) and used program CAPTURE (White et al. 1982) to calculate $\hat{p}$.

ESTIMATING POPULATION SIZE AND DENSITY

Point Estimates

We pooled captures from both low elevation strata because individual plots and strata had too few captures to provide precise estimates of $\hat{p}$. Capture histories of paired owls that were determined to reside within surveyed plots were input to program CAPTURE. We used model M_0 to estimate $\hat{p}$, the probability of detecting an owl in one visit. We calculated $\hat{p}^*$, the probability of detecting an owl at least once, as:

$$\hat{p}^* = 1 - (1 - \hat{p})^k \qquad \text{Eq. 1}$$

where k is the number of visits made to a plot in a year (k = 5 in 1992; k = 3 in 1993, 1994 and 1995). D^a_{hi} is the apparent density of paired owls on plot i in stratum h, calculated as the number of paired resident owls divided by the area of plot I (See Table 2). Given an estimate of apparent density on the ith plot in stratum h we can estimate the apparent population size for stratum h based on the ith plot alone, by multiplying the apparent density by the area of the stratum (A_h) so that:

$$\hat{N}_{hi}^{a} = A_h \times \hat{D}_{hi}^{a} \qquad \text{Eq. 2}$$

The best estimate of apparent population size is the stratum sample mean:

$$\hat{N}_{h}^{a} = \sum_{i=1}^{n_h} \hat{N}_{hi}^{a} / n_h \qquad \text{Eq. 3}$$

for *h=1,2*.

This result comes from application of theorems in (Cochran, 1977).

To obtain estimators of the true population sizes (Table 3) it is necessary to divide by the estimated detection probability so that

$$\hat{N}_h = \hat{N}_h^a / \hat{p}_h^* \qquad \text{Eq. 4}$$

for *h=1,2*.

and the overall population size estimator is the sum of the two stratum estimators.

$$\hat{N} = \sum_h \hat{N}_h \qquad \text{Eq. 5.}$$

This estimate is in terms of paired individuals; we divided by 2 to estimate the number of owl pairs.

Variances Of Estimators

Here we develop estimators for the variance of the estimated sighting or detection probability $(\hat{p})$ in one visit. These variances (Table 4) are not trivial to compute and are based on fitting closed capture-recapture models to the resighting histories of all the paired owls detected in all strata. We develop this method for Model M_0 which assumes the detection probability is constant over all the sampling periods and all animals.

Under Model M_o we estimated $Var(\hat{p})$ by use of bootstrap resampling on the "expected" capture histories. We ran CAPTURE on a data set to obtain $\hat{N}$ and $\hat{p}$. To estimate the vector of capture histories $\underline{\hat{X}}_w^*$ we used the "expected" value for each capture history. Some example estimates are

$$\hat{X}_{111} = \hat{N}\hat{p}^3$$

$$\hat{X}_{110} = \hat{N}\hat{p}^2(1-\hat{p})$$

$$\hat{X}_{100} = \hat{N}\hat{p}(1-\hat{p})^2$$

the numbers of animals from the given capture histories; all others can be calculated similarly. Now we can apply the bootstrap resampling method to this vector (Efron and Tibshirani, 1993). Applications of bootstrapping to closed capture-recapture models have been discussed by (Buckland and Garthwaite, 1991) and (Norris and Pollock, 1995). The method involves taking *random resamples with replacement* from this vector with the number of resamples being $\hat{N}$. For each resample, $\hat{p}$ was estimated using CAPTURE so that an empirical variance estimator like

$$V\hat{a}r(\hat{p}) = \sum_{j=1}^{n_s} (\hat{p}_j - \bar{p})^2 / (n_s - 1) \qquad \text{Eq. 6}$$

could be used to obtain $V\hat{a}r(\hat{p})$.

The advantage of this approach over using the "raw" capture histories is that some observed capture histories can be zero especially if the population of owls is small. Whereas the "expected" histories are never zero although they may be very small. Users will have to develop their own bootstrapping procedure and consult with a statistician.

Given an estimator for the variance of $\hat{p}$, the variance of $\hat{p}^*$ is

$$V\hat{a}r(\hat{p}^*) = V\hat{a}r(\hat{p})\left[k^2(1-\hat{p})^{2(k-1)}\right]. \qquad \text{Eq. 7}$$

Given estimates of $Var(\hat{p})$ and $Var(\hat{p}^*)$ we then estimated all variances of population sizes. These results can be viewed as extensions of those in (Skalski, 1994). The variance of the population size for each stratum (Table 4) is

$$V\hat{a}r(\hat{N}_h^a) = \frac{s_h^2}{n_h} + \frac{\hat{N}_h^a(1-\hat{p}_h^*)}{n_h} \qquad \text{Eq. 8}$$

where

$$s_h^2 = \sum_{i=1}^{n_h} (N_{hi}^a - \hat{N}_h^a)^2 / (n_h - 1) \qquad \text{Eq. 9}$$

and we ignore the finite population correction because of the small sampling fraction used. The estimator of the total apparent population size is

$$\hat{N}^a = \hat{N}_1^a + \hat{N}_2^a \qquad \text{Eq. 10}$$

and the variance for the total apparent population size is

$$V\hat{a}r(\hat{N}^a) = V\hat{a}r(\hat{N}_1^a) + V\hat{a}r(\hat{N}_2^a) \qquad \text{Eq. 11}$$

because the estimates for the 2 strata are independent. The estimator of the true population size of owl pairs is

$$\hat{N} = \hat{N}^{a} / \hat{p}^{*} \qquad \text{Eq. 12}$$

and

$$V\hat{a}r(\hat{N}) \approx \hat{N}^{2}\left[\frac{V\hat{a}r(\hat{N}^{a})}{(\hat{N}^{a})^{2}} + \frac{V\hat{a}r(\hat{p}^{*})}{(\hat{p}^{*})^{2}}\right] \qquad \textbf{Eq. 13}$$

again using the Taylor series method.

Confidence limits (Table 4) were calculated for the population size of each stratum as

$$90\% C.I._{h} = \hat{N}_{h} \pm 1.645 \times V\hat{a}r(\hat{N}_{h})^{0.5} \qquad \text{Eq. 14}$$

and for the total study area as

$$90\% C.I. = \hat{N} \pm 1.645 \times V\hat{a}r(\hat{N})^{0.5}. \qquad \text{Eq. 15}$$

DEMOGRAPHIC MONITORING

SELECTING TERRITORIES TO MONITOR.

To obtain an unbiased estimate of the demographic rates for a population, it is important to use appropriate methods for selecting the territories to monitor. The best option is to monitor all territories in the population, but this is rarely possible in large geographic areas like Olympic National Park. Consequently, the researcher will need to select some portion of the territories using the guidelines below:

1. If territory locations are not known, a survey must be conducted first. The monitoring task will greatly improved if the survey uses the random or systematic sampling methods described under “POPULATION ESTIMATION”.
2. If enough territory locations are known from unbiased sampling methods, then a representative sample has essentially already been selected. Consequently, monitoring this sample of territories will suffice.
3. If many territory locations are known by using unbiased sampling methods, but it is not feasible to monitor all known territories, then an additional selection process must be conducted. Either a random or a systematic process may be used to select

territories for monitoring. The selection process can be applied to the entire population of territories known from an unbiased sample of the study area, or those within strata designated by the researcher. As described above, strata should reflect knowledge of factors (biotic or abiotic) that are known or strongly suspected to influence the abundance, reproduction, or survival of the species of interest.

In the interest of efficiency, it may be preferable to select territories in other types of strata rather than to randomly select individual territories from the entire unbiased sample. For example, territories may be grouped by watersheds, or by the road or trail to be used for access. Once these strata have been created, then watersheds or access routes can be randomly selected. Unstratified random selection of territories will often result in some unselected territories occurring along the access route to a selected territory– this approach is particularly inefficient when access is difficult and slow. The disadvantage of selecting strata is that the resulting sample is not randomized in the style that statisticians prefer, hence statistically valid inferences cannot be made to a larger area. However, this approach may still provide more biologically meaningful results than individual randomization because it allows for a larger sample size due to the increased efficiency.

NOTE Unless a statistically representative sample is taken (after consultation with a statistician of course), results must be treated as an indicator of population trend. In other words, if demographic studies suggest a population change, research will be required to verify trends and perhaps to determine causation.

When establishing strata and clusters it is essential to avoid incorporating the researcher's biases in selecting territories. Particular pitfalls include selecting territories for the following reasons: the territories have recently had good reproductive success; the territories have recently been occupied by a pair; or the territories are easy to get to. Also, it is essential that unproductive and especially unoccupied sites be surveyed. Accurate and representative estimates of the demographic rates for the population will not be obtained unless an unbiased sample of territories is selected.

Once territories have been selected for monitoring, it is important to monitor the same territories every year. Statistical estimates of survival rates are based on the assumption that banded individuals are searched for every year. Such estimates are seriously set back by skipping a year of monitoring a selected site.

FIELD METHODS AT MONITORED TERRITORIES

The two primary data collection tasks for demographic monitoring are: 1) to mark individuals and re-sight them in subsequent years (for estimating survivorship rates); and 2) to determine *status*, that is, use behavioral observations to determine site occupancy and reproductive success (for estimating reproductive rates).

Field effort

Data requirements for demographic monitoring are specified in the guidelines for determining status (Appendix K). The number of site visits needed to satisfy these requirements will vary depending on the success of each visit, and the status at the site. Nonetheless, the basic need is for about 5 visits to each territory during the nesting season. With the difficulty of access in a large wilderness park, it is generally possible to visit only 1 territory per 10 hr. work day. But in areas where territories are particularly close together or close to trails or roads, it may be possible to visit 2 or 3 territories in a day. Thus, a crew of 2 technicians can visit about 8 territories in a 2 week "tour of duty", working 8 10 hr. days, 7 of these in the field and 1 in the office. With a field season that is 7 "tours" long, a single crew can make about 56 site visits. At an average of 5 visits per territory per season, a single crew can monitor 11 territories.

Survival estimation

Survival estimates are based on open population mark-recapture models (Franklin et al, 1996; Nichols, 1992). These models differ from the closed population models used in the population size estimate (above), in that they allow for birth, death, emigration, and immigration. Therefore they can be used to analyze data collected over several years of monitoring. Although the data analysis is quite different for open and closed models, the field techniques are compatible, such that the same marked individuals can be used in both analyses.

Known territories are searched during the nesting season. Unmarked animals are captured and marked; previously marked animals are identified by their unique marks, usually without being recaptured. Techniques for capture and banding are described in detail in Appendices G and H.

Determining Status

Guidelines for determining territory status (occupancy, pairing, reproductive success) are included in the Appendix . These guidelines were adapted from a set developed by US Forest Service (USFS) researchers for demographic studies (Forsman 1983, 1995).

Known territories are searched during the nesting season (as for estimation of annual survival rate above). Previously marked animals are identified by their unique marks, usually without being recaptured. Unmarked animals are captured and marked.

Prey items (lab mice) are offered to owls, and the owls' behavior upon capturing a prey item is observed to provide data for determining the territory status. Owls will feed prey to a mate or young. These behaviors are recorded in the field notes on the Follow-Up Form (Appendix E).

Territory visits must be timed to include all phases of the nesting season, from pair formation through fledging of young. Obviously, a pair that is determined to be non-nesting would not need to be checked for fledglings.

PRESENCE/ABSENCE SURVEYS

DISTRIBUTION OF SAMPLING POINTS

Sampling points or calling stations need to be spaced sufficiently close together that a person surveying from those points will be likely to elicit a response from an owl that is within the survey area. In wilderness areas, it is frequently necessary to conduct daytime surveys because of the rugged and hazardous terrain. For example, sampling points for daytime surveys of spotted owls, need to be no more than 400m apart. Calling stations on steep slopes, must account for actual slope distance rather than mapped distance (i.e., planar distance on topographic maps is always less than actual slope distance in the field). Nighttime spotted owl survey sampling points can be up to 800m apart because owls will respond from farther away.

Sampling points should be marked on a map of the area before going into the field. Points should be located to maximize the coverage of sound projecting from the surveyor and the ability of the surveyor to hear a response. In practice, this means locating calling stations on high points rather than in gullies, and away from noise sources such as streams as much as possible. In addition, stations should be in areas of relatively open vegetation rather than in dense thickets if possible.

FIELD METHODS AT SAMPLING POINTS

Detailed instructions for field technicians are included in Appendix B. Methods are based on (Forsman 1983, 1995).

The purpose of these surveys is to locate animals by eliciting a response to broadcast territorial calls. It is critical that standardized broadcasting methods be used at every sampling

point so that consistent and reliable results can be obtained. For spotted owls, it has proven simple and reliable to teach surveyors to imitate owl calls with their own voice. However, it is imperative that the following be standardized:) length of the calling session at each sampling point; 2) which calls to use; 3) calling frequency,; and 4) how to direct the sound.

We have found that the following standards work well for spotted owls.

1. Calling sessions last 10 minutes at each sampling point.
2. Use only the 2 primary territorial calls (the 4-note location call, and the series hoot).
3. A call is emitted twice per minute for the first 7 minutes, then once per minute for the last 3 minutes (to increase the amount of time to listen for a response).
4. Successive calls are given with the surveyor (and the loudspeaker, if used) pointing towards each quadrant of a circle centered on the surveyor. This focuses the calls in all directions and most thoroughly covers the surrounding area.

Active listening for responses is crucial. Surveyors should be tested for hearing impairment before beginning work, and individuals with poor hearing should only conduct field surveys if they have appropriate correction (hearing aids). Surveyors' ears must be clear of obstructions while listening at a sampling point. This includes removing hats or other head coverings that restrict hearing and tying back hair that obstructs the ears.

Recording data

A copy of the data sheet, and instructions for filling it out, are included in Appendices C and D, respectively.

TEMPORAL REPLICATES

Requirements for replication are set by the USFWS (for ESA compliance). Presence of the species of interest is clearly demonstrated by a single observation, while determining that they are absent requires multiple visits with no response. Generally, for spotted owls, determining absence requires that all the sampling points be visited 6 times. This can be accomplished with 6 visits in a single year, or 3 visits in each of 2 consecutive years. Visits must occur during the active period of nesting and rearing young, generally from April through August.

IMPLEMENTATION AND LOGISTICS

This section covers logistical topics that are common to survey and monitor programs.

PERMITS REQUIRED TO CAPTURE AND BAND BIRDS

Banding.

The Bird Banding Lab (BBL; 12100 Beech Forest Rd., Laurel MD 20708-4037) of the USGS BRD regulates all banding. Olympic NP has a "master banding permit", which needs to be renewed annually. Master permits are only issued to experienced ornithological professionals; the application process takes a considerable length of time. However, it is sometimes possible to obtain a sub-permit from an agency or organization holding a master banding permit. This application process takes less time and is an option worth exploring. For example, spotted owl work in other Pacific Northwest national parks has been conducted using a sub-permit of the ONP master permit. Even for a sub-permit, the paperwork takes time, and should be initiated in the fall preceding the nesting season when banding is to begin.

USFWS "Take Permit".

To work with a species that is federally listed under 10(a) (1) (A) as Threatened or Endangered (T&E), researchers must have a permit for "Incidental Take". This covers any accidental harm or harassment that may occur to a study animal as a result of research activities; permits may be obtained for one or more years. The USFWS requires an annual activities report.

State Endangered species permit.

In addition to the USFWS take permit, states may require a permit for working with T&E species. In Washington these permits are administered through the Washington Department of Fish and Wildlife. This permit must be renewed every year.

HIRING AND PERSONNEL.

Technicians and Volunteers

We have found that we can strike a balance of obtaining high quality data and incurring reasonable cost by using a crew with mixed levels of training and experience. The most consistent high quality (and expensive) results are obtained from paid technicians who have a 4-year degree in biological science and who have proven experience working in rugged wilderness. Wilderness experience can be either professional or recreational. Slightly less expensive crew members include technicians who have strong wilderness experience and local knowledge, but without the biological training. Because our field area is quite physically demanding, we do not accept technicians unless they have proven wilderness or athletic experience. Still less expensive

are long-term volunteers (for example, from the Student Conservation Association) who may or may not have a biology degree, and who have less wilderness experience or local knowledge. Although many people are interested in volunteering for a day or a week, this is often inefficient because "work" time obtained from the volunteer is usually less than the time required to properly train them. Thus, short-term volunteers may actually detract from the project. However, we do occasionally accept a few short-term volunteers. We recommend a maximum of 1 volunteer on a crew with 3 paid technicians. And we prefer 2 of the 3 technicians to have biology degrees.

The hiring process in the National Park Service takes about 4 months from initiation to completion. Notify the personnel office as early as possible in the fiscal year (i.e. in Oct. or Nov.) to advertise the positions you want. Hopefully, the job announcement will be released around Christmas, and is open for 1-2 weeks. It usually requires a week for applications to be received and another week for paperwork to create a certificate of eligible applicants.

The eligible applications then must be assessed to determine which are *qualified* under Office of Personnel Management (OPM) rules. We generally supply a Natural Resources Management employee to determine which meet OPM requirements for the positions they applied. This takes 2-3 days for 100-120 applications. This person cannot be the same person who is selecting candidates.

Finally, the selecting official (whoever is supervising the field project) can look at the qualified applicants to select the individuals they want to hire. Allow another 2 weeks to go through the applications, conduct phone interviews with applicants, check references, and make offers. This needs to be done promptly because the best applicants get competing offers quickly.

EQUIPMENT

The basic equipment that we keep on hand is listed in Appendix L, details of owl banding equipment are listed in Appendix M. Take an inventory of equipment in the fall. Allow plenty of time during the winter to order equipment so that everything will be available when the field season starts.

All equipment should be engraved with an identifying number, and technicians should sign out each item when they take it out to the field and when they return it.

Equipment must be repaired and maintained regularly during the field season. Technicians should be trained in routine maintenance of equipment, and maintenance should be

scheduled duty when returning from the field. Any equipment that has malfunctioned in the field should be marked and set aside for maintenance, professional repair, or replacement as needed.

Maps

A project of this nature uses topographic maps and Global Positioning Systems (GPS) extensively. For general navigation in the backcountry, maps of the scale 1:62,500 (USGS 15' quadrangle) work well. These maps should be coated with waterproofing material, and can be used for two field seasons. A GPS unit and more detailed maps (1:24,000 $7^1/_2$') are needed for searching territories and recording locations of responses. For "site maps", we recommend photocopying the appropriate area from a USGS $7^1/_2$' quadrangle map onto $8^1/_2$ x 11" waterproof paper. Although the black and white photocopy is harder to read than a colored original map, it is much less expensive, and full-sized quadrangle maps are too large to carry several copies in the field for each site to be visited.

Vehicles

The number of vehicles necessary for transportation to the field will depend on the layout of the study area. In some cases, each team of technicians will need their own vehicle, in some cases multiple teams can use a single vehicle. Advance planning is necessary to secure sufficient vehicles in time for the start of the field season. Pickup trucks without canopies are generally unpopular because backpacks and other gear carried in back is subject to getting soaked with rain; enclosed vehicles with space for carrying equipment are preferable.

TRAINING

Preparation for Training

A month before the crew arrives (i.e. mid February) the project supervisor and field supervisors need to allocate training topics among themselves, and contact others who will make presentations. Presenters need to review and familiarize themselves with their topics. Handouts of training materials need to be photocopied for crew members.

Schedule, topics

An example training schedule and topic list is included in Appendix Q. Two weeks of training that includes field days is generally necessary for inexperienced crew members. For experienced technicians this is not necessary, but they can help train the new technicians. And because useful data can be collected during the field training days, very little is lost by including

experienced technicians in the training. Additionally, we have found that experienced technicians are able to understand more of the training material and improve the depth of their comprehension of the project and the data collection process when they participate in these additional training sessions.

The major thrust of the training is focused on the protocols for owl fieldwork and data collection (Appendix B-J). We have found that a field trip to visit an owl territory before discussing field protocols makes the discussion more meaningful and memorable for new trainees.

Safety of the owls is of paramount concern, particularly because they are a threatened species. We stress this fact during training, and caution technicians never to allow the drive for data collection to propel them into capturing an owl in unsafe circumstances. We contract a local veterinarian to make a presentation on care and handling of potential owl injuries associated with capture. We have been fortunate in never had an owl injured on this project.

Another significant component of training includes protocols for activities that take place in the office. This includes responsibilities for field equipment (Appendix S) such as sign-out procedures for tracking who has taken which items with them (Appendix T, U). Equipment that is used intensively needs routine maintenance and care, so these processes are incorporated into standard procedures (Appendix V). Without this accountability, equipment quickly becomes misplaced or unserviceable, and is unavailable for use when needed.

A variety of training topics are related to the wilderness nature of the work, and some are park-specific. These include backcountry skills such as minimum impact camping techniques, off-trail navigation (use of map, compass, and altimeter) (Appendix W), personal safety (Appendix X), basic first aid measures, use of the Olympic NP radio communications system , and emergency procedures.

FIELD SEASON

Work schedule.

We have found it most productive to work long days and long “field tours” because of the difficulty of access to owl territories. Since the study area is large and inaccessible, much time is used driving to trailheads and hiking to sites. Working 8 hours a day, or 5 days a week leaves little productive time at the owl territory. Therefore, we have chosen to run 2 work weeks together into a single “tour” of 8 days in a row, working an average of 10 hours a day. A conventional work schedule may be adequate for study areas with easy access.

Dealing with weather

The most significant impediment to field work is deep snow after a heavy winter. In addition to the physical exhaustion of walking through deep snow, it creates extreme hazard on the steep slopes and fallen logs that technicians traverse to survey territories. As a general practice, territories are only monitored after they become predominantly snow-free.

For demographic monitoring or population estimation, rain rarely prevents fieldwork. Although rain appears to reduce the chance of owls responding to surveys or taking mice, and to reduce technicians' ability to hear responses, mark-recapture statistics adjust for the reduced capture probability and the resulting population estimates will be accurate (unbiased). This contrasts with surveys that seek to determine presence/absence for compliance purposes (for example, prior to a timber sale). For such surveys it is imperative that surveys detect any birds that are present so that they can be protected.

DATA MANAGEMENT, QUALITY CONTROL

We have found it valuable to use a diversity of systems for managing and organizing the data. These systems range from very low technology (paper and pencil) to a sophisticated computer relational database and Geographical Information System (GIS) mapping. Since spotted owls use well-defined territories that remain fairly constant over many years , we have given each territory a unique name and organized our data management around the territories (See Text Box).

Master Files

We maintain a "master file" for each territory. The master file consists of a compartmentalized file folder with copies of all information pertaining to that territory for all years that it was monitored. This includes: field data sheets for every visit (with maps of areas searched and locations of responses); data sheets for every owl capture; maps showing the "site center" for all years; maps showing all response locations for all years; computer generated report summarizing all visits for a given year; computer generated report summarizing territory status for each year it was monitored. Master files are kept in a file cabinet, and they do not leave the office.

DATABASE STRUCTURE

The Olympic National Park owl data are stored in an electronic relational database (Microsoft Access©). This database contains too many objects (tables, queries, forms, macros) to describe in detail here. We will restrict ourselves to describing the most basic and essential data tables.

Primary Tables contain the permanent records of essential field data collected on the project.

SITENAME. This table contains all of the official owl site names within (and near) Olympic NP. It contains one record per territory (site), with information that is basic and largely unchanging over time. This table also serves as a "lookup" table for site names in other tables, and the SiteName field functions to link many of the data in other tables.

STATUS. Consists of site summary information, including site center location and pair, nesting and reproductive status. There is one record per year for each territory.

OWLBAND. Contains the data from owl Capture/Banding Forms. There is one record per capture for every bird.

FUFALL. Contains information about individual visits to owl territories. There is one record per bird observed for each visit, and additionally there is a record for each visit where no owls were observed.

SURVALL. Contains information about responses at individual calling stations during the population estimation (or presence/absence) surveys. There is one record for each visit to each calling station.

Secondary Tables contain: 1) temporary records that are incorporated as permanent records in the "primary tables" after being carefully checked for errors; 2) information for "lookup tables" to assist in data entry.

Band Colors. Contains a list of all the color patterns of marker bands that we use on owls. There is one record per color pattern.

Current Year FUFs. Same as FUFALL (above), but only contains temporary records for the current year. At the end of the field season, these records are incorporated in FUFALL.

Temp FUFs. Same as Current Year Fufs (above), but only contains temporary records for the most recent field tour(s). After being checked for errors, these records are incorporated in Current Year FUFs.

Watershed. A lookup table for the watersheds (and their abbreviations) of Olympic NP.

Other Tables contain: 1) banding records from other parks that are sub-permitted under the Olympic NP master banding permit; 2) banding records from the adjoining USFS study; 3) data selected from "primary tables" for special purpose study.

Working Files

We also keep working files for each territory; these are taken into the field. They contain copies of several elements from the master files: the "site center" map for all years; the computer generated report summarizing territory status. Working files also contain territory maps for the current year, which are marked with response locations and search routes as the season progresses. Additionally, they contain blank data forms, clean maps (without response locations marked), and a "banding scheme" for the territory. Banding schemes are computer generated reports that show: 1) the band colors of all owls banded within a 16 km (10 mi.) radius of the

territory center, and 2) the band colors available for use at the territory (colors that have not been used within a 16 km radius).

Wall Charts

At the beginning of each field season we use large sheets of newsprint to make a chart for tracking the progress of monitoring at each territory. There is a row for each territory (with the names listed alphabetically), a column for each field visit, and a column for each element of the territory status (pair occupancy, nesting, reproduction). Immediately upon returning from the field, technicians pencil in the results of their visits, listing the date of the visit, what owls were observed, and whether or not they took mice. Wall charts show the big picture of the entire population of monitored sites at a glance, and are quickly updated without the time lag of data error-checking.

3-ring binders

Field data (Follow-Up Forms) are filed in 3-ring notebooks after they have been entered in the computer database. Filing is alphabetical by territory name, and chronological within each territory. This keeps the original data for each year together and accessible. At the end of the field season, 2 copies of these forms are made, 1 is sent to the Washington State Department of Fisheries and Wildlife for their spotted owl database, and the other is filed in the master file for each territory.

Capture forms are filed in a separate 3-ring notebook that includes all captures in all territories for all years. Copies are filed in the master file for each territory.

Field Forms

The last day of each “tour of duty” (a 2 week pay period) is devoted to office chores, including submitting field data forms, checking for errors, and inputting data into a computer database.

Technicians submit their field data forms, and supervisors check them for completeness, for internal consistency, and for any obvious errors or confusing information. A checklist of items for supervisors is included as Appendix R. After supervisors have checked the data forms and technicians have made corrections and clarifications, the forms are ready for input into the computer. Technicians perform the data entry, and are reminded to check for errors while doing so. Any forms with errors or questions are referred back to the technicians who collected the data for immediate correction or clarification.

Computer Data Entry

We use a relational database (Microsoft Access) for managing our data. The database has evolved in complexity over time, and an electronic version is available from Olympic National Park staff. Separate tables exist for: surveys, follow-ups, captures, annual territory status, territory names. In addition, there are temporary tables for follow-up data, so that routine input and error checking is done with only the most recently collected data. After it has been thoroughly checked, recent data are then appended to the overall table for follow-up data.

Data entry screens ("forms") have been designed to simplify data entry by mimicking our field data collection forms. These data entry screens also incorporate some simple error trapping by preventing entry of impossible values and selecting input for some fields from a list of possible entries. For example, since the data management is designed around named territories, it is crucial that territory names be entered consistently and without error. Hence, all entry of territory names is limited to values in the table of territory names.

After technicians have entered data in a data table for temporary storage, a supervisor checks for duplicate entries, missing entries, and typographical errors. Additional viewing screens in the database facilitate this process. Next, the supervisor appends the contents of the temporary data table to the current year's data, and clears out the contents of the temporary table. At the end of the field season, a supervisor appends the current year's data to a table that contains all years' data.

ASSESSING SITE STATUS.

At the end of the field season, the project supervisors go through the data from all the territory visits for the year, and make a final assessment of status, following the guidelines in Appendix K. Although status at some territories may have been determined earlier during the field season, many sites cannot be assessed until the last visit is concluded. These status assessments are then entered in the appropriate database table.

PROGRESS REPORT

Each year a progress report is compiled to describe the current year's results, and summarizes previous years' data. This report is distributed to: offices that contribute to funding the project; other agencies that are interested in spotted owl populations; the USFWS office that issues our "Take Permit"; other interested parties; division chiefs within Olympic NP; and former technicians on the owl project.

Outline of headings

A sample progress report is included as Appendix N. The section headings that have been used are: List of Figures; Acknowledgments; Executive Summary; Introduction; Objectives, Monitoring; Subject Reports; Reproductive Success, Habitat Selection, Banding, Other Species; Cooperative Efforts; Budget; Recommendations for Future Research; Literature Cited.

Summary data

Most of the numbers in the progress report come from the "Status" table of the owl database. This contains the occupancy, pair status, nesting status, and reproductive success for each territory in each year it was monitored. The status table is exported from the Microsoft Access database into a dbase file, because it is easy to import a dbase file into the statistical package SAS®[1] (SAS Institute Inc. 1990) for analyzing the data. SAS® programs (Appendix O) summarize the data and specify conditions for which records to keep and delete. The programs contain comments describing what data they require and what output they produce. Each year's data are exported and saved in the progress report subdirectory (folder) for that year (e.g. H:\Owlcrew\Prog_Rep\98\…). The database contains records for other species besides spotted owls (barred owls (*Strix varia*), great horned owls (*Bubo virginianus*), goshawks), records for years before field methods were standardized in 1992, and for territories inside the park that were monitored by other agencies (USFS PNW, and WDNR). Some of these records are eliminated from certain analyses or reports.

SUMMARY AND ANALYSIS GOALS

Inventory

For presence/absence surveys, summary and reporting needs are fairly simple. Reports should include a map of the area surveyed showing the locations of calling stations. Data should include the time of the survey, the number of visits, and the number and locations of responses.

Population estimation inventories have much more extensive analysis and reporting needs. The statistical analysis described above and implemented in the SAS® program (Appendix P) will produce density and population estimates and confidence intervals. Along with these numerical results, it is important to include maps and numerical measures of the

[1] Note: Any use of brand names does not imply endorsement by the USGS

survey areas. GIS support is valuable for producing such reports, but conventional maps can be used as well.

Monitoring

On an annual basis, the main demographic parameter that can be estimated is average fecundity. Although data collection is designed to estimate survival rates (by age class), several years of monitoring are required before these rates can be estimated. Estimates are made by using Program MARK (Gary White, Colorado State University, Fort Collins, Colorado) and the Jolly-Seber model for open populations. For northern spotted owls, this process is conducted every few years in a joint analysis for all the demographic study areas (Forsman et al, 1996).

Band reporting

At the end of each field season, a report of newly banded birds needs to be sent to the Bird Banding Lab (BBL). Software provided by the BBL generates a report in the format required for reporting through the BBL's program.

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Table 1. Area (km^2) of survey strata and plots in Olympic National Park.

Stratum	Stratum area[1]	Area surveyed[1]	Percent surveyed	Number of plots	Mean plot area[1]
East	977.41	105.97	10.8	12	8.83
West	960.16	131.86	13.7	15	8.79
High	1122.83	56.17	5.0	8	7.02
Total	3060.39	293.99	9.6	35	8.40

[1] Area in km^2.

Table 2. Densities and population estimates for each stratum, based upon individual plots. Calculations follow equation 2. ($\hat{N}^{a}_{hi} = A_h \times \hat{D}^{a}_{hi}$ where $D^{a}_{hi} = (\frac{PairedOwls}{PlotArea}) \times StratumArea$)

Stratum	Stratum area[1]	Plot name	Plot area[1]	Paired owls	Apparent density[2]	Apparent number
E	977.41	BURDICK	8.28	2	0.24	236
E	977.41	GODKIN	5.91	2	0.34	331
E	977.41	HAYES	4.61	4	0.87	848
E	977.41	HEART	10.32	0	0.00	0
E	977.41	LITTLE	9.17	0	0.00	0
E	977.41	LONG	8.77	2	0.23	223
E	977.41	MAIDEN	8.39	2	0.24	233
E	977.41	MARYS	8.45	4	0.47	462
E	977.41	NFSOLE	8.80	2	0.23	222
E	977.41	SIEBERT	12.11	0	0.00	0
E	977.41	SOLEDUC	7.14	2	0.28	274
E	977.41	WHISK	14.03	4	0.29	279
H	1122.83	DODGER	8.16	0	0.00	0
H	1122.83	GRAND	6.01	0	0.00	0
H	1122.83	HAPPY	7.21	0	0.00	0
H	1122.83	HOHLAKE	5.53	0	0.00	0
H	1122.83	NEEDLES	6.32	0	0.00	0
H	1122.83	STEEP	10.95	0	0.00	0
H	1122.83	TSHLET	5.49	0	0.00	0
H	1122.83	WYNOO	6.52	0	0.00	0
W	960.16	BOGA	15.60	4	0.26	246
W	960.16	FINLEY	8.35	0	0.00	0
W	960.16	GRAVES	8.33	2	0.24	231
W	960.16	HARLOW	8.73	0	0.00	0
W	960.16	IRELY	8.13	0	0.00	0
W	960.16	JACKSON	8.42	2	0.24	228
W	960.16	KLOO	12.06	2	0.17	159
W	960.16	MOSQUIT	8.98	0	0.00	0
W	960.16	ONEIL	6.17	2	0.32	311
W	960.16	QUEETS	8.34	2	0.24	230
W	960.16	SFCALAW	5.74	0	0.00	0
W	960.16	THREE	6.76	2	0.30	284
W	960.16	TUMWATA	9.10	2	0.22	211
W	960.16	UPBOG	8.82	0	0.00	0
W	960.16	WILDROSE	8.34	2	0.24	230

[1] km^2
[2] Paired owls km^{-2}

Table 3. Averaged apparent and true population size estimates by stratum, and summed for the total study area. Calculations follow equations 3, 4, and 5.

Stratum	Apparent population density[1]	Apparent population size[2]	Overall detection probability[3]	True population density[4]	True population size[5]
E	0.265	259	0.89	0.297	290
H	0	0	0.52	0	0
W	0.148	142	0.89	0.166	159
Total	n/a	401	n/a	n/a	449

[1] $\hat{D}_h^a$ apparent density of paired owls km^{-2} in stratum *h*.

[2] $\hat{N}_h^a$ (from eq. 3: $\hat{N}_h^a = \sum_{i=1}^{n_h} \hat{N}_{hi}^a / n_h$)

[3] $\hat{p}^*$ (from eq. 1)

[4] $\hat{D}$ true density of paired owls km^{-2} in stratum *h*. $\hat{D} = \hat{D}_h^a / \hat{p}_h^*$

[5] $\hat{N}_h$ (from eq. 4: $\hat{N}_h = \hat{N}_h^a / \hat{p}_h^*$)

Table 4. Variance estimates for strata and entire park. Calculations follow equations 11, 12, and 13.

Stratum	Plots' sample variance[1]	Number of plots	Apparent population variance[2]	True population variance[3]	True population Std. Dev.[4]	True population 90% C.I.[5]
E	54468.63	12	4541.38	5799.95	76.2	125
H	0.00	8	0.00	n/a	0	0
W	15475.72	15	1032.74	1325.73	36.4	60
Total	n/a	35	5574.12	7125.68	84.4	138

[1] s_h^2 (from eq. 10:

[2] $V\hat{a}r(\hat{N}_h^a)$, defined in eq. 11, and $V\hat{a}r(\hat{N}^a)$ defined in eq. 14.

[3] $V\hat{a}r(\hat{N})$ defined in eq. 16.

[4] $V\hat{a}r(\hat{N})^{0.5}$

[5] $V\hat{a}r(\hat{N})^{0.5} \times 1.645$

APPENDICES

APPENDIX A. HIRING TECHNICIANS, APPLICANT RATING GUIDE

NAME: Fill in the applicant's name.

LEVEL, RATING, INITIALS, COMMENTS: Fill in the level for which you are ranking the applicant , fill in your summary rating AFTER checking references and getting any additional information necessary by talking to the applicant. If unable to get sufficient information (cannot contact references or the applicant), make summary rating anyway, and indicate what critical information is lacking. Put your initials, and any comments you have that will help identify the person and their appropriateness for the job.

EXPERIENCE: Use the comment section to summarize the experience in a few words. Use the following guides for the numerical ratings. Do not overemphasize the numerical scores, concentrate on the comments.

a. Spotted owls. 1= a few volunteer surveys; 2= worked surveying for one season; 3= worked several seasons surveying, or one season with capture and banding.

b. Wildlife field work. 1= a little bit of volunteer work; 2= worked one season collecting data and observing; 3= worked several seasons collecting data, or one season with capture and handling.

c. Other outdoor jobs. 1= some volunteer work, or a small percentage of a job is outdoors; 2= job required extensive time in easy environment (flat, open country, benign climate); 3= jobs required extensive time in difficult environment (steep, densely vegetated country, harsh climate).

d. Backpacking. 1= a few recreational trips; 2= extensive recreational trips, or a seasonal job that required frequent overnight backpacking; 3= teaching outdoors skills, several seasons of jobs that require extensive backcountry work, major recreational expeditions (Alaska, Himalaya, solo Mt. Rainier, climbed the mountains on Mars, etc.).

e. Offtrail. 1= a course in orienteering; 2= some recreational off trail trips; 3= taught off trail skills, or worked at jobs requiring extensive off trail travel.

f. Supervisory. 1= supervised a few volunteers for short durations; 2= supervised a work crew for a single season, or a few T.A.s for a lab course; 3= multiple seasons of supervising work crews.

g. Computer. 1= limited data entry or use of packaged programs (word processing, spreadsheets, etc.), perhaps restricted to 1 computer type (e.g. Mac, IBM, mainframe); 2= extensive work entering data on multiple data bases, use of many different packages, many different types of computers, some limited programming; 3= extensive programming.

EDUCATION: Fill in the highest level at which work was done (even if the degree is not completed), and the major fields of study. Fill in the grade point average (to the nearest whole number, e.g. 3, not 3.25).

PHYSICAL CONDITION: Much of this will have to be filled out from talking to the applicant, people rarely put this kind of information on their SF-171. If they give enough info on the 171 to make you confident of their strength in the backcountry, don't bother filling these other categories in. Use them only if their strength is not obvious from their backcountry experience.

h. Regular exercise. 1= once a week, flat country; 2= several times per week, hilly country; 3= competitive athlete.

i. Strenuous jobs. 1= job required strength (heavy lifting, etc.) for short periods of time; 2= job required strength for sustained periods of time; 3= job required aerobic endurance (sustained hiking, swimming, paddling, biking etc.).

j. Athletic experience. 1= was on a high school team, not currently active; 2= was on college team; 3= currently competitively active.

k. Hearing. Explain that the work requires normal hearing to be certain of locating owls that respond to survey. We will give hearing tests to everyone when they begin work. There are several things that commonly cause some loss of hearing, have they been exposed to any of them? They are: childhood earaches or ear infections; frequent exposure to loud noise (e.g. shooting firearms, operating equipment such as a chainsaw, jackhammer, listening to very loud music). Do they have any other indications that their hearing is in any way impaired?

l. Color vision. Explain that the work requires identification of color bands, and ask if they have any color blindness.

m. Smoking. It's hard to imagine this being a problem, particularly if they have good physical fitness. But explain that the job requires good aerobic fitness, and that it would be very hard for a smoker to perform the duties. Ask them how they would rate their health and aerobic fitness. Don’t ask them whether they smoke.

REFERENCES: As you go through the application, copy into this space the names and numbers of the people who seem like they would be the best references to check. Try to include at least one recent (in the past 3 years) work supervisor. If someone looks like an important reference, but the applicant has said not to contact them, ask the applicant why they don't want you to contact that person. Try to check with at least 3 references for any applicant who is a possible consideration. Check even with those whose application looks only marginal. Some people don't look good on paper, but are actually outstanding workers.

APPENDIX B. FIELD SURVEY PROTOCOL INSTRUCTIONS.

SURVEY PLOT PROTOCOLS

What are survey plots:

Survey plots are the areas within which we will be conducting surveys to find spotted owls.

How we will survey the plots:

We will set up transect lines throughout survey plots. Calling stations will be established along these transects. The goal is to have a network of calling stations, spaced 400 meters (horizontal distance) apart, that covers the entire survey plot. Each time we visit a survey plot we will walk the transects in a sequential order, and use a standardized calling protocol at stations in an attempt to elicit responses from owls.

Why we have standardized protocols:

To use our data in estimating the densities of territorial spotted owls, we must ensure that all owls within survey plots have an equal exposure to capture. The standardized survey protocols are an attempt to ensure that equal search effort is expended on all survey plots during all visits.

How to set up survey plots:

The first field tour will be used to set up survey plots (flag transect lines; establish calling stations; locate good base camps; take notes on navigation routes, map transect lines and location of calling stations).

ABSOLUTELY **NO** HOOTING ON THIS SET UP TOUR!!!! If you get an unsolicited response, you should fill out a follow-up form, but put minimal effort in finding these birds. You will not have mice or banding kits anyway.

You will be making extensive use of maps, compass, altimeter, and pacing to set up transects and stations. You should be comfortable using all of these skills before heading into the field. Set your altimeter at the start of each day at a known elevation. Check it at other known elevations during the course of the day.

Altimeter readings may vary during subsequent visits to the stations. **Do not** reposition stations on subsequent tours! Leave them where they were originally installed. If subsequent elevation readings at stations are different, make note of it.

Topographic maps with transects and stations laid out will be supplied to each crew. The transect lines connecting stations are the best "office" guess as to good travel routes between stations. These may be modified based upon actual field conditions, but the general layout should be followed. We have tried, as much as possible, to layout transects along ridgelines for both ease of travel and better sound projection. However, ridgelines may not present and navigation becomes trickier.

Stations will be located on the ground as closely as possible to their indicated map location. Any field adjustments should be relatively minor, such as moving up 15 feet in elevation to put station at a better calling spot.

Set up transects in a sequential order to ensure that a contiguous block of transects is ready at the end of this set-up tour. We do **not** want to have some transects completed on one side of the survey plot, some on the other, and a gap in the middle. You will be briefed on priority starting points (if not, ask!). We also want to be able to set up the entire survey plot in one tour. There may be more stations laid out on paper than can feasibly be set up (and subsequently surveyed) during

one field tour. In that case, set up as many as you can in a sequential and contiguous block, beginning at the priority start point.

It is important that we use a standardized method of flagging to mark transects and navigation routes:

Navigation routes: These are routes that may be flagged to lead you to the start of transects. They should be marked with single strands of flagging. Transects are marked the same way, so be sure to indicate on map and in notes where navigation routes have been put in.

Transect routes: The beginning and end of a transect route is marked with three bands of flagging around a tree. The transect number and station number is marked on each band of ribbon. Choose a tree at least 12" dbh and clearly visible from afar in all directions.

Routes between call stations on a transect line are marked with a flag line of single ribbons, which may hang from branches or be tied around tree boles. Navigation routes are marked similarly, so be sure to carefully indicate in your notes, and on the map, the locations of all these routes.

If the transect route includes a non-obvious change in direction (ex: right angle turn, or a spot where a ridge line divides and the route either sharply changes direction or splits into two routes), then mark this route change with two bands of flagging, each with a written identification of transect # and direction of change. When surveying, read any writing on the flagging, check your map and be careful that you don't confuse these with stations.

Call Stations: We will be marking call stations by putting two bands of different colored ribbon around the tree selected as a station. Write the transect number and station number on each. Select trees at least 12" dbh, and clearly visible from afar in all directions, to use as station trees. Avoid placing call stations directly adjacent to huge trees, rocks or other obstructions as these will limit sound dispersal. When surveying, read any writing on the flagging, check your map, and be careful that you don't confuse these with change-of-route markings.

Permanent markers will be provided to mark flagging with transect numbers, elevation information, directions and compass headings, splits in the transect line or other relevant information.

Flagging Hints:

- IT IS IMPOSSIBLE TO USE TOO MUCH FLAGGING!!!! Unless, of course, you use so much of it that you run out before you finish setting up all the transects. TAKE LOTS AND USE LOTS WHEN SETTING UP TRANSECTS!! TAKE MORE THAN YOU THINK YOU COULD POSSIBLY USE, FOR YOU SHALL USE IT!!! Don't worry (too much) about littering the wilderness landscape . . . we have committed ourselves to going back and removing all flagging when our study is complete.
- Flagging around trees is most easily seen if it is not twisted.
- Mark the route so it can be followed in both directions. Look back to your last flag to see if it can be seen from your current flag and look forward to possible flagging locations.
- Use additional flagging in areas that are nondescript, have thick vegetation, or lack a logical route.
- Remember that flagging is lost to wind and curious hungry elk....so it’s always a good idea to mark a bit extra and don't freak out if you can't quickly find your next flag.
- Hang long pieces at eye level . . . don't use little scraps and don't put 'em down at ankle height . . . or 7' high (if setting up transects on snow, consider how high the flagging may be after the snow melts!)

It is important that you take good transect description notes in order that others may easily relocate and follow transect lines, and find calling stations.

Notes should include at a minimum:
- Description of station tree and stand/vegetation characteristics.
- Unusual route descriptions, e.g. detours around cliffs.

Surveying the Plots:

We will be visiting each low elevation survey plot three times. Ideally, we want to survey the entire survey plot every time we visit it. However, we may not be able to survey the entire area each time due to heavy rains or other unforeseeable events. We need three valid visits to each survey plot for it to be statistically useful. Thus, we want to make sure that any stations that do not get surveyed are the same ones each time. This means we will always start our surveys at the same point and work through the survey plot sequentially using the same order of transects and stations each time. If some areas (whole transects, or blocks of stations) are not visited three times, they will have to be eliminated from the analysis.

<u>Hooting protocols for survey plots:</u>

1) Follow the standardized route while hooting survey plots. Start at the first station of the first transect at one end of the survey plot, and survey in a sequential order. The order in which transects and stations are surveyed should remain consistent throughout all surveys of the survey plot.
2) Fill out the Owl Survey Form as you do the survey. Each Owl Survey Form contains data collected from stations on a single transect during the same day. Always start a new form when you start a new transect. If your survey of a transect is split between two days, you should use a separate form for each day.
3) Do not hoot as you approach or leave a station. Wait until both you and your partner have reached the station before you begin calling.
4) Calls should be made of consistent volume throughout the survey efforts, with the only exception being that the first two calls at a station be of softer volume.
5) Hoot 10 minutes at each station.
   A) Hoot once every 30 seconds for 7 minutes. The first two calls should be of softer volume. Alternate 3-note location calls, 4-note location calls, and series calls. Do not use any other calls for station calling. Use equal proportions of male and female pitch calls.
   B) Hoot once on the seventh, eighth, and ninth minute. Vary calls as before, and listen for the last minute of the ten minute period.
   C) The caller should work clockwise (or counter-clockwise, if you prefer . . . just turn the same way each time), hooting towards a new quadrant of the circle with each call.
6) If you have not heard an owl do not spend any additional time at a station as this may bias the sampling, even if (**particularly** if) you know there is an owl site close by.
7) If you get an owl response, you will pause the survey effort while you describe the responding bird. When you have finished the follow-up process you will continue with the survey effort. In order to have an equal chance of finding the mate of a responding owl, but to avoid unnecessary harassment when all owls have probably been found, follow these guidelines:
   A) If the responding owl was a **<u>single</u>** Spotted or "Sparred" (hybrid spotted/barred) owl, you will **not** skip the next station. You will continue to hoot all stations adjacent to the response.

B) If the responding owls were a **pair** of Spotted's or "Sparred's", you **will** skip the next full station.

C) If the responding owl was a Barred you **will** skip the next station, then resume calling at the next full station.

D) If you elicit a response from a known or potential predator of Spotted owls, you will stop calling **immediately** and **will** skip the next full station.

ANSWERS TO SOME POTENTIAL QUESTIONS:

Q: What if you're hooting a station, and get a response that leads you almost directly to another, unhooted station. Do you subsequently hoot that station again when you get to it?

A: NO, if you found a pair. But if you found a single owl, then YES, hoot the station to see if you get a response from its mate.

Q: What if an owl responds at a station, you do a follow-up, go to next station, call, get response from (probably) same bird in same area. Do you tromp back to where you just came from to get a visual and do new follow-up?

A: NO, if response is from same area and is same sex as the first response. You can assume it's same bird. But if is a different sex, then YES, return for a follow-up.

Q: What if weather is showery: you get rains that make you think no chance for rest of day, you go back to camp, it clears up with half the day still available, but where you left off is far away. However, there is a transect nearby camp that could be done?

A: First: Try to avoid this scenario, wait out the weather (no more than an hour) rather than return to camp if possible. Second: Yes, you can do a nearby transect. There is nothing magic about transects, or about completing one in a day. Transects simply link stations into a convenient pattern. What is important is to call all the stations, and to do it in as regular and consistent a manner as possible. This way, if any are missed, it should always be the same ones that are missed and we can throw that area out (rather than having a moth-eaten patchwork of missed stations).

Q: In filling out Follow-Up Forms for owls detected on survey plot surveys, is the survey method always filled out as "S" (Stations on a Survey)?

A: NO!! During survey plot surveys, it is very important that we differentiate between birds actually detected as a result of calling at stations from those we find by following detected birds. There may be different capture probabilities for the bird responding versus the birds that we were led to, and proper statistical analysis of the data is dependent upon making this distinction. For example, if we hoot at a station and a male flies in to us, then the survey method for that bird is "S" (Stations on a Survey). If we then mouse that bird and it leads us to a female or juveniles, then the survey method for those birds would be "I" (Intensive search). Similarly, if we hoot a station, get a male response in the distance, track that bird down and find other owls with it, then the survey method for the male would be "S", and for the others would be "I". The responding bird was found by doing our stations on a transect whereas the other birds were found as the result of an intensive search based on detecting the first bird.

Q: What if an owl is heard outside the defined survey area?

A: Follow-up on the bird as you would within a survey plot. (It will not be included in the survey results, but it may be valuable to monitor.)

APPENDIX C. FIELD SURVEY DATA SHEET.

OWL SURVEY FORM, Olympic National Park

Survey Area:_____ Drainage:_____ Date: _____/_____/_____
month day year

Survey #:____ Observers:_____ Transect #:_____

Sta. #	Start Time	Dur.	Elev.	Weather (P/W/C/T)	Noise	Call Meth	Comm ent	FUF #

Precipitation: **N**one; **L**ight Rain; **R**ain; **T**hunder; **H**ail; **S**nowing. Wind: **L**ow; **M**oderate; **H**igh. Noise: **L**ow; **M**edium; **H**igh.
Comments for Responses, 1st Letter: **S**potted; **B**arred; Unknown Stri**X**; **G**reat Horned; **P**ygmy; Saw **W**het; S**C**reech; **U**nknown; **H**ybrid (Sparred); **M**ultiple Species;
2nd Letter: **F**emale; **M**ale; **U**nknown sex; **P**air; **J**uvenile; Family **G**roup.
Comments for Stations Not Done: **NN** - Not attempted; **NW** - Weather/Noise; **NE** – Error; **NB** - Nearby Barred Owl; **NG** - Nearby Goshawk; **NH** - Nearby Great Horned Owl; **NO** - Not Done for Other Reasons; **NP** - Not done due to STOC pair

APPENDIX D. FIELD SURVEY DATA RECORDING INSTRUCTIONS.

The field survey data recording instructions below are available in a Word document: SurveyDataInstructions.Doc.

OWL SURVEY FORM

Guidelines for Filling Out the Form

The Owl Survey Form is used to collect data from transect surveys. Transects are laid out within census blocks, and calling stations are established along the transects. Surveyors work their way through the census block, utilizing a standardized calling protocol, in an attempt to elicit owl responses. The goal is to provide an "equal effort" search for owls throughout the entire census block. When owls are detected, every effort is made to locate them, capture unbanded birds and band them, and collect additional data (see instructions and protocol for Follow-Up and Banding forms).

Each Owl Survey Form contains data collected from stations on a single transect during the same day. Always start a new form when you start a new transect. If your survey of a transect is split between two days, you should use a separate form for each day.

These forms should be filled out in pencil. Any corrections made after the original data collection should be changed by making a line through the original data (so that it is still legible), writing the revised data next to it, and initialing the change.

Owl Survey Form Data Descriptions

Survey Area: The assigned name of the census block you are surveying.

Drainage: The standardized 4-letter code for the major drainage in which the survey area lies. A list of drainage codes is available in the office. If unsure of code while filling out form, put in the first four letters of the major drainage name.

Date: The date the transect was surveyed. Use "month/day/ year" format, and spell out the first three letters of the month. For example, June 8, 1993 would be written as "JUN/08/93".

Survey #: Fill in the survey trip number. Some census blocks will be surveyed three times, and others will only be surveyed once.

Observers: Fill in the three initials of all observers present.

Transect #: Enter the number of the transect being surveyed.

Station #: The number of the calling station at which you are hooting and collecting data. (If protocol states that halfway points between stations are also used for calling, then enter the full station numbers on either side of the "half-station". Example: If a calling point between stations 5 and 6 is utilized, it would be entered on the form as Station # "05/06")

Start Time: The time you begin calling from a station. Use military time (Example: 2:30PM would be written as "1430").

Duration: The length of time you call from a station. Protocol requires a duration of 10 minutes at each station (2 minutes at each half-station, if they are utilized). If an owl, or a potential owl predator, responds while you are calling, then enter the actual number of minutes you spent calling prior to the response. Round off all entries to the nearest whole minute.

Elevation: Write down the elevation, in feet, of the calling station.

Weather: Enter the codes for the weather conditions (precipitation, wind, cloud cover, temperature) at the time the station is called. Separate the codes with a slash (ex.: N/L/10/15). The codes are as follows:

Precipitation: The precipitation at the time the station was called. Codes are as follows:

N - None
L - Light Rain
R - Rain
T - Thunderstorm
H - Hail
S - Snowing

Wind: Wind conditions at the time the station was called. Codes are as follows:

L - Low (calm, or light winds)
M - Medium (moderate winds)
H - High (strong winds)

Cloud cover: Estimate the percentage of cloud cover at the time the station was called, to the nearest 10%.

Temperature: The ambient temperature, in degrees Celsius, at the time the station was called.

Noise: The average ambient noise level at the time the station was called. Codes are as follows:

L - Low: Noise levels that would not interfere with your ability to detect the vocalizations of a responding owl.
M - Medium: Noise levels that may somewhat interfere with your ability to detect the vocalizations of a responding owl.
H – High: Noise levels that would definitely interfere with your ability to detect the vocalizations of a responding owl.

Call method: The calling method used to attempt to elicit owl responses. Use the following codes:

V - Vocal
T - Tape
B - Both Vocal and Tape
F - Hoot Flute
N – None (used only for an unsolicited owl response)

Vocal will be by far the most common method . . . that's why we're called "owl hooters". You will probably never use a tape on this project.

Comment codes: Two letter code used to provide information about either the owls that responded at a station or half-station, or why a station was not done (skipped). If owls are detected, the first letter is a species code and the 2nd describes sex(es) of responding owls (exception: if their are a mixture of species detected, use the code "MS"):

1st Letter	2nd Letter
S - Spotted Owl	F - Female
B - Barred Owl	M - Male
X - *Strix*, unknown	U - Unknown
P - Pygmy Owl	P - Pair
W - Saw-Whet Owl	J - Juvenile
C - Screech Owl	G - Family Group
G - Great Horned Owl	
U - Unknown	

H - Hybrid Spotted/Barred
MS - Use this code for mixed species.

If the station or half-station is not done (skipped), use the following codes to explain why:

NN	Transect stations or half-stations not attempted
NW	Not done due to weather or noise
NE	Not done due to error (eg. station not found and not hooted, include in comments why)
NB	Not done due to nearby Barred Owl detection
NG	Not done due to nearby Goshawk detection
NH	Not done due to nearby Great Horned Owl detection
NO	Not done for other reasons
NP	Not done due to spotted owl pair

F.U.F. #: If there was a response at a station, then a Follow-Up Form should be filled out. Enter the Follow-Up Form number into this space. **It is vital that this be done, as this number is used to tie together transect survey data with associated response information.**

APPENDIX E. FIELD FOLLOW-UP FORM DATA SHEET.

OWL FOLLOW-UP FORM - Olympic National Park

F.U.F. #:_____
Assoc. #:_____

Site Name:_____ Date: _____/_____/_____
month day year

Species:_____ Response?: Y N
Observers:_____

Drainage:_____ Call Method:_____ Noise:_____

Precip: _____ Wind: ____ Cloud: ____% Temp: ____°C Light: _____

Start Time:_____ Finish Time:_____ Nesting Indicators:_____

Nest Located?: Y N Nest Tag #:_____

		Surv	Detection		Band Information				Mice			UTM		
Sex	**Age**	**Meth**	**Time**	**Type**	**Number**	**Leg**	**Color**	**Leg**	**Off**	**Tak**	**Elev**	**UTM-E**	**UTM-N**	**Acc**

Sex	**Calls Given (Circle)** Attachment	Radio Transmitter Serial # Mode	Frequency		
	L C AC S B N J WC GH				
	L C AC S B N J WC GH				
	L C AC S B N J WC GH				
	L C AC S B N J WC GH				
	L C AC S B N J WC GH				

Fate of mice:
_____
_____
_____
_____
_____
_____

OWL FOLLOW-UP FORM (Continuation)

Detailed Notes and Chronology of Events

F.U.F. #:_____ Site Name:_____

Date:_____/____/____ Observers:_____

Directions for relocating site:

Visit Synopsis**:**

DATA CHECKED: _____ DATA ENTERED: _____

Appendix F. Field follow-up form data recording instructions.

The field follow up form data recording instructions below are available in a Word document: FUFInstructions.Doc.

OWL FOLLOW-UP FORM

Guidelines for Filling Out the Form

A Follow-Up Form is filled out for each response from Spotted, Barred, "Sparred" (hybrid Spotted/Barred), Unknown Strix spp., or Great Horned owls. It is also used to record Goshawk responses. A separate form is used for each species (ex.: two forms would be filled out for responses by a Spotted Owl and by a Barred Owl at the same calling station).

Follow-Up Forms are also filled in when there is no response to a search for a known owl. In this situation, you would fill in all data, identify the marked owl you were trying to re-sight and note that you did not detect it, and note in the General Comments the area and elevation range covered during the search.

A location map must accompany each Follow-Up Form. You will use the map to show locations of owls, roost trees, nest trees, areas searched, etc. Make sure that you have enough copies of maps of the survey area with you to handle the maximum number of owl responses imaginable. These maps should be copied onto water-resistant paper from 7.5 minute USGS quads. They should have scale, contour interval, quad name, and UTM grid marks on them. Generally, these map copies will be provided to you, though on occasion you may have to make your own.

Forms should be filled out in pencil. Any corrections made after the original data collection should be changed by making a line through the original data (so that it is still legible), writing the new data next to it, and initialing it.

FOLLOW-UP FORM DATA DESCRIPTION

F.U.F. #: Follow-Up Form number. Every Follow-Up Form taken into the field should have a pre-assigned number written in the upper right corner. These numbers need to be unique for each form, and are assigned in the office. If you find yourself in the field with a form that doesn't have a FUF #, write "TEMP" plus a sequential digit into the space, and bring it to the attention of a supervisor upon return.

Assoc. #: Associated Follow-Up Form number. Used if two or more Follow-Up Forms need to be linked. For example, if two owl species respond at the same survey station, you would fill out two Follow-Up forms and write the FUF # of each in the Assoc. # space of the other. Could also be used in the highly unlikely event of having more than five owls of the same species for one Follow-Up form, and needing to use a second form to complete the data.

Site Name: Official site names are assigned in the office. If you are surveying an area where an official site name has already been assigned, make sure you use that name. If it is a new site, or if you are unsure as to whether it is a new site or not, **leave this space blank**. You may suggest a site name in your notes, based upon a local geographic feature. If you think it might be an existing site, write down your reasoning in your notes. In either case, take good notes, fill out map location accurately and bring it to the attention of supervisors upon return from the field.

Date: The date data were collected. Use "month/day/year" format, and spell out (or use 3 letter abbreviation) the month. For example, April 8, 1993 would be written as "APR/08/93".

Species: A four-letter code indicating the owl species for which data are being recorded. Code is made up of the first two letters of genus and species, ex. Barred owl (Strix varia) = STVA. There can be only one species per Follow-Up form. Species codes are as follows:

STOC - Spotted Owl
STVA - Barred Owl
STXX - "Sparred" Owl (Spotted/Barred hybrid)
STUN - Unknown Strix species
BUVI - Great Horned Owl
ACGE - Northern Goshawk

If there is no response during a search for a known owl, make sure you enter the species code of the bird you were looking for.

Response: Circle either Y (Yes) or N (No). If no response to a search for a known owl, you must still collect all data not strictly related to a found bird.

Observers: Fill in the 3 initials of all observers present.

Survey # and Survey Area: Leave these blank when doing follow-ups to monitor known sites. When doing a follow-up on an owl that responds to a survey, include the survey plot name, and which visit of the year you are on (1st, 2nd, 3rd, etc.).

Drainage: The standardized 4-letter code for the major drainage in which the response (or no-response search) occurred. A list is available in the office. If unsure of code while filling out form, put in the first four letters of the major drainage name.

Transect, Station and Half Station: Leave these blank when doing follow-ups to monitor known sites. When doing a follow-up on an owl that responds to a survey, fill in the transect number, and the station number that the owl responded at.

Call Method: The calling method used to attempt to elicit owl responses. Use the following codes:

V - Vocal
T - Tape
B - Both Vocal and Tape
N - None
F - Hoot flute

Vocal will be by far the most common method . . . that's why we're called "owl hooters". You will probably never use a tape on this project.

"N" (None) indicates an unsolicited owl response. For example, you awake in the middle of the night to the sound of a spotted owl hooting nearby. Or while hiking to your first transect of the day, and prior to doing any calling, you see or hear an owl.

Noise: The ambient noise level at the time your calling elicited a response. For "no response" during a search for a known owl, indicate the general ambient noise level during your search efforts. Codes are as follows:

L - Low: Noise levels that would not interfere with your ability to detect the vocalizations of a responding owl.

M - Medium: Noise levels that may somewhat interfere with your ability to detect the vocalizations of a responding owl.

H - High Noise levels that would definitely interfere with your ability to detect the vocalizations of a responding owl.

Precipitation: A description of the precipitation at the time your calling elicited a response. For "no response" during a search for known owls, indicate the general level of precipitation during your search efforts. Codes are as follows:

N - None
L - Light Rain
R - Rain
T - Thunderstorm
H - Hail
S - Snowing

Wind: A description of wind conditions at the time your calling elicited a response. For "no response" during a search for known owls, indicate the general wind condition during your search efforts. Codes are as follows:

L - Low (calm, or very light winds)
M - Medium (light to moderate winds)
H - High (strong winds)

Cloud: Estimate the percentage of cloud cover at the time your calling elicited a response. Estimate to the nearest 10%. For "no response" during a search for known owls, indicate the average cloud cover percentage during your search efforts.

Temperature: The ambient temperature, in degrees Celsius, at the time your calling elicited a response. For "no response" during a search for known owls, record the average temperature during your search efforts.

Light: The light conditions at the time of response, or during a search for known owls that resulted in "no response". Codes are as follows:

D - Daylight
N - Nighttime
T - Twilight

Follow-up effort

Start Time: The time at which the follow up begins. This is somewhat arbitrary. For a survey, we will define this as the time when the owl responds at a station. For a historical nest or roost, it is the time you begin to search for the owl (this can mean the time you arrive at the nest site, and can include silent searching, or squeaking, or it can be the time you start hooting near a site). Use military time. (ex: 1:30 PM is entered as 1330)

Finish Time: The time at which the observers cease the follow-up effort, quit searching, or leave the site of a response. Use military time.

Nesting Indicators: These are observations that are used to determine nesting status. Enter all appropriate code numbers.

1 - Female roosting for more than 30 minutes (15 Apr. - 1 June)
2 - Prey accepted, not taken to nest or young (1 Apr. - 15 July)
3 - Female observed on nest

4 - Prey taken to nest or fledglings (this can be either prey we offer, or natural prey)

5 - Young detected with adult

6 - Brood patch on female

7 - No brood patch on female (1 May - 15 July)

8 - Regenerating Brood Patch

For example: you hoot up a female spotted owl, capture and band her, find a brood patch, release her, give her a free mouse which she takes to juveniles. You would enter "4,5,6"

Nest Located?: Circle Y (Yes) or N (No) to indicate whether this years nest was located on this occasion. If you only visited an old nest tree, the answer is no.

Nest Tree Tag #: Enter the Nest Tree Tag # if a current nest tree was located.

Sex: Use the following codes to record the sex of responding owls:

M - Male

F - Female

U - Unknown

Age: Use the following codes to record the age of responding owls:

A - Adult (3 or more years of age)

S1 - First year Subadult

S2 - Second year Subadult

SU - Unknown year Subadult

AS - Adult or Subadult

J - Juvenile (young of the year)

U - Unknown

Adult or subadult status can be determined only if the terminal tail band pattern is clearly seen. Adults have mottled and rounded tail tips. First year Subadults (and juveniles) have white pointed tail tips. Second year Subadults have white rounded tail tips.

Survey Method: Enter the code for the survey method used to locate each owl (nothing is entered for a "no-response" situation, as the assumption is that this is the result of an intensive search for known owls). Codes are as follows:

S - Survey Stations. Use this code only for owls detected as a direct result of hooting stations along transects in established survey plots.

I - Intensive search. Use this code only for owls detected while searching an area that is not part of a survey plot survey effort; OR for owls found as a result of following another owl that was detected at a survey station.

R - Radio telemetry. For owls located by using telemetry.

U - Unsolicited response. Use this code only for owls which were detected when there was no attempt made to elicit responses. Examples would include waking up in the middle of the night to an owl hooting nearby or seeing an owl while hiking (but **not** hooting) along a trail.

Detection Time: The time the owl is first heard or seen. Use military time (Ex.: 2:30PM is entered as 1430).

Detection Type: Use the following codes to indicate the sensory modalities by which the owl was observed. More than one code should be entered if appropriate (e.g. AV for seen and heard).

A - Auditory (heard owl's vocalizations)

V - Visual (saw owl)

R - Radio (heard telemetry signal)

D - Dead (found owl remains)

Band Number: Enter one of the following items:

USFWS Band # -- Enter the USFWS band number **only** if the bird was in hand and you read the number directly from the band.

AL -- If the bird was **not** in hand, but you were able to **positively** see an aluminum band, then enter "AL" in this space.

NONE -- If you were able to get good views of both legs, and could **positively** confirm that there was no aluminum band on either leg, then enter "NONE" in this space.

UNKNOWN -- If you were unable to **positively** confirm whether or not the bird has an aluminum band, then write "UNKNOWN" in this space.

Band # Leg: Enter R (Right) or L (Left) to indicate which leg an aluminum USFWS band was seen or placed upon.

Band Color: Enter one of the following items:

Band Color -- Write in the color of the plastic band only if it was **positively** identified. For multi-color bands, write the first three letters of each color, separated with a slash (ex.: a Red+White+Red band would be written down as "RED/WHI/RED"; Yellow+Black+Yellow would be "YEL/BLA/YEL").

(Band Color) -- If you are able to **positively** confirm the presence of a color band, but unable to distinguish the exact color, then write the suspected color in parenthesis [ex: (ORANGE) or (RED or ORANGE)]

PRESENT -- If you are able to **positively** confirm the presence of a color band, but have no clue whatsoever as to the color, then write "PRESENT" in the space.

NONE -- If you were able to get good views of both legs, and could **positively** confirm that there was no color band on either leg, then enter "NONE" in this space.

UNKNOWN -- If you were unable to **positively** confirm whether or not the bird has a color band, then write "UNKNOWN" in this space.

Band Color Leg: Enter R (Right) or L (Left) to indicate which leg the plastic color band was seen or placed upon.

Mice offered: Enter the number of mice offered to the owl. An offer begins when you put out a mouse and ends when either the owl takes the mouse or when you pack up and leave the site. Switching mice, moving the mousing platform, and taking breaks (between setting mice out, or for capture and banding) **do not** constitute separate offers.

Mice Taken: Enter the number of mice that were taken by this owl.

Elevation: Enter the elevation, in feet, of the observed location **of the owl** that most closely indicates the center of that owl's activity area (site center). This basically means that you may be following an owl to a number of different elevations, and that the most important elevation is that one where the owl was closest to the site center. There is a hierarchy of importance involved, listed as follows from least-to-most certainty of being near the site center:

- Owl heard from a distance, and you were unable to meet the owl up close and personal (you would enter your best estimate of the elevation **of the owl**).

- Single owl observed. Enter the elevation **of the owl** where it was observed roosting the longest period of time, particularly if it appears to be a frequently used roost tree (lots of pellets and/or whitewash around tree)

- Pair observed. Enter the elevation **of the owl** where it was observed with its mate.

- Juveniles observed, or adults with juveniles. Enter the elevation **of the owl** where the juveniles were observed, or juveniles with adult(s) were observed.

- This year's nest located. Enter the elevation of the nest tree where the owl was observed.

For "no response" to a search for known owls, write down the elevation range covered during the search in "General Comments", but don't enter anything in elevation boxes.

UTM-East: Enter the six-digit easting UTM coordinate of the owl's location. Use the same site center hierarchy listed under "Elevation" to determine the highest priority location of the owl to record.

UTM-North: Enter the seven-digit northing UTM coordinate of the owl's location. Use the same site center hierarchy listed under "Elevation" to determine the highest priority location of the owl to record.

UTM Accuracy: An indication of how accurate you believe your UTM locations for owls are, using the following categories:

Enter	If you estimate your UTM's are:
10	Accurate to nearest 10 meters
100	Accurate to nearest 100 meters
1000	Accurate to nearest 1000 meters

Calls given: For each of the responding owls, enter the sex of the bird and the circle the types of calls vocalized by that bird. Remember that the only vocalization that definitively identifies a spotted owl is the 3 or 4 note location call. Types of calls are as follows:

L - 3 or 4 note Spotted Owl location call
*C - Contact call
*AC - Agitated contact call
*S - Series call
*B - Barking call
*N - Nest call
*J - Juvenile begging call
WC - "Who-Cooks-For-You" Barred Owl call
GH - Great Horned Owl call

Note: asterisks indicate those calls given by both Spotted **and** Barred owls.

Fate of Mice: Note here what the owls did with the mice they took. Possible fates include: eaten, cached, delivered to juvenile and eaten by juvenile, delivered into nest, etc.

An example for these notes might read:

Mouse #1 to male: used to lure and capture, recovered. Mouse #2 to male: eaten. Mouse #3 to male: delivered to nest. Mouse #1 to female: delivered to nest. Mouse #2 to female: eaten

This is a synopsis of what happened to the taken mice. Your copious notes in the "Detailed Notes and Chronology of Events" section of the Follow-Up form should provide more information on the timing and details of mousing and fate of mice.

Directions for relocating site: Provide detailed instructions for relocating the response site. Describe how to get to the site from a known and permanent location such as a trail, road, prominent geologic feature, etc. Be as clear and detailed as possible. It is not necessary to write directions if you were following good directions and reached the site without problems. New site directions will be added to the site directions computer files in the office.

Visit synopsis: Use this space to provide a synopsis of what the visit was about. This is sort of an abstract of the visit: describe the background reason for the visit, results, and

conclusions. Your voluminous notes in the "Detailed Notes and Chronology of Events" portion of the Follow-Up Form will provide the glorious details. This section should be used to summarize and note any other general comments. Examples:

"First identification of owl at a new site. Attempted to determine pair status. Only detected male. Need additional visits for pair status."

"Second visits to Grunge Hill site to determine reproductive status. Found nest for the first time! Saw female near nest, but couldn't get her to come down. Didn't see any juveniles, but heard begging calls. Concluded that there was successful reproduction, but need additional visit to determine how many juveniles there are. We tagged and flagged nest tree."

Detailed Notes and Chronology of Events: Fill in the F.U.F. #, Site Name, Date and Observers information in case this sheet gets separated from the others.

This is where you record **everything** that happens during a response, or during a particularly eventful "no response" search for a known owl. Take detailed, sequential notes using military time to record the chronology of events.

You should record detailed descriptions of owl behavior, movements, interactions with other owls, mousing procedures and results, capture and banding processes and results, changes in weather, roost tree and nest tree descriptions (and drawings, if you're artistically inclined), length of periods of activity or inactivity, problems encountered, etc., etc., etc.!

Basically, write down everything. Great detail is much preferable to lack of information.

Legibility is essential!!!!!

APPENDIX G. CAPTURE PROTOCOLS.

OLYMPIC NATIONAL PARK - SPOTTED OWL CAPTURE PROTOCOLS

WHEN TO CAPTURE

We will want to capture and band **all** unbanded spotted owls we encounter. In addition, we will always capture and change bands on adults with juvenile or subadult bands, or subadults with juvenile bands.

If you can see that the owl is banded, but can't discern the exact colors, you will want to lure or mouse the owl down for a better look. In this situation, you would only go for the capture if the apparent band color is totally different from what is expected in the area. In other words, if there's supposedly only a yellow banded bird in the area, but you think the band color is blue or green, then go for the capture to confirm color and get the band number.

We will also attempt to recapture previously captured/banded female spotted owls under certain conditions. We will be doing this to check brood patches in an attempt to determine nesting status (in particular, to confirm a suspected nest failure). This will be done under the following conditions:

- During the period of April 15 - June 1 (roughly, the latter part of the nesting season).

- If there are some indications that the female is not nesting, such as extended roosting times or mice **not** taken to the nest.

- If recapture is attempted, the capture method will be hand-grabbing only. We will **not** noose the female, and subject her to the dangers thereof, just to collect brood patch data.

We will not be expending much effort on attempting to capture and band Barred owls. You would attempt this only if the Barred owl is immediately adjacent and shows any immediate interest in lure or mouse. We do not want to spend effort on trying to capture and band Barred Owls at the expense of completing spotted owl survey work.

WHETHER TO HAND-GRAB OR NOOSE

Hand-grabbing is the safest and the preferred capture method, and will be attempted first in all situations. As mentioned previously, noosing **will not** be attempted at all for recapture attempts with females to determine brood patch status.

The decision to noose should not be made lightly. More on this in the "Noosing Techniques" section.

PRE CAPTURE:

You've tracked down the bird, you're all jazzed up and ready to capture and band it, you're rarin' to go! So now you really need to . . . . . relax. Take a few moments to get your act together, while you take turns with your partner(s) keeping an eye on the bird. We want to work quickly, **safely,** and efficiently with the owls, and taking some time to get ready is more safe and efficient, in the long run, than rushing in unprepared. "Make haste slowly!"

Make sure you are dressed properly. The capture and banding process can take some time, and you can become easily chilled (it's hard to take precise measurements when you're

shaking like a leaf!). Don't be fooled by how warm you feel immediately after the search effort that located the bird . . . put on extra clothing.

If you're thirsty and/or starving, take a drink and/or chow down a quick snack. A gourmet meal would probably not be appropriate right now, but you can munch on a candy bar or some such while preparing for the capture.

Choose a good clear, level site near the owl, in which to band (if such a place can be found!).

Make sure everyone is ready, in position, and understands their role in the drama about to unfold. **Now** you're ready to proceed with the capture and banding.

MOUSING and HAND GRABBING PROTOCOL

Mousing is used for three purposes:

1. To lure an owl down during a capture (hand-grab) attempt.
2. To lure an owl down to get a closer look at the band color.
3. To provide "free" mice to an owl in the hopes of following it to the mate, young, or a nest tree in order to determine pair and nesting status, and reproductive success (and band other family members).

Specific procedures relating to all of these purposes are as follows:

1. Once the owl is located, have one crew member **WATCH THE OWL AT ALL TIMES** as they are extremely quiet in flight and it's easy to lose them...causing unnecessary work...trust us.
2. Have your gear ready (see "Banding Techniques") and organized so that if the bird flies off, either you or your partner can take off after it in hot pursuit.
3. Choose a mousing location from which the owl can see the mouse, has a clear flight path to the mouse, and a clear flight path beyond the mouse. The owl may not come down if there isn't a clear approach and fly-through area. Try to place the mouse in an area that the owl will need to swoop down almost directly toward you to get the mouse (it is easier to grab it in this way).
4. Find a stump, small tree, or lean a dead limb against a tree to use as a mousing platform. Put the mouse about waist to shoulder height on your chosen mousing platform. NOTE: **NEVER** "hand mouse" an owl (i.e. never place mouse on your hand, head, or other body parts while luring owl down).
5. Stand close to the mouse, but slightly off to one side so that you're not directly in line with the owl's flight path. Have your grabbing hand close to the mouse, slowly following it's movements on the mousing platform. It's all the better if your platform is such that you can keep your grabbing hand hidden from the owl's view. Be as still as possible
6. If the owl is not looking, make mouse noises. If owl is way up high, use a lure to get them interested and to come lower to the ground. If need be, prod the mouse to get it to move around on the mousing platform . . . the owl will be much more interested if the mouse is active.
7. Again, keep your eyes on owl at all times. Even a momentary lapse of attention might be the time when the owl goes for the mouse and catches you unprepared. The owl is interested when it starts to bob its head, shift its weight and hunch over.
8. Attempt to hand grab the owl with the **first mouse** offered. If you miss the grab (and this will happen), use as many mice as needed to lure in and grab the owl. Try to grab both legs of the owl, but it sometimes does occur that only one leg is grabbed. This is not a problem, but the handler should get both legs under control as soon as possible. In addition, it is very important to make sure the wings are quickly brought under control

in order to prevent any possible injury to the bird as it is struggling. Gently fold these against the body in their natural position.

9. Realize that at some point during the capture and banding process the owl may grab you with its talons or get you with its beak. It is slightly painful, but tolerable. When this happens do not panic or jerk as this may injure the bird. Be careful and prepared for this. Your partner can then gently pry the owl's talons out of your hand.

10. The person **not** grabbing should recover the mouse immediately upon capture of the bird.

11. Band the owl, take measurements, release owl. (See "Banding Techniques")

12. Offer more mice to the owl in an attempt to locate a mate, juveniles, and/or nest. Be ready to follow the owl if it zooms off. While it's perched, watch the direction the owl hoots and looks. If it frequently turns its head in a certain direction, it may be watching another owl or young!

An offer begins when you put out a mouse and ends when either the owl takes the mouse or when you pack up and leave the site. Switching mice, moving the mousing platform, and taking breaks (between setting mice out or for capture and banding) **do not** constitute separate offers.

Continue to offer mice as they are taken until you get the necessary reproductive data or the owl stops taking mice. Make an effort to offer at least four mice.

13. Repeat above procedures with the owl's mate, if possible.

14. Take extremely detailed notes on the number of mice offered and taken, the fate of each mouse, and the timing of all these events. This detailed information is crucial in using established guidelines to determine pair status, nesting status and reproductive success.

NOOSING TECHNIQUES

NOOSE POLE

It is important that crew members understand the construction of the noose-pole mechanism in order to repair and make emergency adjustments with it in the field.

A collapsible fishing pole is used as the noose pole. Full length when extended is 16.6 ft. A 2 foot piece of insulated electrical wire is bent in half and placed into the last pole section. Small rubber stoppers are threaded through each end of the wire and secured by wrapping back the wire ends and tightening them down with pliers. The rubber pieces are thinly sliced to hold the noose. This noose holder can be taken out of the pole section and stored in the banding kit. A wire loop with a quick-release is attached to the last pole section, one end of the noose attaches to the quick-release.

THE NOOSE

The noose is made of monofilament line, there is an orange ball that acts as a neck stop that will stop the noose from constricting the owl, yet maintain a hold to noose the owl. We also have some nooses without neck stops that are often more effective but don't provide you with as much of a margin for error.

Helpful Hints

* Extra pieces of electrical tape may be wrapped around the pole for later use. It comes in handy if electrical wire, or epoxy holding the swivel clip breaks.
* Try not to bend electrical wire any more than necessary. Constant bending at the same points weakens the wire and eventually causes it to break.

* Carry a few extra rubber stoppers. Know how to put them on securely so that they won't move around on the wire.
* There is an extra noose in your banding kit. (It may or may not have a neck stop)

NOOSING CAUTIONS

Before noosing, try to hand grab an owl using mice. If mice or a lure won't bring the owl down and the owl can be safely reached and noosed, then do it.

Inspect the assembled noose pole before beginning. Be certain that the noose and swivel are firmly attached to the noose pole and that the last smallest section of the pole is not able to slip out.

Noosing owls is a serious procedure and is always done with caution and safety in mind for the owl and yourself. If you are unsure of either, do not attempt noosing. Owls can die if noosing procedures are done improperly. In addition to the moral responsibility involved in capturing any animal, there are also the social and regulatory ramifications of injuring or killing a high-profile species such as the spotted owl.

We are not trying to frighten you from attempting noosing under good conditions. We **are** trying to make you aware that a careful assessment of the situation should be made prior to any attempt to noose.

This "risk assessment" is a mandatory part of your note-taking. As part of any noosing attempt, your notes will include details specifically related to why the conditions were good or bad for noosing. If the conditions were marginal, yet you decided to proceed with the noosing attempt, you must provide information in your notes as to why you made that decision.

<u>WHEN TO NOOSE</u>

Adult spotted owls

1. Owl will not come down for mouse or lure, and...
2. can be safely reached with noose pole, and...
3. is in a safe area to noose

Juvenile spotted owls

Juvenile owls are captured predominately with a noose pole as they seldom have learned the hunting skills to come down for mice.

Young spotted owls fledge before they can fly. They get around by walking or climbing using their talons and beak. This can create problems during capture. Because they can't fly, young juveniles tend to hang on to the branch tenaciously after you noose them. They can hang on for many minutes and may be injured if you try to pull them off the branch with the noose. This abates some as they gain their flight feathers and learn to fly. Noosing young fledglings should be done very carefully and with at least two people present.

Carefully noose the bird. Try to **gently** nudge or pull it off the branch. If it releases the branch, continue as you would for an adult. If it does not, you may be able to entice the bird to release the branch by gently touching the abdomen with a stick and hoping it will step onto this offerred perch (like getting a parakeet to perch on your finger).

Release the bird by placing it back on the perch it was taken from if possible. If not, place it on a leaning tree or branch that the bird can walk up. **DO NOT** leave them near the ground, as they may be more susceptible to predation.

As the fledglings grow their flight feathers and learn to fly, they begin to act more like adults and can be captured more easily. However, always be ready for the worst.

WHEN NOT TO NOOSE

- Owl is perched in a location that is surrounded by limbs that would hamper noosing or allow the noosed owl to get hung up in those branches.
- Owl is perched too high to reach with a noose pole. It is only possible to noose an owl you can safely reach. You should not attempt to noose at the extreme limit of the noose pole's length: you will always want to be able to have enough extra length of pole available to lift the owl back over the limb should it go over the opposite side.
- Owl is in a location that is unsafe for you to noose from, such as the edge of a cliff.

NOOSING METHODS

Set up the noose pole so that there is enough length to reach the owl without extending your arms all the way. Make sure the sections are all seated tightened so the pole won't collapse unexpectedly under the owl's weight.

Position the noose on the wire holder so that the circumference is large enough to fit over the head of the owl.

ASSESS THE SITUATION FOR:

* a spot that is safe for you to noose from.
* any potential for owl injury and how to avoid it
* a clear path to bring the owl down
* potential problems and how to solve them, ex. what to do if the owl goes over a limb away from you.

If the owl is in a bad spot to capture, try to lure it to a better perch with the toy mouse. If the owl won't move **DO NOT** attempt a capture, avoid any risk of injuring the owl. There is always another day.

If the owl is in a good spot to noose, then: Choose an open area to bring the owl down safely, your partner should be ready to bring the owl under control and take the noose off.

While attempting to noose the owl, have your partner distract the owl with the mouse lure or a bandanna.

During distraction of owl, bring noose above owl and lower it over the head. You can noose the owl from the front or the back. You should move slowly and smoothly with the noose pole, pausing if the bird reacts to the noose pole.

When noose is around owl's neck pull firmly in the direction you want to bring the owl. **DO NOT YANK!**

The owl may not move from its perch when you pull the noose, keep pulling and the owl will eventually attempt to fly away.

If the owl starts to go over the opposite side, pull it to the side you want it to come.

When the owl starts to fly, bring it down to the ground near your partner so that they can get the owl under control and the noose off. The partner may want to use a gloved hand to capture the owl. If you grab directly for its feet it will attach them to your hand. Then your free hand can be used to grab the legs. You may want to try putting a stick in the talons and then getting the leg. Be aware to keep the owl from scratching itself - especially in the eye.

When taking the noose off the owl, release it from the pole by the quick release, or leave noose attached to pole and loosen noose around the owl's neck. Loosening the noose from around the owl's neck is done by pushing the tail end of the noose through the small noose hole, which creates a larger loop, then this is lifted off of the owl.

Bring the owl under control, folding the wings naturally against its back.

Find a comfortable spot to sit down, place owl with its tail toward your knees. The bander should place a bandana under the owl with part of it over its eyes.

Keep a good grip on the legs at all times, making sure they are away from the owl's eyes. Don't panic or jerk if the owl gets you with talons or beak, it doesn't hurt much and you could injure the owl.

Commence banding of owl. (See "Banding Techniques")

APPENDIX H. BANDING PROTOCOLS.

BANDING PROTOCOLS FOR SPOTTED OWLS - ONP

Banding of spotted owls is a technique used in a variety of situations to meet a variety of objectives including:

1. Identifying individual birds.
2. Following occupation and turnover of birds on selected sites over time.
3. Determining the exact number of spotted owls within a designated area.
4. Detecting movement of adults and juveniles between sites.
5. Measuring demographic parameters such as survival rates, age-specific rates, reproductive success and site fidelity.

All persons wishing to band birds must be covered by a banding permit issued by the US Fish and Wildlife Service (USFWS) and a permit from the state involved. Most banders are covered as sub-permitees under a master permit held by the agency or organization, We are covered under a National Park permit. This simplifies matters for the USFWS and the banders, and is the preferred way to operate. The USFWS would rather not issue permits to individuals or subsets of agencies, as it creates more paperwork for them.

Permittees are required to submit accurate and complete records of their efforts at least annually. Failure to do so, or gross inaccuracy/mistakes can lead to the loss of banding privileges. Therefore it is critical that you, the bander, maintain complete, accurate and timely records of your banding activities.

Data forms for recording banding information in the field vary by agency. Make sure you understand the Olympic National Park form that you will use **before** going out to band!

Banding birds is only the first step in a banding program. The most valuable information is gathered by re-observations of the banded birds. Such re-observations may not be as exciting as banding, but are actually more valuable. Precision is critical. If you are not sure of the color or leg, indicate so on the form per instructions, and in your notes. Continue to try and confirm the band beyond reasonable doubt.

The major value in color-banding lies in our ability to distinguish individual birds without recapturing them. To do so, we must ensure that we do not band birds using the same color/leg combinations in close proximity. Thus we have banding schemes for different areas, and it is vital that we follow these schemes.

Capturing, handling and banding birds always involves the potential for injuring the animal or altering its behavior. This puts a great responsibility on the bander to consider the bird's safety **above all else**, and becomes even more critical with a high profile species like the spotted owl. Think of this as a moral and ethical responsibility, and keep it in mind at all times.

BANDING TECHNIQUES

Banding is done in either 2 or 3 person teams. On a 2 person team, one person bands and takes notes, and the other person holds the bird and assists the bander as needed. On a 3 person team, one person is designated solely as note taker. Teamwork, cooperation, and communication are essential during the banding process to allow things to run as smoothly as possible.

BEFORE LEAVING THE OFFICE:

Check to make sure that the banding kit is complete. Double check that there are sufficient numbers of zip ties, bands of both types, a noose holder and extra nooses. Ensure that you have a banding scheme specific to the particular census block unit, or historic site area, that you will be visiting.

PRE CAPTURE:

Take the time to prepare yourself and your gear for the capture and banding processes (see "Capture Protocols" document).

Choose a good clear, level site near the owl, in which to band (if such a place can be found!). Lay out all banding equipment needed. Have an aluminum and color band ready. The aluminum band should be opened and ready to go on the leg. Use the USFWS (aluminum) bands in sequential order. The color band must be double checked against the banding scheme. NOTE: If there are two juveniles on a site, and you are able to capture both, place the juvenile color bands on opposite legs on each bird.

Make sure everyone is ready, in position, and understands their roles before proceeding.

CAPTURE:

The owl will be captured either by hand-grabbing or noosing. The protocols for both capture techniques are described in the "Capture Protocols" document, and should be carefully reviewed prior to going into the field.

Upon capture, the handler should get both legs under control as soon as possible. In addition, it is very important to make sure the wings are quickly brought under control in order to prevent any possible injury to the bird as it is struggling. Gently fold these against the body in their natural position.

Realize that at some point during the capture and banding process the owl may grab you with its talons or get you with its beak. It is slightly painful, but tolerable. When this happens do not panic or jerk as this may injure the bird. Be careful and prepared for this.

BANDING:

Banding is the first priority. Band the bird as quickly and efficiently as possible to reduce stress. Keep loud or sharp noises to a minimum. The person holding the bird may want to give a soft contact whistle every now and then, which may help to calm the bird. During hot weather, watch for panting or gular fluttering as a sign of overheating. If, during the following measurements, the bird seems overly stressed, discontinue what you are doing and release the bird early. Always weigh the owl before releasing it.

The person who hand-grabbed the bird, or removed it from the noose, should be the one holding the bird throughout the banding process. This will minimize transfers of the bird, reducing the possibility of injury (to bird **and** handlers!) or escape. If for some reason, you do transfer the owl from one person to another, make sure that someone has control of both feet during this transfer.

The holder should take a seat in the chosen location. The bird should be on his/her lap with the tail towards the knees. The owl's head should be covered with a bandanna to help keep it calm. The bird should be held with a firm but sensitive grip, making sure to keep the legs away from its eyes if it struggles in order to prevent any possible injury to the eye. The legs should be held separately, one in each hand.

The bander should be completing the banding form during the banding process unless there is a third person as a designated note taker.

The first priority will always be to place the bands on the bird. Attach the USFWS band, keeping the numbers upright (numbers would be upright with the bird standing). Ensure the ends of the band are even - clamp down ends with pliers if necessary. Rotate the band to free the leg feathers. The holder should read off the band numbers as the bander records. Next put on the color band and place two zip ties in the band hole, tighten and cut off extra material. Rotate the band to clear feathers. After banding, double check the bands and which leg they're on. Before releasing the bird, triple check the band number. If you get the impression that it is vital that band information be recorded accurately, you are right.

CHANGING BANDS:

If you locate an adult owl with juvenile (red/white/red) or subadult (yellow/black/yellow) bands, or a subadult owl that is banded with a juvenile band, you will want to capture the bird and change the color band. You will not change the aluminum band. If it is a subadult with juvenile bands, you will put on a solid color band, and include in your notes that it is a subadult owl. If it is an adult, you will also put on a solid color band.

To remove the old color band, very carefully cut at both ends of the band just inside of the rivet, with the cutting pliers. This will make a break across the band allowing for easy removal. Record the changing of color bands on capture/banding/molt form.

APPENDIX I. CAPTURE DATA FORM.

OWL CAPTURE/BANDING/MOLT FORM - Olympic National Park

Site Name:_____ Species:_____ Date: _____/_____/_____
month day year

Observers:_____ Survey Area:_____ Drainage:_____ FUF #:_____
UTM-E:_____ UTM-N:_____ UTM accuracy:_____ Elev:_____
Capture Method:_____ Handling Time - Beginning:_____ End:_____
Sex:_____ Age:_____
Band #:_____ Leg:_____ New number?:_____
Band Color:_____ Leg:_____ New Color?:_____ Tab:_____
Radio Ser #:_____ Freq:_____ Attachment:_____ New radio?:____
Weight (grams): Gross:_____ - Tare:_____ = Net:_____ Keel: _____
Left Talon: _____mm _____mm Right Talon: _____mm _____mm
Front Rear Front Rear

Beak: _____mm _____mm Wing Chord: _____mm Left Right
Length Depth (Circle One)

X for unmolted feather; fractions in 1/10's to indicate % development of regenerating feather (ex. 1/10, feather just out of sheath; 5/10, feather half regenerated, etc.); F recently fully regenerated feather; B for broken feather.

PRIMARIES: 1 2 3 4 5 6 7 8 9 10

Left										
Right										

SECONDARIES:1 2 3 4 5 6 7 8 9 10 11 12 13

Left													
Right													

RETRICES: 1 2 3 4 5 6

Left						
Right						

Tail: _____mm Tip Color: Mottled / White / Unknown
(Circle One)

Tip Shape: Pointed / Rounded / Unknown # Complete Bars: _____ _____
(Circle One) Left Right

Brood Patch: Present / Absent / Unknown Size: _____X_____
(Circle One) (Millimeters)

Brood Patch Description: _____
_____

Comments: _____
_____
_____
_____
_____
_____

APPENDIX J. CAPTURE DATA INSTRUCTIONS.

A copy of this information in a Word file with measurement diagrams and scanned photographs illustrating the tail tip characteristics, and tail barring patterns is available as BandIllustrate.doc.

BANDING CHEATSHEET

Capturing, handling and banding birds always involves the potential for injuring the animal or altering its behavior. This puts a great responsibility on the bander to ***consider the bird's safety above all else***, and becomes even more critical with a high profile species like the spotted owl. Think of this as a moral and ethical responsibility, and keep it in mind at all times.

PRE CAPTURE: Choose a good clear, level site near the owl, in which to band (if such a place can be found!). Lay out all banding equipment needed. Have an aluminum and color band ready **(CHECK YOUR BANDING SCHEME!)**. The aluminum band should be opened and ready to go on the leg. NOTE: If there are two juveniles on a site, and you are able to capture both, place the juvenile color bands on opposite legs on each bird.

CAPTURE: Upon capture, the handler should get both legs under control as soon as possible. In addition, it is very important to make sure the wings are quickly brought under control in order to prevent any possible injury to the bird as it is struggling. Gently fold these against the body in their natural position.

BANDING: Band the bird as quickly and efficiently as possible to reduce stress. Keep loud or sharp noises to a minimum. The person holding the bird may want to give a soft contact whistle every now and then, which may help to calm the bird. During hot weather, watch for panting or gular fluttering as a sign of overheating. If, during the following measurements, the bird seems overly stressed, discontinue what you are doing and release the bird early.

The person who hand-grabbed the bird, or removed it from the noose, should be the one holding the bird throughout the banding process. This will minimize transfers of the bird, reducing the possibility of injury (to bird **and** handlers!) or escape. If for some reason, you do transfer the owl from one person to another, make sure that someone has control of both feet during this transfer.

The holder should take a seat in the chosen location. The bird should be on his/her lap with the tail towards the knees. The owl's head should be covered with a bandanna to help keep it calm. The bird should be held with a firm but sensitive grip, making sure to keep the legs away from its eyes if it struggles in order to prevent any possible injury to the eye. The legs should be held separately, one with each hand.

The first priority will always be to place the bands on the bird. Attach the USFWS band, so the numbers are upright when the bird is standing. Ensure the ends of the band are even - clamp down ends with pliers if necessary. Rotate the band to free the leg feathers. The holder should read off the band numbers and the bander should record them on the data sheet. Next put on the color band and place two zip ties through the band hole, tighten and cut off remaining material. Rotate the band to clear feathers. After banding, double check the bands and which leg they're on. Before releasing the bird, triple check the band number.

MEASUREMENTS: As you are measuring and examining the bird, look for anything unusual (e.g. broken talons, injuries, etc.) and make note of this in the comments section on the banding form. Check and make sure the calipers and scale are zeroed before using them. After putting the bands on, measurements (in **mm**) are listed in order of priority:

Tail Tip Color & Shape: Tail tip patterns are used to age spotted owls. Adults have mottled, rounded tips. Subadults and juveniles have white tips. Subadult birds with white tips may be further classified into: 1st year - the tip is sharp and pointed, 2nd year - tip is more rounded. Consult the tail pictures on the back. Make a "best guess" on it and make note of it on the form if you are unsure.

Brood Patch: This is used to determine reproductive status, and is especially useful for determining failed nesting attempts. Check for brood patch by blowing feathers away on the belly of the bird. Early in the season if a female is incubating she will have a bare patch that appears bright red and scaly, becoming less red and yellow-tinged later on in the season. Do not confuse the apteria with the brood patch. The apteria is a permanent bare patch between feather tracts on the lower belly of the bird, approximately 40-50 mm x 20 mm in size. A fully-developed brood patch covers a much larger area (most of the lower abdomen, extending to the base of the wings). The apteria and brood patch are more easily confused later on in the season as the brood patch feathers begin to regenerate. Measure the maximum length and width of the brood patch, in centimeters, using the calipers. Measure the length of any regenerating feathers. Describe the brood patch in the comments, including color and texture of the skin, and any evidence of regenerating feathers around the edge. The presence of a brood patch may be used as a guide for when to release the bird: if the weather is cool and the mousing, capture and banding process up to this point has taken a long time **and** now you find a brood patch, you may want to just weigh her and release her so she can get back and warm the nest.

Mass: This is next in priority, but should be done as the last measurement as the risk of escape is higher. In other words, if at any point during the banding process the bird is getting really stressed out, stop taking other measurements, weigh the bird, and release it. When you capture a bird you should **ALWAYS** weigh it before releasing. The holder should support the bird as it is lifted up, then let go briefly in order to allow the bander to read the gross mass. The tare (mass of the leg noose or bandanna plus two bands, plus any mice eaten) is then subtracted. The net mass is then recorded on the form.

Keel: Palpate the keel of the breastbone. Enter a number to indicate condition of the breast muscle: 1 = emaciated, on the verge of starvation; 2 = under-weight; 3 = full, good condition; 4 = obese.

Wing Chord: Use tape to measure from notch in the bend of the wing to the wing tip, in millimeters. Make sure **not** to flatten the wing.

Molt: Count and check primaries, secondaries and retrices in the manner described on the form and illustrated on this "cheat sheet". Note molted, regenerated or broken feathers. The leading primary is designated as #10, and you count down. The leading secondary is #1, and you count up. Newly regenerated feathers can be recognized due to their salmon pink hue. When looking at the primaries and secondaries you will need to really stretch the wing out. Owls do not like to have their wings messed with, and the bird is likely to struggle at this point. Use a gentle but firm hand, or wait for the bird to calm down if necessary.

Tail: Blow feathers clear at base of tail feathers to ensure you are starting your measurement from the skin. Use plastic ruler to measure to the tip of the longest of the two deck (middle tail) feathers, in millimeters. Do **not** flatten the feathers.

Tail Bars: Count number of "complete" bars on the bird's left and right deck (central tail) feathers. A "complete" bar extends from the mid-rib of the feather to **at least** one side of the

feather, but not necessarily both sides. **The tip always counts as one complete bar, even if it's mottled**. A bar is "incomplete" if it does not reach from the center rib to the edge on at least one side. Be conservative in your estimate, if there is any question in your mind as to whether a bar is complete or not, call it incomplete. The number of tail bars is used in sexing a bird. Females generally have 4 or more complete bars, male 3 or less.

Talons: Use calipers to measure the length of talons, in millimeters. Measure both the front and rear talons on both the left and right legs. Measure from end of skin on talon, directly across the curvature as shown on this "cheat sheet".

Beak: Measure length and depth, in millimeters. Beak depth is measured straight down from base of nares to lower beak. Beak length is measured from base of nares to tip of beak. Measured with calipers, as illustrated on this "cheat sheet".

CODES:

SPECIES:	STOC = SPOTTED	SEX:	M = MALE	AGE:	A = ADULT (fig. c)
	STVA = BARRED		F = FEMALE		S1 = SUBADULT 1ST YEAR (fig. a)
	STXX = HYBRID		U = UNKNOWN		S2 = SUBADULT 2ND YEAR (fig. b)
					J = JUVENILE (fig. z)

AVERAGE WEIGHT OF MICE = 30 GRAMS PER MOUSE

APPENDIX K. DETERMINING NESTING AND REPRODUCTIVE STATUS.

STANDARDS AND GUIDELINES FOR DETERMINING PAIR, NESTING, AND REPRODUCTIVE STATUS OF SPOTTED OWLS IN NATIONAL PARKS IN WASHINGTON STATE.

Established, March 3, 1993. D. Erran Seaman.
Slight amendments December 8, 1993.
(Adapted from USFS guidelines dated 4 May 1990 – needs updating to reflect Forsman 1995)

I) **PAIR STATUS**. Determination of pair status can be done anytime during the early/pre-nesting period through the late fledgling period (15 March to 15 July).

A) **A pair** is established by any of the following, observed on 2 or more occasions at least 1 week apart. In some cases, only one visit is required (as noted below).

1) A male and female are observed in proximity to each other;
2) A male takes a mouse to a female, or a female is detected (heard or seen) on a nest (only one visit is required, but see **nesting status**);
3) One or both adults are observed with young (young alone do not define a pair, as they may be barred owls) (only one visit required);
4) One bird is heard, and another is seen in proximity (within about 800 m) to the vocalizing bird within 10 minutes; or
5) A male and a female vocalize back and forth in proximity to each other within 10 minutes.
6) If previously banded individuals were confirmed on the site in a previous year, and both are found (together or singly) on the same site, they may be considered a pair (only one visit required).

B) **A single** is established by the presence or response of a single owl for a specific area (e.g. historic owl site) on 2 or more occasions within the season, with no response by an owl of the opposite sex after 6 complete visits.

C) **Unknown**. A response of a male or female which does not meet the criteria for determining pair or single status (e.g. 6 visits not made, or not located on 2 occasions).

D) **0.** Six complete visits with no response from any owls. This is our own status code for no owls present at a site.

II) **NEST STATUS**. Surveys pertaining to nest status are made during the nesting period, between 1 April and 1 July.

A) **Nesting** is established by observing any of the following:

1) A female is detected (heard or seen) on the nest on 2 or more occasions, spaced at least 1 week apart. If she is observed on the nest late in the nesting season (after 1 May), a single visit is sufficient.
2) Either member of a pair carries prey (natural or provided by you) to the nest on 2 or more occasions, spaced at least 1 week apart. If the observation is late in the nesting season (after 1 May), a single visit is sufficient.
3) A combination of the previous 2 conditions.
4) A female possesses a brood patch when examined in hand.
5) A combination of a brood patch on the female, and either of the first 2 conditions is required prior to 15 April.
6) Young are detected in the presence of 1 or both adults.

B) **Non-nesting** may be inferred from 1 of the following conditions.

1) The female is observed roosting (i.e. off the nest) for more than 30 minutes on at least 2 visits (spaced at least 3 weeks apart) between 15 April and 1 June. This requires some judgment, because females with large nestlings (i.e. in late May) may roost for fairly extended periods if the weather is warm.
2) The female does not possess a brood patch when examined in hand between 1 May and 15 July.
3) You offer 4 mice to one or both members of the pair, and they take at least 2 mice, but do not deliver them to a nest on at least 2 visits (spaced at least 3 weeks apart) between 15 April and 1 June.
4) Confirmed single.

C) **Unknown.** The above criteria are not met. If nesting status is not determined before 1 June, you **CAN NOT** classify the owls as non-nesting.

III) **REPRODUCTIVE STATUS.** The issue here is the number of young **fledged**. It is important to determine reproductive status as soon after fledging as possible, because many young owls will die in the month or 2 after fledging.

A) **Successful reproduction, 1 or more young fledged**. Count the number of young. An auditory detection (even without visual confirmation) is acceptable, but it can be difficult to determine the number this way. 2 visits (spaced 3 to 10 days apart) are necessary to get a reliable count.

B) **Non-reproduction, 0 young fledged**.

1) A female has a brood patch with regenerating feathers in it, when examined in hand between 1 May and 1 June.
2) You offer 4 mice to one or both members of the pair, and they take at least 2 mice, but do not deliver them to young on at least 2 visits between 1 June and 15 July.
3) A pair is observed at least once between 1 April and 15 July, but is not found in at least 3 subsequent visits (spaced at least 1 week apart) before 15 July. At least one of these visits must include the period when fledglings have recently left the nest (1 June to 30 June).
4) Confirmed non-nesting.

C) **Unknown reproduction**. The above criteria are not met.

APPENDIX L. FIELD EQUIPMENT: LIST.

Thermometers (Alcohol)
Compasses (Prismatic)
Backpacking stoves, and matching fuel bottles
Backpacking cooksets
Water filters
Waterproof binoculars
Altimeters
First Aid kits, containing: First Aid instruction booklet; Waterproof bag; Bandages in ziploc bag; scissors; tweezers; latex gloves; razor blade; needle; iodine (water purifier); Ibuprofen; Aminofen; Benadryl; Bronkaid; Neosporin; Antiseptic towelettes; Iodine swab; adhesive tape; gauze bandage; assorted bandages (specialty); sterile gauze pad 4" x 4"; moleskin (for blisters); tampons.
Headlamps
Backpacks
Backcountry repair kits,
Tents
Owl capture (noose) poles
Owl banding kits, contents detailed in Appendix **M.**

APPENDIX M. BANDING SUPPLIES AND SOURCES.

Bandana (to cover the owl's eyes, and restrain the bird in your lap)
Small needle-nose pliers (about 5-6" long, for bending the metal locking band)
Small plastic "zip-ties" (for fastening color bands on the owls)
Small wire-cutters (about 4" long, for cutting off old color bands, snipping ends of zip-ties)
Calipers (from Forestry Suppliers, 800-647-5368, Plastic metric dial caliper #59591, $25 ea.)
Measuring tape (from Forestry Suppliers, Lufkin yellow-clad executive metric tape measure #39309 $11 ea.)
Ruler (from Forestry Suppliers, Metric/English ruler, 12" #47460, $0.90 ea.)
Pesola scale (from Forestry Suppliers, 1 kg. capacity, #93540 $37)
Rat toy (lure, cat toy from your local pet store)
Nooses (from Ray Forson, 32522 Fern Rd. Philomath OR 97370, but I don't think he is in the owl business any more. Eric Forsman [541-750-7266] would know an alternate source, if necessary.
Electrical tape
Wire noose holder
Swivels for noose pole (from fishing supply store)
Noose poles (Telescoping fishing Poles, 20' #920-303 about $22 from: Jann's Sportman's Supplies, 3350 Brairfield Blvd., Maumee, Ohio 43537, PHONE #: 1-800-638-2723)

APPENDIX N. PROGRESS REPORT EXAMPLE.

SPOTTED OWL MONITORING
IN
OLYMPIC NATIONAL PARK
1998 ANNUAL REPORT

D. Erran Seaman, Ecologist

U.S.G.S Biological Resources Division

Forest and Rangeland Ecosystem Science Center

Olympic Field Station

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Port Angeles WA 98362.

NOT FOR PUBLICATION

Prepared for the use of the U.S.G.S Biological Resources Division,

the National Park Service, and Cooperating Agencies.

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ACKNOWLEDGEMENTS

This project owes its success to the extremely hard work and serious dedication of many field technicians. A.E. Farris, S.A. Gremel, T.S. Kiener, A.L. Kirkaldie, K.V. Koelle, H.K. Pedersen, S.C. Spock, H.R. Stallman, M.E. Tengesdahl, and M.F. Wehling collected the data.

S.A. Gremel and H.K. Pedersen ably coordinated and supervised the field work. R.A. Hoffman and K.F. Beirne provided GIS support and analysis.

EXECUTIVE SUMMARY

This report summarizes progress on the northern spotted owl monitoring project in Olympic National Park (OLYM) in 1998. Demographic monitoring in OLYM is intended to follow-up the inventory project at Olympic National Park (1992-1995), and to coordinate with owl demographic studies conducted by the USFS PNW research team on the Olympic peninsula, and with other owl demographic studies conducted by the USFS and BLM in Washington, Oregon, and California. Specific objectives are to:

1) Study the population ecology of the spotted owl in the pristine habitat of OLYM;
2) Estimate demographic rates for the spotted owl population at OLYM (annual reproductive success, and age-specific birth and death rates).

We spent approximately 5,500 person/hours in the field, and made 258 visits to 58 spotted owl territories ("sites") to determine their occupancy and reproductive status. The reproductive success (fecundity) of spotted owl pairs on the Olympic peninsula has varied widely from year to year. Fecundity was estimated at 0.58 (number of female offspring per paired adult female) in 1998, essentially equal to the highly successful reproductive years of 1992, 1994, and 1996. Fecundity was much higher on the east side of the park (0.67) than the west side (0.25) in 1998.

We relocated 54 adult owls that had been banded previously, and we banded 27 new owls (10 adults and 17 juveniles) in 1998. One of the previously banded adults had been banded as a juvenile at another location in the park; this was the first juvenile banded during this project to be recaptured as an adult. These bring the total number of banded owls in the park to 229, which is an excellent base for continued monitoring of demographic trends.

We cooperated with non-NPS agencies that conduct spotted owl work. We shared all pertinent data with Eric Forsman (USFS) and performed joint analysis of the Olympic Peninsula owl population. Preliminary results suggest that survival and reproductive rates in the park are likely to be high enough to support a stable population. We continue to send all owl location data to the Washington Department of Fish and Wildlife (WDFW) for their state-wide spotted owl database.

RECOMMENDATIONS FOR FUTURE RESEARCH/MONITORING

Olympic National Park is an outstanding "control area" for studying spotted owls. The large area of pristine habitat is unmatched anywhere in the owl's range. This presents a unique opportunity

for making scientific contributions to the recovery effort for spotted owls, and for learning more about their ecology.

1. Continue demographic monitoring. The President's Northwest Forest Plan requires monitoring of the survival and reproductive rates of spotted owls at least through the year 2002 (as does the ESA). Recent review of spotted owl demographic studies assessed priorities and retained the Olympic peninsula province as a high priority site.

2. Monitor owl prey (flying squirrels, woodrats, hares, mice) densities. I hypothesize that prey density is an important factor influencing owl demography and population density in a pristine landscape. A study that integrates owl demography, prey densities, and landscape/habitat factors is needed to clarify these relationships.

3. Conclude study of habitat selection. We designed a habitat study to determine what forest characteristics spotted owls are selecting for in the context of the pristine forest of OLYM. Field data collection was completed in 1998, only analysis of the data remains.

INTRODUCTION

This report summarizes progress on the owl monitoring project in Olympic National Park (OLYM) during the 1998 breeding season, and covers results from the field work, as well as the topics of cooperative efforts, and project administration. It is intended as a summary of results for administrators and cooperators, but does not present detailed methodologies or data analysis. Study methods are detailed more fully in Fredrickson *et al.* (1992) and Seaman *et al.* (1992). Peer reviewed professional publications will follow with more rigorous treatments of data analysis.

OBJECTIVES

Demographic monitoring in OLYM is intended to follow-up the inventory project at Olympic National Park (1992-1995), and to coordinate with owl demographic studies conducted by the USFS PNW research team on the Olympic peninsula, and with other owl demographic studies conducted by the USFS and BLM in Washington, Oregon, and California. The specific objectives are to:

1) Study the population ecology of the spotted owl in the pristine habitat of OLYM;
2) Estimate the owl population's annual reproductive success, and age-specific birth and death rates.

SUBJECT REPORTS

Monitoring

OLYM monitored 53 spotted owl territories ("sites") in 1998, USFS research crews monitored an additional 5 sites within the park, and Washington State Department of Natural Resources (DNR) monitored 4 sites within the park. An additional 46 sites that have been occupied within the past 6 years were not monitored. The criteria used to select sites for monitoring included: accessibility, presence of previously banded owls, and funding availability. The cost/benefit ratio of monitoring nest sites was kept as favorable as possible by only monitoring sites that were within one day's hike from a trailhead or from another monitored site.

The winter of 1997-1998 was relatively mild, with minimal snow accumulations at the elevations of owl territories. Field visits to the sites were conducted during the breeding season, March 18th to July 23rd. The total monitoring effort for 1998 was approximately 550 person/days (5,500 person/hours) in the field.

The 58 sites visited by OLYM and USFS personnel were visited 258 times (mean(sd) = 4.5(2.2), range = 1 to 10). We obtained 144 responses (mean(sd) = 2.5(2.5) range = 0 to 8). We obtained no response at 18 sites. In 1998, 24 nesting pairs were located; 3 on the west side of the park, 21 on the east side. We have made an effort to monitor the same sites from year to year, including sites that have not been occupied recently. It is important to document unoccupied sites to characterize the distribution of spotted owls on the landscape.

More sites were occupied by two owls in 1992, 1994, 1996 and 1998 (years of high reproductive success), and fewer sites were occupied by two owls in 1993, 1995 and 1997 (years of low reproductive success, Figure 1).

Reproductive Success

Spotted owl reproductive success (fecundity) is defined as the number of female young produced per pair. Fecundity at our monitored sites in 1998 was 0.58. This is a fairly high

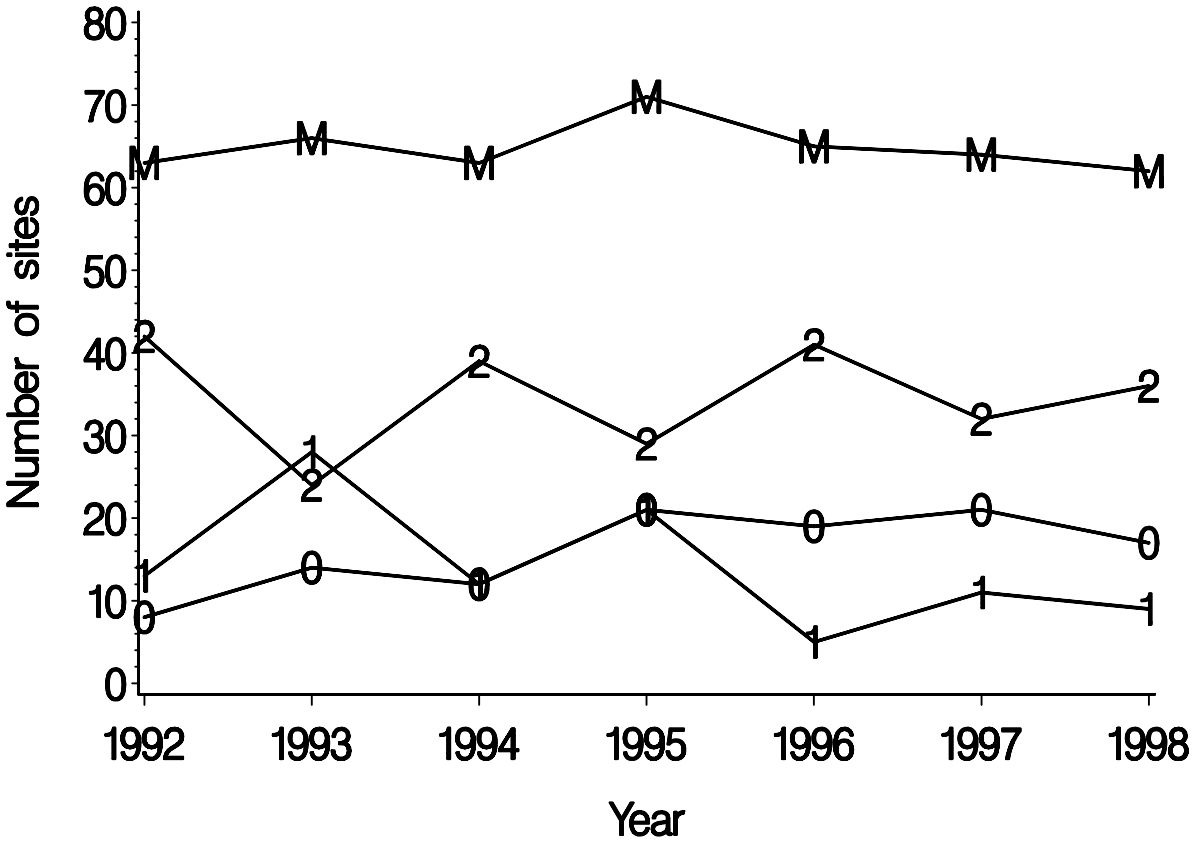

Figure 1. Number of monitored spotted owl sites (M), and number of sites occupied by O, 1, or 2 adult owls. Note the complementary nature of the numbers of sites with 1 vs. 2 owls.

fecundity value, comparable to successful nesting years during the previous 6 years of monitoring. Reproductive success was much higher on the east side of the park than the west side in 1998. On the east side, 24 monitored pairs produced 32 young (fecundity = 0.67), and on the west side, 6 pairs produced 3 young (fecundity = 0.25). Although fecundity differences between the east and west side are not statistically significant (p=0.37), fecundity has been higher on the east side in all years except 1996. Average park-wide fecundity for 1992-1998 was 0.46 (s.e. 0.03), which is significantly greater than the long-term average fecundity (0.34) over the range of the northern spotted owl (Burnham *et al.* 1996).

Fecundity in the park shows a pattern of alternating years of relatively high reproductive success and years of little or no successful reproduction (Figure 2). I do not believe that this pattern is indicative of any long term regular cycle, it is most likely a response to annual variation in weather. Reproductive records from other owl study areas in Washington and Oregon show a similar pattern for the years since 1992, but show irregular fluctuations in the years preceding 1992 (Knight and Seaman 1995).

Fecundity in the park was equal to or greater than fecundity in the surrounding National Forest in most years, but not in 1997. Fecundity estimates are particularly important because the population estimate alone is not sufficient to determine whether the park population is strong. A population that consists of high numbers of animals with poor reproductive success and poor survival rates will contribute little to the survival of the species. In contrast, the spotted owl population in Olympic National Park appears strong since reproductive rates are fairly high. However, a large number of owl sites have produced no offspring during this project (1992-1998, Figure 3), and a few sites have produced the majority of

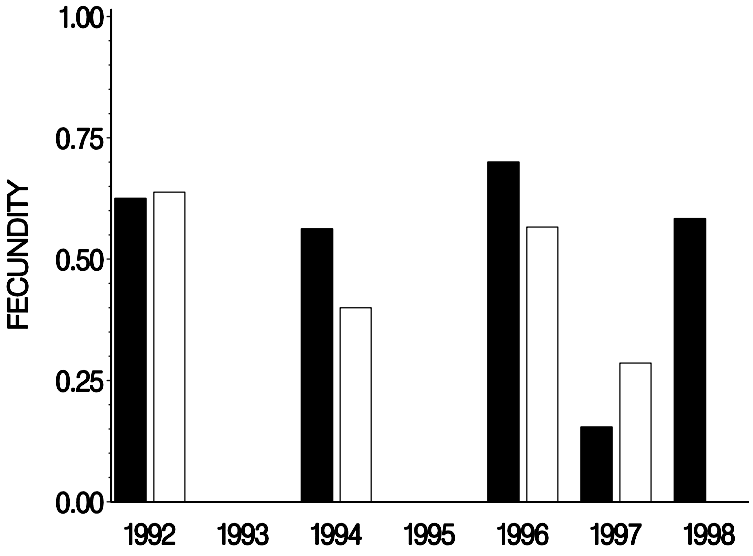

Figure 2. Average fecundity for owl pairs monitored on the Olympic peninsula, 1992 – 1998. Black bars are Olympic National Park, white bars are National Forest (National Forest data not available for 1998).

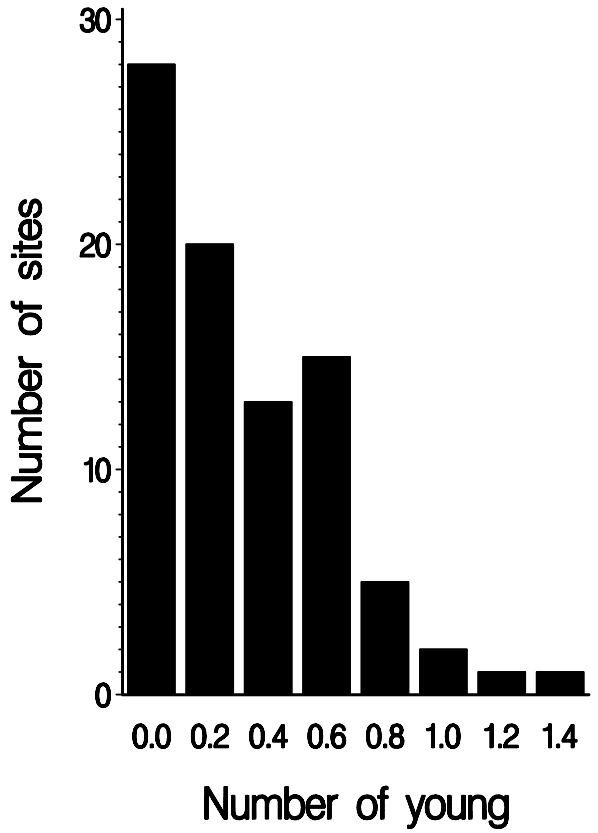

Figure 3. Average annual reproductive success (both sexes, not just female young), for sites that have been monitored for more than 2 years.

fledglings. Additional monitoring to estimate reproductive and survival rates is necessary to conclusively determine the park population growth rate.

Habitat selection

Approximately 40 spotted owl nest locations have been identified since the inventory/monitoring project began in 1992. These locations have been marked, and there are now enough of them to support the rigorous habitat analysis which was one of the original objectives of the project. Sampling methods were developed in 1996 in consultation with plant ecologists and a statistician. Field data collection was completed in FY 1998.

Banding

Banding owls is necessary to identify individuals. We used standard capture techniques for spotted owls, and emphasized owl safety during training (Forsman 1983). There have been no owl injuries in over 300 successful captures (using both the "hand-grab" and noosing techniques) of 229 different owls at OLYM. In 1998 we banded 17 juveniles and 10 new adults.

We relocated 54 adult owls that had been banded previously. One of the previously banded adults had been banded as a juvenile at another location in the park; this was the first juvenile banded during this project to be recaptured as an adult.

Other species

Other species of raptors also responded to our surveys. We recorded responses from 3 pairs and 8 individual barred owls (*Strix varia*). Of these 11 sites, 3 were new sites not previously occupied by barred owls. Previously, barred owls had only been found fairly close to the park boundary. But since 1996, barred owls have occupied sites deep in the park, 15 to 25

miles from the park boundary. This expansion deeper into the park in the past few years needs to be carefully monitored. Barred owls have recently expanded their geographic range into the Pacific Northwest; barred owls almost certainly compete with spotted owls, and it is likely that they occasionally prey on spotted owls (Dark et al. 1998).

Despite the fact that barred owls are found at new sites every year, it is not clear whether the number of occupied barred owl territories in the park is increasing. Barred owls appear to have less fidelity to nesting sites than spotted owls do, and several old sites are abandoned every year. But, because we are unable to put much effort into banding barred owls, it is impossible to know how many individuals we have located in the park.

Some limited hybridization between barred and spotted owls does occur. No new hybrids were found in 1998.

We located goshawks (*Accipiter gentilis*) at only 2 sites in 1998, both territories were known from previously years.

COOPERATIVE EFFORTS

Monitoring data from OLYM was combined with that from the surrounding National Forest study for demographic analysis of northern spotted owl populations range-wide. This court-mandated data analysis took place in Corvallis, OR, in December 1998; a full report will be produced by the organizers of that analysis.

BUDGET

Funding was provided at the level of $125,000 in FY 1998. The "effectiveness monitoring" component of the President's Forest Plan requires demographic monitoring of 8 spotted owl populations through the year 2002; the Olympic peninsula population was specifically included in the 8 populations to be monitored.

RECOMMENDATIONS FOR FUTURE RESEARCH/MONITORING

Olympic National Park is an outstanding "control area" for studying spotted owls. The large area of pristine habitat is unmatched anywhere in the owls' range. This presents a unique opportunity for making scientific contributions to the recovery effort for spotted owls, and for learning more about their ecology.

1. Continue demographic monitoring. The President's Northwest Forest Plan requires monitoring of the survival and reproductive rates of spotted owls for at least 4 more years (as does the ESA). Recent review of spotted owl demographic studies has assessed priorities, continued some studies and eliminated low priority studies; the Olympic peninsula province was retained as a high priority site. The spotted owl population on the peninsula is a single population that freely crosses the border between the adjacent USFS and NPS lands. Therefore, the two studies should be retained as a unit.
2. Monitor owl prey (flying squirrels, woodrats, hares, mice) densities. I hypothesize that prey density is an important factor influencing owl demography and population density in a pristine landscape. A study that integrates owl demography, prey densities, and landscape/habitat factors is needed to clarify these relationships. Remarkable patterns of fecundity and population density have been identified by the current study. These patterns could hold important keys to understanding spotted owl population trends, but without such research the causes of the patterns will remain poorly understood.
3. Conclude study of habitat selection. Approximately 40 nest sites have been located in OLYM. The greatest proportion of these sites are on the east side of the park, many are in habitat that previous analyses (e.g. Holthausen *et al.* 1995) have deemed to be poor quality or unsuitable for spotted owls. We have designed a habitat study to determine what forest characteristics spotted owls are selecting for in the context of the pristine forest of OLYM.

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APPENDIX O. SAS PROGRAMS FOR SUMMARIZING DATA.

The following SAS programs are used for producing the numerical and graphical results included in the annual progress report.

```
/* BEGIN PROGRAM: NUMOWLS.SAS */
/*************************************************************************
***
 This program uses the STATUS table from the OWLDATA database.  It makes fig.
2 for the progress report -- the number of adult owls found at monitored
sites, for all years of monitoring.  It uses the STATUS table (saved and
imported as a dbase table).
*************************************************************************
**/
DATA NUMBER OTHERS;
  SET STATUS;
  IF SPECIES NE 'STOC' THEN DELETE;
  IF YEAR < 1992 THEN DELETE;
  NUMOWLS = NUMMALE + NUMFEMAL + NUMUNKNO;
  IF SITE < 3 THEN NUMOWLS = 2;
/*
    ELSE IF SITE < 5 THEN NUMOWLS = 1;
      ELSE NUMOWLS = 0;
*/
  IF MONITORE = 'OLYM' THEN OUTPUT NUMBER;
  ELSE OUTPUT OTHERS;
  RUN;

PROC SORT DATA = OTHERS;
  BY YEAR SITE_NAM;
  RUN;
/*
PROC PRINT DATA = OTHERS;
  VAR SITE_NAM YEAR NUMOWLS SITE PAIR MONITORE;
  RUN;
*/
PROC SORT DATA = NUMBER;
  BY YEAR NUMOWLS SITE_NAM;

DATA RAW;
  SET NUMBER;
  RUN;

PROC FREQ DATA = RAW;
  TABLES NUMOWLS * YEAR / LIST NOPERCENT OUT = FREQS;
  RUN;
/*
PROC PRINT DATA = NUMBER;
  VAR SITE_NAM YEAR NUMOWLS SITE PAIR;
  RUN;
*/

PROC SORT DATA = FREQS OUT = YEARS;
  BY YEAR;
  RUN;
PROC MEANS DATA = YEARS NOPRINT;
```

```
  BY YEAR;
  VAR COUNT;
  OUTPUT OUT = TOT SUM = COUNT;
DATA NEWFREQS;
  SET FREQS TOT;
  IF NUMOWLS = . THEN NUMOWLS = 3;
  RUN;
PROC PRINT DATA = NEWFREQS;
  TITLE 'Number of sites occupied by 0, 1, or 2 owls in each year (3=
#Monitored sites)';
  RUN;

PROC MEANS DATA = NEWFREQS;
  BY NUMOWLS;
  VAR COUNT;
  OUTPUT OUT = ALLMEAN MEAN = NUMSITES STD = SD;
  RUN;
DATA ALLMEAN;
  SET ALLMEAN;
  FORMAT NUMSITES F5.1 SD F5.1;
  RUN;
PROC PRINT DATA = ALLMEAN;
  TITLE 'MEAN AND STD. DEV. OF NUMBER OF SITES MONITORED ANNUALLY SINCE
1992';
  VAR NUMOWLS NUMSITES SD;
  RUN;
/**********THE NEXT SECTION MAKES BLACK/WHITE GRAPHIC FOR REPORT ********/
GOPTIONS RESET = ALL DEVICE = WIN CBACK = WHITE CTEXT = BLACK FTEXT = SWISSL;

AXIS1 MINOR = NONE W=2 LABEL=(H=2 'Year') VALUE = (H=2) C=BLACK;
AXIS2 MINOR = NONE W=2 LABEL=(H=2 A=90 'Number of sites') VALUE = (H=2)
C=BLACK;
SYMBOL1 I=JOIN F=SWISSL V=0 C=BLACK H=2 W=2;
SYMBOL2 I=JOIN F=SWISSL V=1 C=BLACK H=2 W=2;
SYMBOL3 I=JOIN F=SWISSL V=2 C=BLACK H=2 W=2;
SYMBOL4 I=JOIN F=SWISSL V=M C=BLACK H=2 W=2;
/*
FILENAME G1 'H:\OWLCREW\PROG_REP\99\OWLNUM.TIF';
GOPTIONS DEVICE = TIFFB GSFNAME = G1 GSFMODE = REPLACE;
*/
PROC GPLOT DATA = NEWFREQS;
  PLOT COUNT * YEAR = NUMOWLS / NOLEGEND HAXIS = AXIS1 VAXIS = AXIS2;
RUN;
QUIT;
/*********** THE NEXT SECTION MAKES GRAPHIC FOR COLOR SLIDES ************/
GOPTIONS DEVICE = WIN FTEXT = SWISS CBACK=BLUE CTEXT = YELLOW;

AXIS1 MINOR=NONE C=YELLOW W=3 LABEL=(H=2 'Year') VALUE=(H=2) MAJOR=(W=2);
AXIS2 C=YELLOW W=2 LABEL=(H=2 A=90 'Number of sites') VALUE=(H=2) MAJOR=(W=2)
MINOR=(N=1 W=2);
SYMBOL1 I=JOIN F=SWISSL V=0 C=YELLOW H=2 W=3;
SYMBOL2 I=JOIN F=SWISSL V=1 C=YELLOW H=2 W=3;
SYMBOL3 I=JOIN F=SWISSL V=2 C=YELLOW H=2 W=3;
SYMBOL4 I=JOIN F=SWISSL V=M C=YELLOW H=2 W=3;
/*
FILENAME G2 'H:\OWLCREW\PROG_REP\99\OWLNUM.CGM';
GOPTIONS DEVICE = CGMMWWC GSFNAME = G2 GSFMODE = REPLACE;
*/
PROC GPLOT DATA = NEWFREQS;
```

```
  PLOT COUNT * YEAR = NUMOWLS / NOLEGEND HAXIS = AXIS1 VAXIS = AXIS2;
  TITLE 'SITE OCCUPANCY';
  TITLE2;
RUN;
QUIT;
/* END PROGRAM: NUMOWLS.SAS */
```

```
/* BEGIN PROGRAM: VISITS.SAS */

/* FIRST, IMPORT H:\OWLCREW\PROG_REP\9x\VISITS.DBF for the current year.
Create this by exporting the query "Number of visits - used in report" from
the Owldata Access database. */

/*************************************************************************
This program summarizes the number of visits made to owl sites, and the
numbers of owl responses obtained.
*************************************************************************/

DATA VISITS;
  SET VISITS;
  RENAME EXPR1 = YEAR;
  IF YES = . THEN YES = 0;
  IF NO = . THEN NO = 0;
  TOTVIS = YES + NO;
RUN;

PROC PRINT DATA = VISITS;
  TITLE 'Number of visits and responses per site per year';
RUN;

PROC SORT DATA = VISITS;
  BY YEAR SITE_NAM;
RUN;

PROC MEANS DATA = VISITS NOPRINT;
  BY YEAR;
  VAR TOTVIS YES;
  OUTPUT OUT = MEANVIS N=NSITES SUM=TOTVIS RESPONSE MEAN=MEANVIS MEANRESP
STD=SDVIS SDRESP
                       MAX=MAXVIS MIN=MINVIS;
RUN;

PROC PRINT DATA = MEANVIS;
  FORMAT MEANVIS MEANRESP SDVIS SDRESP F4.1;
  VAR YEAR NSITES TOTVIS RESPONSE MEANVIS MEANRESP SDVIS SDRESP MAXVIS
MINVIS;
  TITLE 'Sum, Mean and Std.Dev. of number of visits and responses by year';
RUN;

DATA NORESP;
  SET VISITS;
  IF YES = 0;
  /* This selects only the sites that never had a response in a given year */
RUN;

PROC PRINT DATA = NORESP;
  VAR YEAR SITE_NAM NO;
  TITLE 'Number of no-response visits per site per year';
RUN;

PROC MEANS DATA = NORESP;
  BY YEAR;
  VAR NO;
  OUTPUT OUT = NUMNO N=NUMSITES;
```

```
  /* This counts the number of sites that never had a response in a given
year */
RUN;

PROC PRINT DATA = NUMNO;
  TITLE 'Number of sites with no response, by year';
  VAR YEAR NUMSITES;
RUN;
/* END PROGRAM: VISITS.SAS */
```

```
/* BEGIN PROGRAM: FECUND.SAS */
/*************************************************************************
*
  This program calculates annual fecundity for owls in the park.  It also
incorporates annual fecundity from USFS PNW research on the Olympic peninsula
for comparison to the park.  And it looks at reproductive success of
individual territories in the park, compares them to the overall mean
reproductive success, and graphs the number of territories with their overall
reproductive success.
*************************************************************************
*/

GOPTIONS RESET = ALL DEVICE = WIN;
/*************************************************************************
**
  FIRST, IMPORT H:\OWLCREW\PROG_REP\9x\STATUS.DBF DATA FILE (DBASE3 TABLE)
FOR THE CURRENT YEAR AS SAS DATASET 'STATUS'
*************************************************************************
*/
DATA ONE;
  SET STATUS;
  IF SPECIES EQ 'STOC';
  IF JUV_NUM = . THEN JUV_NUM = 0;
  IF PAIR = 'P' THEN
    FECUNDIT = JUV_NUM / 2;
  RENAME SITE_NAM = SITENAME;
  RUN;
/*
PROC PRINT DATA = ONE;
  RUN;
*/
/* Get data from Brian Biswell (Olympia PNW lab) for the USFS PNW study, put
it in this file. */
DATA FOREST;
  INFILE 'H:\OWLCREW\DATA\PNW\ONF_FEC.DTA';
  INPUT YEAR NUM_FEM AVG_FEC SE_FEC;
  OWNER = 'ONF';
  IF YEAR >= 1992;
  RUN;

PROC SORT DATA = ONE OUT = YEARS;
  BY YEAR SITENAME;
  RUN;
```

```
DATA OLYPEN;
  MERGE YEARS FOREST;
  BY YEAR;
  RUN;
PROC PRINT DATA = OLYPEN;
  RUN;

DATA RECENT;
  SET YEARS;
  IF YEAR > 1991;
  IF OWNER EQ 'OLYM';
  IF PAIR = 'P' THEN P_NUM = 1;
    ELSE P_NUM = 0;

  /* Code occupancy to look at correlation between occupancy and reproductive
success. */
  IF SITE_INT <= 3 THEN OCCUPIED = 1;
    ELSE OCCUPIED = 0;
  IF SITE_INT <2 THEN OCC_PAIR = 1;
    ELSE OCC_PAIR = 0;
  IF SITE_INT = 3 THEN OCC_SING = 1;
    ELSE OCC_SING = 0;
  RUN;
/*
PROC PRINT DATA = RECENT;
  VAR YEAR SITENAME FECUNDIT SITE_INT OCCUPIED OCC_SING OCC_PAIR;
  RUN;
*/
/***************************************************************************
The following section analyzes correlation between occupancy and reproductive
success.
***************************************************************************/
PROC SORT DATA = RECENT OUT = SITES;
  BY SITE_NAM YEAR;
  RUN;
PROC MEANS DATA = SITES NOPRINT /*SUM N*/;
  BY SITE_NAM;
  VAR OCCUPIED OCC_PAIR OCC_SING FECUNDIT;
  OUTPUT OUT = MEANOCC SUM = OCCUPIED OCC_PAIR OCC_SING FECUNDIT;
  RUN;
DATA MEANOCC;
  SET MEANOCC;
  PCT_POCC = OCC_PAIR / _FREQ_; /* Percent of monitored years the site was
occupied by a pair */
  PCT_SOCC = OCC_SING / _FREQ_;  /* Percent of monitored years the site was
occupied by a single */
  PCT_OCC = OCCUPIED / _FREQ_;  /* Percent of monitored years the site was
occupied at all */
  RUN;
PROC PRINT DATA = MEANOCC;
  RUN;

PROC CORR DATA = MEANOCC;
  VAR FECUNDIT OCC_PAIR OCC_SING OCCUPIED;
  RUN;
PROC CORR DATA = MEANOCC;
  VAR FECUNDIT PCT_POCC PCT_SOCC PCT_OCC;
  RUN;
```

```
/********* End of section analyzing correlation between occupancy and
reproductive success. *********/

/***** This section compares OLYM fecundity to all study areas (Franklin et
al 1999) ****/
DATA COMPARE;
  SET RECENT;
  IF YEAR < 1999; /* No comparative data is available yet for 1999. */
  COMP_FEC = FECUNDIT - 0.321; /* 0.321 is the mean fecundity for all study
areas. */
  /* Calculate the difference between OLYM fecundity and average fecundity
for all demographic studies in all years. */
  RUN;

PROC MEANS DATA = COMPARE MEAN STDERR T PRT N;
/* Test whether the comparative fecundity is different from 0, which is the
same as testing whether the OLYM fecundity is different from the average for
all study areas. */
  VAR COMP_FEC FECUNDIT;
  TITLE 'T-TEST FOR DIFFERENCE BETWEEN OLYM FECUNDITY AND ALL OTHER STUDIES';
  TITLE2 'COMP_FEC IS THE COMPARED FECUNDITY, TEST IS WHETHER THIS IS
DIFFERENT FROM 0';
  RUN;

/* @!!!@ Add in a t-test to compare OLYM fecundity to ONF.  But how? Year by
year paired test? */

/******** End comparison to all study areas ******************************/

/*****************************************************************************
The following section summarizes OLYM fecundity by East vs. West side, and
does ANOVA to look at year and side effects
*****************************************************************************
*/
PROC SUMMARY DATA = RECENT;
  CLASS YEAR;
  ID OWNER;
  VAR FECUNDIT P_NUM;
  OUTPUT OUT = YEARMEAN MEAN = AVG_FEC STDERR = SE_FEC SUM = F_YOUNG PAIRS;
  RUN;

PROC SORT DATA = RECENT OUT = SIDES;
  BY YEAR SIDE;
PROC SUMMARY DATA = SIDES;
  CLASS YEAR SIDE;
  VAR FECUNDIT P_NUM;
  OUTPUT OUT = SIDEMEAN MEAN = AVG_FEC STDERR = SE_FEC SUM = F_YOUNG PAIRS;
  RUN;
PROC PRINT DATA = SIDEMEAN;
  TITLE 'FECUNDITY BY YEAR, EAST VS. WEST SIDE';
  RUN;
DATA YEARMEAN;
  SET YEARMEAN;
  FORMAT AVG_FEC F5.2 SE_FEC F5.2;
  RUN;
PROC PRINT DATA = YEARMEAN;
/* Print this for including in progress report */
  TITLE 'FECUNDITY 1992-1999, WHOLE PARK';
  VAR YEAR F_YOUNG PAIRS AVG_FEC SE_FEC;
```

```
  RUN;

DATA PEN;
  SET YEARMEAN FOREST;
  IF YEAR = . THEN DELETE;
  RUN;

PROC GLM DATA = RECENT;
  CLASS YEAR SIDE;
  MODEL FECUNDIT = YEAR SIDE;
  RUN;

/********* End analysis of year and side effects on OLYM fecundity ********/

/****** Graphs OLYM E vs. W fecundity for progress report *****************/

GOPTIONS RESET = ALL DEVICE = WIN FTEXT=SWISSL;
/*
FILENAME G2 'H:\OWLCREW\PROG_REP\99\FEC_EW.JPG';
GOPTIONS CBACK = WHITE DEVICE = IMGJPEG GSFNAME = G2 GSFMODE = REPLACE;
*/
AXIS1 C=BLACK W=2 LABEL = (A=90 H=2.5 'Fecundity') ORDER = (0 TO 1 BY 0.25)
      MINOR = (N=4) VALUE=(H=2.5);
AXIS2 C=BLACK W=2 LABEL = NONE VALUE=NONE;
AXIS3 C=BLACK LABEL = NONE VALUE=(H=2.5);

PATTERN1 V=S C=BLACK;
PATTERN2 V=M5 C=BLACK;

DATA NEWSIDE;
  SET SIDEMEAN;
  IF _TYPE_ = 3;
  IF YEAR = . THEN DELETE;
  IF SIDE = 'W' THEN SIDE = 'A';
    ELSE SIDE = 'B';
  RUN;
PROC GCHART DATA = NEWSIDE;
  VBAR SIDE / GROUP = YEAR TYPE = SUM SUMVAR = AVG_FEC PATTERNID = MIDPOINT
              RAXIS = AXIS1 MAXIS = AXIS2 GAXIS = AXIS3;
  RUN;
QUIT;
/******* End graphing E vs. W fecundity for progress report **************/
/*
DATA J96;
  SET RECENT;
  IF YEAR < 1997;
  RUN;
PROC MEANS DATA = J96 NOPRINT;
  VAR FECUNDIT;
  OUTPUT OUT = ALLMEAN MEAN = AVG_FEC STDERR = SE_FEC;
  RUN;
PROC PRINT DATA = ALLMEAN;
  TITLE 'OVERALL MEAN FECUNDITY, 1992-1996, OLYMPIC NATIONAL PARK';
  RUN;
*/

/******* Plot fecundity for OLYM alone **********************************/
GOPTIONS DEVICE = WIN FTEXT=SWISSL;
```

```
SYMBOL I=STDMJT W=2;
AXIS1 W=2 LABEL = (A=90 H=2 'FECUNDITY') ORDER = (0 TO 1 BY 0.25) MINOR =
(N=4)
      VALUE=(H=2);
AXIS2 W=2 LABEL = (H=2) MINOR = NONE VALUE=(H=2);

/*
FILENAME G1 'H:\OWLCREW\PROG_REP\97\FECUND.HPG';
GOPTIONS DEVICE = HPGL GSFNAME = G1 GSFMODE = REPLACE;
*/
PROC GPLOT DATA = RECENT;
  PLOT FECUNDIT * YEAR / HAXIS = AXIS2 VAXIS = AXIS1;
  TITLE;
  RUN;
QUIT;

/******* Plot fecundity for OLYM compared to PNW, B&W for report **********/
GOPTIONS DEVICE = WIN FTEXT=SWISSL;
/*
FILENAME G2 'H:\OWLCREW\PROG_REP\97\FEC_COMP.HPG';
GOPTIONS CBACK=WHITE DEVICE=HPGL GSFNAME=G2 GSFMODE=REPLACE;
*/
AXIS1 C=BLACK W=2 LABEL=(A=90 H=2 'Fecundity') ORDER=(0 TO 1 BY 0.25)
      MINOR=(N=4) VALUE=(H=2);
AXIS2 C=BLACK W=2 LABEL=NONE VALUE=NONE;
AXIS3 C=BLACK LABEL=NONE VALUE=(H=2);

PATTERN1 V=S C=BLACK;
PATTERN2 V=E C=BLACK;

PROC GCHART DATA = PEN;
  VBAR OWNER / GROUP = YEAR TYPE = SUM SUMVAR = AVG_FEC PATTERNID = MIDPOINT
               RAXIS = AXIS1 MAXIS = AXIS2 GAXIS = AXIS3;
  TITLE;
  FOOTNOTE;
  RUN;
QUIT;

/********* Plot E vs. W fecundity in OLYM ******************************/
/*
FILENAME G2 'H:\OWLCREW\PROG_REP\99\FEC_EW.CGM';
GOPTIONS CBACK = BLUE CTEXT = YELLOW DEVICE = CGMMWWC GSFNAME = G2 GSFMODE =
REPLACE;
*/
AXIS1 C=YELLOW W=2 LABEL = (A=90 H=2.5 'Fecundity') ORDER = (0 TO 1 BY 0.25)
      MINOR = (N=4) VALUE=(H=2.5);
AXIS2 C=YELLOW W=2 LABEL = NONE VALUE=NONE;
AXIS3 C=YELLOW LABEL = NONE VALUE=(H=2.5);

PATTERN1 V=S C=YELLOW;
PATTERN2 V=S C=RED;

PROC GCHART DATA = NEWSIDE;
  VBAR SIDE / GROUP = YEAR TYPE = SUM SUMVAR = AVG_FEC PATTERNID = MIDPOINT
               RAXIS = AXIS1 MAXIS = AXIS2 GAXIS = AXIS3;
  TITLE 'Annual Fecundity in Olympic National Park';
  TITLE2 H=2 J=L C=YELLOW '                West side'  J=R C=RED 'East side
';
  RUN;
```

```
QUIT;

/**************** Plot OLYM vs. FS fecundity, color for slides
**************/
/*
FILENAME G2 'H:\OWLCREW\PROG_REP\98\FEC_COMP.CGM';
GOPTIONS CBACK=BLUE FTEXT=SWISSL DEVICE=CGMMWWC GSFNAME=G2 GSFMODE=REPLACE;
*/
GOPTIONS DEVICE=WIN CBACK=BLUE;
AXIS1 C=YELLOW W=2 LABEL = (A=90 H=2 'Fecundity') ORDER = (0 TO 1 BY 0.25)
      MINOR = (N=4) VALUE=(H=2);
AXIS2 C=YELLOW W=2 LABEL = (H=2) MINOR = NONE VALUE=(H=2);
AXIS3 C=YELLOW W=2 LABEL = NONE VALUE=NONE;
AXIS4 C=YELLOW LABEL = NONE VALUE=(H=2);

PATTERN1 V=S C=YELLOW;
PATTERN2 V=S C=LILAC;

PROC GCHART DATA = PEN;
  VBAR OWNER / GROUP = YEAR TYPE = SUM SUMVAR = AVG_FEC PATTERNID = MIDPOINT
               RAXIS = AXIS1 MAXIS = AXIS3 GAXIS = AXIS4;
  FOOTNOTE C=YELLOW H=2 'National Park  ' C=LILAC '  National Forest';
  TITLE C=YELLOW 'Comparison of Annual Reproductive Success';
  RUN;
QUIT;
/************ End color slide plot ****************************************/

/*****************************************************************************
*
  This section makes the dataset MANYYEAR, for the chart used in Fig. 4 of
the progress report.
*****************************************************************************
*/
PROC SORT DATA = RECENT OUT = SITES;
  BY SITENAME YEAR;
  RUN;
PROC MEANS DATA = SITES NOPRINT;
  ID SITE_NUM SIDE;
  BY SITENAME;
  VAR JUV_NUM;
  OUTPUT OUT = SITESUM SUM = SUM_JUVS;
  RUN;
/*
PROC PRINT DATA = SITESUM;
  RUN;
*/
DATA MANYYEAR;
  SET SITESUM;
  IF _FREQ_ > 2;
  MEANJUVS = SUM_JUVS / _FREQ_;
  RUN;
/****** End making MANYYEAR data for Fig. 4
*********************************/

/****** The following makes a black & white graphic for progress report.
****/

DATA NEWMEAN;
  SET MANYYEAR;
```

```
  MEANFJUV = MEANJUVS / 2; /* Mean number of female juveniles produced. */
  RUN;

GOPTIONS DEVICE = WIN CBACK=WHITE CTEXT=BLACK FTEXT = SWISSL;
/*
FILENAME G3 'H:\OWLCREW\PROG_REP\99\FYOUNG.JPG';
GOPTIONS FTEXT = SWISSL DEVICE = IMGJPEG GSFNAME = G3 GSFMODE = REPLACE;
*/

AXIS1 W=2 LABEL=(H=2 'Number of female young') VALUE = (H=1.5) C=BLACK;
AXIS2 W=2 LABEL=(A=90 H=2 'Number of sites') VALUE = (H=1.5) C=BLACK;
PATTERN1 V=S C=BLACK;
PROC GCHART DATA = NEWMEAN;
  VBAR MEANFJUV / MIDPOINTS = (0 TO 0.7 BY 0.1) MAXIS = AXIS1 RAXIS = AXIS2;
  TITLE;
  FOOTNOTE;
  RUN;
QUIT;

PROC FREQ DATA = NEWMEAN;
  TABLES SUM_JUVS;
  RUN;

/********** The following makes a color graphic for slides. ***************/

GOPTIONS DEVICE = WIN CBACK = BLUE CTEXT=YELLOW;
/*
FILENAME G4 'H:\OWLCREW\PROG_REP\98\YOUNG.CGM';
GOPTIONS CBACK = BLUE CTEXT=YELLOW FTEXT=SWISSL DEVICE = CGMMWWC GSFNAME = G4
GSFMODE = REPLACE;
*/
AXIS1 C=YELLOW W=2 LABEL = (H=2 'Number of Young') MINOR = NONE
VALUE=(H=1.5);
AXIS2 C=YELLOW W=2 LABEL = (A=90 H=2 'Number of Sites') MINOR = (N=4 W=2)
MAJOR=(W=2)
      VALUE=(H=2);

PATTERN1 V=S C=YELLOW;
PROC GCHART DATA = MANYYEAR;
  VBAR MEANJUVS / MIDPOINTS = (0 TO 1.4 BY 0.2) MAXIS = AXIS1 RAXIS = AXIS2;
  TITLE C=YELLOW 'Average Annual Reproductive Success';
  TITLE2 H=2 'of Owl Sites in OLYM';
  TITLE3;
  FOOTNOTE;
  RUN;
QUIT;

/*
FILENAME G5 'H:\OWLCREW\PROG_REP\98\TOTYOUNG.CGM';
GOPTIONS CBACK = BLUE CTEXT=YELLOW FTEXT=SWISSL DEVICE = CGMMWWC GSFNAME = G5
GSFMODE = REPLACE;
*/
PROC GCHART DATA = MANYYEAR;
  VBAR SUM_JUVS / MIDPOINTS = (0 TO 11 BY 1) MAXIS = AXIS1 RAXIS = AXIS2;
  TITLE C=YELLOW 'Total Reproductive Success';
  TITLE2 H=2 'of Owl Sites in OLYM';
  TITLE3;
  FOOTNOTE;
  RUN;
```

```
QUIT;

/*************************************************************************
**
The following prints the sitenames in order of decreasing reproductive
success
*************************************************************************
*/
PROC SORT DATA = MANYYEAR;
  BY DESCENDING SUM_JUVS;
  RUN;
PROC PRINT DATA = MANYYEAR;
  VAR SITENAME _FREQ_ SUM_JUVS MEANJUVS;
  TITLE;
  RUN;
/* END PROGRAM: FECUND.SAS
```

APPENDIX P. SAS PROGRAM FOR POPULATION ESTIMATE.

The following SAS program implements the equations in the section on population estimation. It produces estimates of density and numbers, along with variances and confidence intervals, for each stratum and for the whole park.

```
/* BEGIN POP_EST2.SAS */
/*************************************************************************

A PROGRAM TO ESTIMATE THE OWL POPULATION OF OLYMPIC NATIONAL PARK, INCLUDING
VARIANCES FOR COMPUTING A CONFIDENCE INTERVAL.  THIS IMPLEMENTS PROCEDURES
DEVELOPED BY K. H. POLLOCK IN A REPORT CONTRACTED BY OLYMPIC NATIONAL PARK.
COMMENTS REFER TO EQUATION NUMBERS IN THAT REPORT.

PAIRS ARE INDICATED HERE AS NUMBER OF PAIRED INDIVIDUALS, I.E. TWICE THE
   ACTUAL NUMBERS OF PAIRS.  AFTER ALL CALCULATIONS ARE DONE, THE NUMBER IS
   DIVIDED BY 2 TO RETURN TO THE ACTUAL NUMBER OF PAIRS.

POP_EST2.SAS MAKES ESTIMATES USING ALL YEARS' DATA.  POP_EST1.SAS ONLY MADE
   AN ESTIMATE FOR A SINGLE YEAR'S DATA AT A TIME.
*************************************************************************/

DATA PLOTCNT;
/* THE COUNTS OF OWLS BY SURVEY PLOT, ALSO AREA OF THE PLOTS. */
  INFILE 'C:\OWL\DATA\DENSITY\PLOTAREA.DT2';
  INPUT PLOT $ 1-10 STRATUM $ 12 AREA 17-25 YEAR 33-34 INDIVS 37 PAIRS 43;
  AREA = AREA / 100; /* CONVERT TO KM^2 */
/*  PAIRS = PAIRS /2; */
  PAIRDENA = PAIRS / AREA;
  INDDENA = INDIVS / AREA;
  RUN;
PROC SORT DATA = PLOTCNT;
  BY STRATUM PLOT;
  RUN;
DATA TOTSTRAT; /* TOTAL AREA FOR EACH STRATUM */
  INFILE 'C:\OWL\DATA\DENSITY\STRATTOT.DTA';
  INPUT STRATUM $ 1 TOTAREA;
  TOTAREA = TOTAREA / 100; /* CONVERT TO KM^2 */
  RUN;
PROC SORT DATA = TOTSTRAT;
  BY STRATUM;
  RUN;
DATA EXP;
/* ANNUAL ESTIMATES OF CAPTURE PROBABILITY AND VARIANCE BY STRATUM */
  INFILE 'C:\PASCAL\CI\VAR_P_PR.OUT';
  INPUT YEAR 3-4 STRATUM $ 5 S2 $ 5-8 K NHATJ PHAT REPS NEWPHAT VARPHAT;

  PSTAR = 1 - (1 - PHAT) ** K;
  VARPSTAR = VARPHAT * (K**2 * (1 - PHAT) ** (2 * (K-1))); /* EQ. 3.2.1 */
  RUN;
DATA ALL;
  MERGE TOTSTRAT PLOTCNT;
  BY STRATUM;

  FORMAT AREA F6.2 PAIRDENA F5.2 PAIRNUMA F3.0;
```

```
  PAIRNUMA = PAIRDENA * TOTAREA; /* EQ. 2.3.2 APPARENT NUMBER OF PAIRED
INDIVIDUALS */
  INDNUMA = INDDENA * TOTAREA;     /* APPARENT NUMBER OF INDIVIDUALS */
  RUN;
PROC SORT DATA = ALL;
  BY /* YEAR */ STRATUM;
  RUN;
PROC MEANS DATA = ALL NOPRINT;
  /* GET MEAN APPARENT DENSITIES FOR EACH STRATUM */
  BY STRATUM;
  ID TOTAREA;
  VAR PAIRNUMA PAIRDENA INDNUMA;
  OUTPUT OUT = STRATNUM MEAN = NHATAH MEANDENA MEANINA /* EQ. 3.3.1 */
                        VAR  = SH VARDENA VARINA;     /* EQ. 3.3.2 */
  RUN;
PROC SORT DATA = EXP;
  BY STRATUM;
  RUN;
DATA VARSTUFF;
  MERGE STRATNUM EXP;
  BY STRATUM;
  N_PLOTS = _FREQ_;
  VARNAH = (SH / N_PLOTS) + (NHATAH * (1 - PSTAR) / N_PLOTS); /* EQ. 3.3.1 */
  NH = NHATAH / PSTAR; /* EQ. 2.3.4 */
  VARNH = NH ** 2 * ((VARNAH / NHATAH ** 2) + (VARPSTAR / PSTAR ** 2)); /*
EQ. 3.3.3 */

  MEANDENT = MEANDENA / PSTAR;
  SA = VARNAH ** 0.5;
  ST = VARNH ** 0.5;
  RUN;
PROC MEANS DATA = VARSTUFF NOPRINT;
  VAR NH VARNH NHATAH VARNAH N_PLOTS;
  OUTPUT OUT = PARK SUM = NH VARNH NHATAH VARNAH N_PLOTS; /* EQ. 2.3.6 &
3.3.4 */
  RUN;
DATA PARK;
  SET PARK;
  STRATUM = 'T';
  RUN;
DATA TOTPOP;
  SET VARSTUFF PARK;
  ST = VARNH ** 0.5;
  SA = VARNAH ** 0.5;
  CL90T = (1.645 * ST);
  CL90A = (1.645 * SA);
  POPAP = (NHATAH + CL90A);
  POPAM = (NHATAH - CL90A);
  POPTP = (NH + CL90T);
  POPTM = (NH - CL90T);
  RUN;
/*
PROC PRINT DATA = EXP;
  TITLE 'EXP DATA';
  RUN;
PROC PRINT DATA = STRATNUM;
  TITLE 'STRATNUM DATA';
  RUN;
PROC PRINT DATA = ALL;
```

```
  TITLE 'ALL DATA';
  VAR STRATUM TOTAREA PLOT AREA PAIRS PAIRDENA PAIRNUMA;
  RUN;
PROC PRINT DATA = VARSTUFF;
  TITLE 'VARSTUFF DATA';
  TITLE2 'COMMON CAPTURE PROBABILITIES ACROSS ALL STRATA AND YEARS';
  FORMAT NHATAH F5.1 PSTAR F4.2 NH F5.1;
  VAR STRATUM SH N_PLOTS NHATAH VARNAH NH VARNH /* PSTAR */;
  RUN;
PROC PRINT DATA = TOTPOP;
  TITLE 'TOTPOP DATA';
  TITLE2 'COMMON CAPTURE PROBABILITIES ACROSS ALL STRATA AND YEARS';
  FORMAT NHATAH F5.1 NH F5.1;
  VAR STRATUM SH N_PLOTS NHATAH VARNAH NH VARNH CL90T POPTP POPTM /* CL90A
POPAP POPAM */;
RUN;
*/
DATA FULLSET;
  SET VARSTUFF TOTPOP;
DATA FORCHART;
  SET FULLSET;
  DENSITY = MEANDENA;
  POP = NHATAH;
  TYPE = 'APPARENT';
  OUTPUT;
  POP = NHATAH + (1.645 * SA);
  OUTPUT;
  POP = NHATAH - (1.645 * SA);
  OUTPUT;

  DENSITY = MEANDENT;
  POP = NH;
  TYPE = 'TRUE';
  OUTPUT;
  POP = NH + (1.645 * ST);
  OUTPUT;
  POP = NH - (1.645 * ST);
  OUTPUT;

  KEEP DENSITY TYPE POP STRATUM;
  RUN;
DATA OUTSTUFF;
  SET FULLSET;
  FILE 'C:\OWL\FIELD\DATA\POPCHART.DT2';
  PUT STRATUM MEANDENT F9.6 NH F9.3;
  RUN;

PROC PRINT DATA = FORCHART;
  TITLE 'FORCHART DATA';
  RUN;

/*************************************************************************
 THIS SECTION PRODUCES SUMMARY STATISTICS ON PLOT AREA */
/*
PROC MEANS DATA = ALL NOPRINT;
  BY STRATUM;
  ID TOTAREA;
  VAR AREA;
  OUTPUT OUT = SURVAREA SUM = SURVAREA MEAN = PLOTMEAN;
```

```
PROC SUMMARY DATA = SURVAREA;
  VAR TOTAREA SURVAREA;
  OUTPUT OUT = NEXT SUM = TOTAREA SURVAREA;
DATA SURVAREA;
  SET SURVAREA NEXT;
  PCTSURV = SURVAREA / TOTAREA * 100;
PROC PRINT DATA = SURVAREA;
  TITLE 'AREA OF SURVEYED PLOTS';
  VAR STRATUM TOTAREA SURVAREA PCTSURV _FREQ_ PLOTMEAN;
  RUN;
*/
/********** END OF PLOT AREA SECTION ************************************/
QUIT;
/* END POP_EST2.SAS */
```

APPENDIX Q. OWL CREW TRAINING SCHEDULE.

TRAINING SCHEDULE

Week 1, Day 1

8:00 am	Welcome, introductions of people.
9:00 am	Introduction to project purpose and design.
10:00 am	New employees complete paperwork for hiring, obtain keys, are given tour of facilities.
12:00 am	Lunch
12:30 pm	Presentations by park staff of issues and projects concerning natural and cultural resources.
3:00 pm	Issue personal equipment to employees.
4:30 pm	End.

Week 1, Day 2

8:00 am	Field day, visit owl territories, practice hooting.
4:30 pm	End.

Week 1, Day 3

8:00 am	Monitoring owl territories. Field protocols, data collection forms, hooting, mousing, capturing. Methods and guidelines for determining status.
12:00 am	Lunch
12:30 pm	Cooperating with trail crew, trail reports.
1:00 pm	Backcountry skills, minimum impact, food, clothing, equipment.
2:00 pm	Live owls and raptors from the Raptor Rehabilitation Center.
3:00 pm	Practice measuring distance by pacing, tree species identification.
4:00 pm	Orientation to mouse breeding facility.
4:30 pm	End.

Week 1, Day 4

8:00 am	Navigating with map, compass, and altimeter.
12:00 am	Field visit to owl territories.
4:30 pm	End.

Week 1, Day 5

8:00 am	Park radio system
9:00 am	Questions from yesterday's site visits.
9:30 am	Writing & following directions to find owl territories.
10:00 am	Owl banding: protocols, unique color banding, data forms. Practice banding, weighing, measuring.
12:00 am	Lunch
12:30 pm	Office paperwork
1:30 pm	Computer data entry.
2:30 pm	Performance standards, feedback sessions.
3:30 pm	Safety
4:30 pm	End.

Week 2, Day 1

8:00 am	First Aid
10:00 am	Care of owl injuries.
11:00 am	Raptor identification
12:00 am	Lunch
12:30 pm	Backcountry trip orientation: equipment use, vehicles, trip goals.
3:00 pm	End

Week 2, Day 2, 3, 4

Field trip, visiting owl territories, practice monitoring.

Week 2, Day 5

8:00 am	Field trip debriefing, questions, discussion.
10:00 am	Equipment return, chores (maintenance, repair, etc.)
12:00 am	Lunch
12:30 pm	Data checking, data entry.
3:00 pm	End.

APPENDIX R. FOLLOW-UP FORM DATA CHECKING.

FUF CHECKING

- Check location dot on FUF map -- are the UTMs and elevation correct?
- Check master maps, are location or search route copied correctly from the field map?
- All FUF sections should be filled in or lined out.
- Check notes to see if there is info to support determination of: species, sex, age.
- Look for non-nesting indicators:
  - mice taken, not delivered = 2
  - female roosting is not valid until April 15 (=1)

APPENDIX S. FIELD EQUIPMENT: ACCOUNTING, MAINTENANCE.

EQUIPMENT PROTOCOL

SIGN OUT AND SIGN IN PROCEDURE

INDIVIDUAL EQUIPMENT:
Individual gear includes: compasses, binoculars, headlamps, and a limited number of daypacks/backpacks. Each crewperson must sign their name on the "Individual equipment checkout form" and include the equipment type, I.D. number and the date checked out. This form must be filled out before project gear goes into the field. If you prefer to use your personal gear in place of provided project equipment we **cannot** be responsible if it is lost, stolen, or broken. At the end of the field season a supervisor will check to see that the equipment is returned. This procedure is used to identify lost or inoperative equipment.

TEAM EQUIPMENT:
Team equipment is checked out before each team leaves for a survey plot or historic site visit. The equipment checkout form is located next to the grey metal cabinet. At the end of a survey trip all team gear is checked back in, cleaned and dried. Specific equipment is maintained as follows:

water filters backflushed with clean water
tents cleaned and dried
banding kits and first aid kits restocked (& dried if necessary)
radio batteries updated on hours of use or recharged
stoves cleaned and burn tested
cook kits washed
fuel bottles filled
mice cans cleaned and returned to mouse house
noose pole repairs if needed

All gear should be checked in and comments made about broken or lost gear and any other problems. Bring to the attention of a supervisor.

MISCELLANEOUS EQUIPMENT

RADIO BATTERIES
There are two types of radios available to use, the MT-1000 and MT-500, each takes a different battery. The MT-1000 takes a grey alkaline (A5070) and a dark grey rechargeable (H5447); the MT-500 takes a white alkaline (H568), and an orange rechargeable (H4463B). Make sure you have the correct battery spares prior to field departure.

Alkaline (throw away) batteries are stored in the owl crew refrigerator. Upon return from the field, write on each used battery the hours of use and place in the **USED BATTERY** box. If the battery is dead, write "DEAD" on the label and place in **DEAD BATTERY** box. Rechargeable (NiCad) batteries should be placed in the **TO BE RECHARGED** box upon return from the field.

INOPERATIVE EQUIPMENT

Field gear that is broken or just not working correctly should be placed in the **INOPERATIVE EQUIPMENT** box, an attached note explaining the problem and the initials of the crew person should be included.

LOST EQUIPMENT

Bright colored flagging should be affixed to gear (radios, altimeters, binoculars, and compasses in particular) that may be set down and blend in with the forest. Check for all of your gear before departing a station, owl response site, or campsite. If gear becomes lost, retrace your steps and try to remember where you last saw or used it. If you cannot find gear, write down type of gear and area lost. Report the loss immediately upon return from the field.

APPENDIX T. EQUIPMENT SIGN-OUT FORM, INDIVIDUAL GEAR.

NAME:_____

EQUIPMENT	CIRCLE ONE	ID #	DATE OUT	DATE IN
COMPASS	SUUNTO, SILVA			
HEADLAMP	PETZL, MOUNTAINEER			
BINOCULARS	SWIFT, BAUSCH & LOMB BRUNTON, NIKON			
DAY PACK	CAMP TRAILS			
BACKPACK	NORTH FACE			
MISCELLANEOUS				
(NOTEBOOK)				

SIGNATURE_____ DATE_____

EQUIPMENT RETURNED Y N DATE_____ SUPERVISOR INIT_____

EQUIPMENT CONDITION AND COMMENTS:

APPENDIX U. EQUIPMENT SIGN-OUT FORM, GROUP GEAR.

TEAM EQUIPMENT CHECKOUT FORM

TOUR DESTINATION(S):_____ TEAM INIT:_____
DATE OUT:_____ DATE IN:_____

ITEM	**I.D. #**	**RETURNED** (Y OR N)
RADIO	_____	
ALTIMETER	_____	
TENT	_____	
STOVE	_____	
FUEL BOTTLE	_____	
WATER FILTER	_____	
1ST AID KIT	_____	
BACKCOUNTRY REPAIR KIT	_____	

	NON I.D. # (MAKE CHECK BY ITEM)
RADIO BATTERY	_____
NOOSE POLE	_____
BANDING KIT	_____
COOK KIT	_____
TARP	_____
TENT GROUNDCLOTH	_____
ROPE	_____
CUSTOM CORRECT MAP	_____
BANDING SCHEME!!	_____
FUF FORMS	_____
FUF CHEAT SHEET	_____
WORKING FILES	_____
BANDING FORMS	_____
RADIO CHEAT SHEET	_____

COMMENTS: (PROBLEMS W/GEAR, BROKEN GEAR, STASHED ITEMS, ETC.)

APPENDIX V. EQUIPMENT MAINTENANCE SIGN-UP FORM.

SHARED JOBS CREW SIGN UP SHEET		
Job	Volunteer name	Time completed
Vehicles Record Mileage, Fill with Gas, Clean, Check Oil, Check Battery Water, Coolant, Air in Tires, Air in Spare	1.	
	2.	
	3.	
	4.	
Tents Dry, Clean, Put in Bags	1.	
	2.	
Stoves & Fuel Bottles Clean, Burn-test, Fill with Fuel	1.	
	2.	
Water Filters **Clean**	1.	
Mice Put Away, Clean Cages, Feed, Water	1.	
	2.	
	3.	
Equipment Inventory Make sure it is all returned	1.	
	2.	
Banding Kits **Restock**	1.	
Radio Batteries **Recharge**	1.	
Data Entry & Site Directions	1.	

½ hour shifts	2.	
	3.	
	4.	

APPENDIX W. BACKCOUNTRY NAVIGATION TRAINING.

We recommend a 5 hour training course, taught by someone highly experienced in off-trail navigation. Most of the time is spent indoors, presenting material and working with map exercises. The following topics and time allocations have worked well for us.

1) Introduction (30 minutes)
2) Topographic maps (10 min.)
- A) Map name, date
- B) Types of information
- C) Map symbols
- D) Distance. (15 min.)
- E) Direction. (15 min.)
- F) Elevations/Contours, in detail. (50 min.)

Break (10 min.)
- G) Coordinates (30 min.)
  - i) UTM
  - ii) Latitude/Longitude
  - iii) Legals
- B) When not to trust your map. (15 min.)

3) **Using a compass.** (20 min.)
4) Using an altimeter. (10 min.)
5) Route-finding. (15 min.)
6) Putting it all together. (15 min.)
Break (30 min.)
7) Pacing, walking bearings (30 min.)

APPENDIX X. BACKCOUNTRY SAFETY.

GENERAL SAFETY PROCEDURES

Safety is a primary concern in carrying out this project. We are **NOT** here to obtain data at the expense of your lives! If you feel uncomfortable doing something, speak up. Do not proceed until you are comfortable with what needs to be done. Do not attempt actions that will jeopardize your or other crew members' safety. Take time to review all potentially unsafe situations and be sure to think of outcomes prior to acting. Clear communication can help in avoiding misunderstanding or mistakes.

* Review the maps of the area you will be working in to familiarize yourself with the lay of the land prior to entering an area. Continue more detailed review of maps and terrain as you move through an area to become "oriented" to the area.
* Always carry a radio and extra batteries and the team first aid kit.
* Every crew person should carry a map of the survey area and a compass; each team should carry an altimeter.
* If splitting up for any reason try and remain in vocal contact. If you plan on going out of hearing range then arrange a meeting time and place and a fall-back plan.
* Always carry a headlamp on surveys. Surveys will be conducted during daylight, but sometimes the sun sinks fast when your having fun. If you are delayed coming back to camp, the headlamp will get you out in the dark. Make sure that your batteries are fresh and always carry spares.
* Bring extra clothing and food on surveys in case of a change in weather or unexpected circumstances.
* Teams should have plans or ideas on how to re-orient themselves if they become lost. Use the compass, altimeter and map in these efforts and take your time and evaluate the situation carefully. If still confused then have a backup plan such as hiking due north to a readily identifiable feature such as a river or trail.
* If there is an injury requiring medical attention, contact a supervisor after you have attended to the injured person. If its an emergency, then call dispatch (730) on your radio and be prepared to give victim's name, location, and nature of injury.

COMMON UNSAFE SITUATIONS AND ACTIONS TO REDUCE HAZARDS:

* Slippery logs or old logs with bark that sheds when walked upon. Also pay attention to wet slippery rocks or rocks/ground covered with moss or other vegetation. Wood is extremely slippery when wet, so walk carefully over footlog and puncheon bridges, and other bridges.
* When crossing streams or river courses, unhitch your belt loop on backpack, wear sneakers and use a stick for balance. Use caution when crossing through fast moving water that is knee to thigh deep, it can knock you off balance. Waist deep water can lift a person. Watch for debris (trees) moving downstream toward you. IF IN DOUBT, DON'T CROSS!
* If crossing over large blown down trees, it may help to remove your pack and put it over the other side if necessary.

* Wearing gloves (preferably leather) is a good idea when moving through Devil's club, brambles, salmonberry, spruce or rough terrain to prevent abrasions, falls, and puncture wounds. Also when moving through dense underbrush, be wary of limbs poking eyes.
* Only use binoculars when on steady ground.
* Pay attention to your physical condition and that of your crew mates. If you feel extraordinarily tired or are having unusual back pain, etc., then try and take it easy or get more rest. Learn to recognize the signs of HYPOTHERMIA (shivering, drowsiness, loss of coordination) and methods of treatment: remove wet clothing, replace with dry, keep person warm, let them rest. Consult your first aid manual for this and other emergencies.
* Drink plenty of fluids throughout the day to prevent dehydration. To insure an uncontaminated water supply, ALWAYS treat water chemically or use a water filter. Remember that pumped water left over time can grow bacteria, so wash water containers regularly. Giardia symptoms may include stomach ache, diarrhea (yellow frothy type), sulfur burps and gastric pain.
* When handling owls remember that getting taloned or bitten is often the rule and not the exception. You can use gloves to protect yourself or if you are a masochist, enjoy the thrill of removing buried talons carefully so as not to injure the bird.

APPENDIX Y. BACKCOUNTRY FIRST AID BASICS.

BASICS OF FIRST AID TRAINING

WHAT TO COVER: Basic first aid with backcountry emphasis.
How to treat common backcountry injuries with first aid kit and backcountry equipment available, using a hands-on approach.

BACKCOUNTRY INJURIES AND HOW TO TREAT THEM

ANKLE SPRAIN:
Ace bandage wrap would be nice but too big and expensive to carry in first aid kit. Could get by with the triangular bandage.

FRACTURES:
Control serious bleeding, treat for shock, check for pulse of injured extremity, remove or cut clothing from injury site, if possible gently move fractured limb to splinting position, splint extremity, immobilize joints above and below the fracture site, leave fingers and toes exposed to monitor circulation and nerve function.

LEG FRACTURE:
Splint in place, if open fracture bandage to stop bleeding. A splint can be made from noose pole sections wrapped with tri bandage, rope to keep splint in place.

ARM FRACTURE:
Bandage open fracture wounds. Splint w/ arm to body use tri bandage. Splint with the 2 ft section of electric wire from the noose pole

HAND FRACTURE:
Check for circulation and nerve impairment. splint with ruler, pencil

JOINT DISLOCATION:
Common dislocations are shoulder, check for pulse in injured extremity, splint with tri bandage. DO NOT attempt to straighten any dislocated joint (serious nerve and blood vessel damage may occur)

EXTERNAL BLEEDING - Methods to control: direct pressure, elevation
DO NOT elevate extremity if there is a possible fracture, dislocation, impaled object, or spinal cord injury. Pressure points (use only if direct pressure and elevation fail): Brachial and femoral, are the most important to know.

NEVER remove a dressing that is in place, apply more dressing on top if needed.

LACERATION:
Use butterfly bandages to close the wound then dress with 4x4 sterile pads, bandage with gauze, and triangular bandage.

PUNCTURE:
DO NOT remove an impaled object, dress and bandage around it, stabilizing the object. Treat for shock

OTHER

HYPOTHERMIA:
Keep person dry and warm, remove wet clothing, place person in sleeping bag. NEVER allow a person to remain in or return to a cold environment.

HEAT EXHAUSTION OR STROKE:
Cool the person, get in shade, treat for shock check vital signs

SHOCK:
Metabolic (loss of body fluids) and Anaphylactic (allergic reaction)
Treatment: ABC (Check for Airway, Breathing, Circulation), control bleeding, splint fractures, elevation of legs, be alert for vomiting, keep victim warm, check vital signs often.

ANIMAL ATTACKS: Cougar and bear, what to do: Stand up, DO NOT RUN, look as tall as you can.

CHOKING: Heimlich Maneuver and abdominal thrust (when person is lying down).

FIELD EQUIPMENT THAT CAN BE USED IN FIRST AID PROCEDURES:

NOOSE POLE: The collapsible noose pole contains 5 - 3 ft sections to be used as splints for leg fractures and a 2 ft piece of electrical wire to hold the noose that can serve as a splint for an arm fracture.

BANDING KIT: Bandana can be used as a bandage or dressing material.

OTHER: Tent poles used as splints, sleeping pad as a splint also.