Survey Techniques for Bald Eagles in Alaska

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Introduction

Interest in obtaining information about Bald Eagle (*Haliaeetus leucocephalus*) populations in Alaska probably began with Imler (1941). His food habits studies commenced 24 years after the territorial government established a bounty system to reimburse citizens for dead eagles. After serving as a factor in eagle mortality for 35 years, the bounty was removed in 1953, again altering the population dynamics of the Bald Eagle. Later, additional pressures confronted the eagle population in the form of logging operations, fishing practices, fluctuations in prey base and removal of chicks for translocation to the eastern United States.

Surveys have been used to estimate eagle population parameters and to monitor changes. The first region-wide population survey was conducted by King et al. (1972) in Southeast Alaska using an airplane. Intensive boat searches for Bald Eagle nests began in 1969 (Hodges 1984). Since then survey techniques have evolved and expanded to all parts of Alaska.

Adult Bald Eagles and their nests are easily observed compared to most other bird species. Even though the visibility rate may be as low as 50% on a given survey, there is still good justification for the survey if repeatability and consistency are practiced. Observer bias, or differential abilities by observers, is a pestering factor in many surveys, but it can be addressed with diligent training or bias estimation.

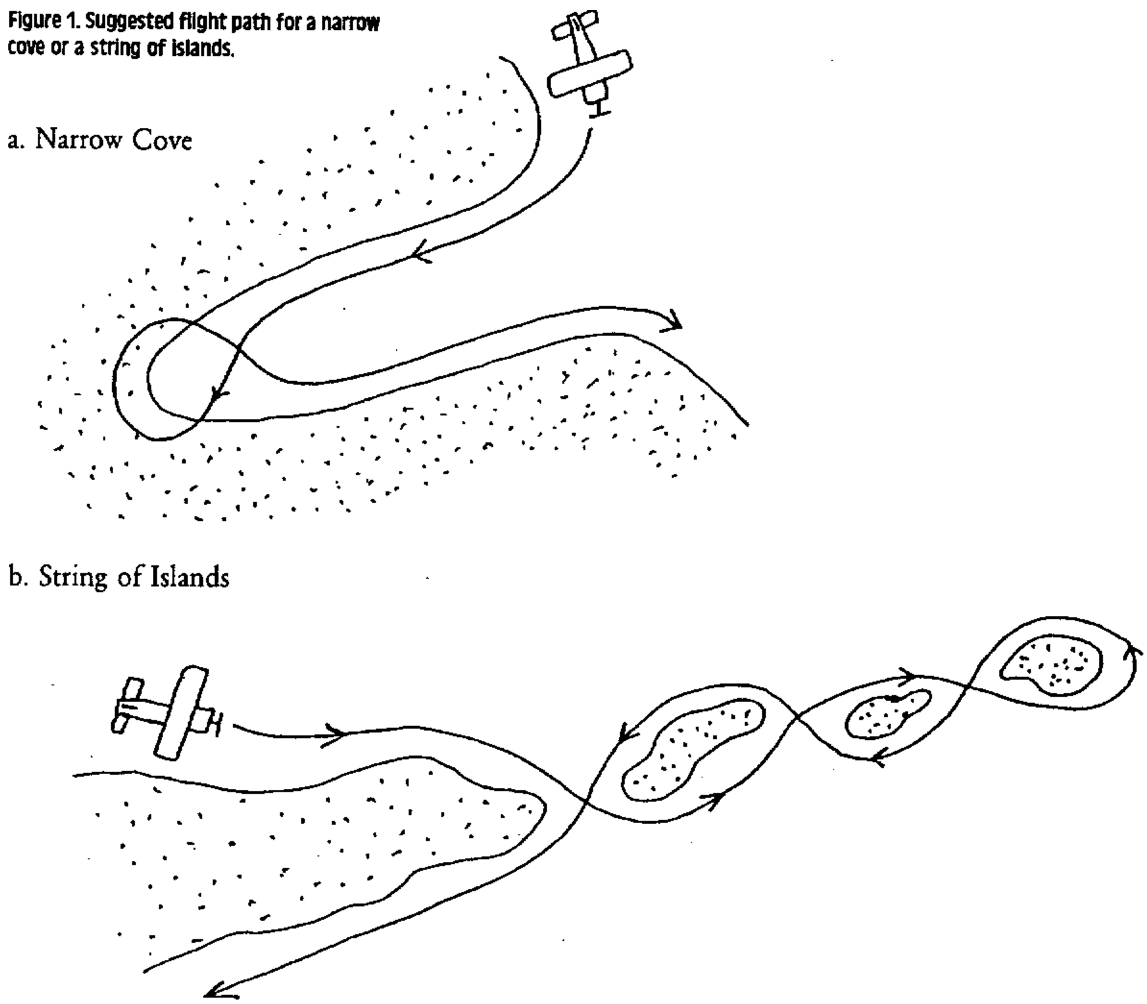
Population Surveys

Population surveys are used to determine the number of individual birds associated with a given area. The techniques presented here assume that the eagles are located within viewing distance of some body of water.

Fixed wing: High wing airplanes are preferred because observers are usually looking down on perched eagles. Coastlines, river corridors or lake shores are flown at an altitude of approximately 30 m above the substrate (tree tops or ground) with a viewing angle of 45 degrees downward. One or two observers are located on the right side of the plane. The pilot should be used to scan for soaring eagles and observe perched eagles whenever safety permits.

The flight path should be flown in a way that maximizes observability and minimizes air sickness. Right turns around a sharp point of land requires an increase in aircraft altitude to avoid a steep turn that would cause the lowered wing to obstruct the observers' view. Wide coves are flown with left turns and may require decreased altitude to avoid obstructing the observers' view with the landing gear, a particular concern with float planes. If the cove is too tight to allow a comfortable left turn over the water, then the flight path should cross the far shoreline and commence a right turn just landward of the shore to keep the observer looking down at the coastal habitat (See Figure la). A string of islands can often be surveyed with a figure 8 pattern that takes less time and reduces the G forces on the plane and its occupants (See Figure 1b). During left turns the island habitat will be on the pilot's side and the observers will look across out the left windows. Survey airspeed should remain at least 50% above stall speed at all times.

Figure 1. Suggested flight path for a narrow cove or a string of islands.



Observations can be plotted onto maps or recorded into an onboard computer. Linking the computer to the Global Positioning System (GPS) navigation radio in the airplane works well except for those cases when the eagle or nest is not immediately adjacent to the airplane. Manual mapping will usually be more accurate than GPS mapping when landmarks are abundant but less accurate when landmarks are scarce.

Helicopter: Generally the same survey procedures apply when conducting a population survey by helicopter. Slower safe airspeeds are possible, which result in more gentle turns and more observation time per unit of habitat.

Boat: Population surveys by boat are conducted at slow speeds under 10 km/h. Distance from shore is a compromise between maintaining proximity to the coastal habitat and a setback distance that allows a perspective of the trees behind the shoreline face. Binoculars can be used to scan with increased acuity. An intense boat survey will provide a much better survey for immature eagles in dense foliage than an aerial survey. Eagles that flush in the direction of travel should be monitored to avoid double counting.

Timing: Ideally, population surveys should occur at a time when eagles are not clumped in distribution. Traditionally surveys have been conducted in the spring during incubation, providing auxiliary information about nesting attempts. This time of year has drawbacks. In coastal areas with coniferous forests, incubating adults will be less visible to observers in an aircraft than perched eagles and they may be totally hidden from the view of a boat. Herring and eulachon runs also occur in spring causing large concentrations of eagles. Perhaps a better time for population surveys in coastal areas would be late June before the salmon runs commence. Interior rivers must be surveyed before the trees have leafed out, which necessitates surveys during incubation.

Age ratios: Perched eagles are generally not used to estimate the ratio of immature eagles to adults eagles because immature eagles are more difficult to see. Assuming that adults and immatures have the same probability of flushing or flying, we can use the age ratio observed for flying eagles to represent the age ratio of eagles in the study area. This also assumes that adult and immature eagles in flight have an equal probability of being recorded.

Sources of error: Weather conditions can have a significant effect on the distribution of eagles and consequently on the population survey. During clear weather eagles are more likely to soar, particularly if the weather has been wet during the preceding days. The eagles want to dry their wings and see where the latest food source may be. This behavior will decrease the number of eagles seen along the shoreline or river survey.

Observer differences in ability, experience and interest also will affect the results of the survey. These effects can be major sources of variability and ways of dealing with them are discussed under Observer Bias at the end of this paper.

Nest Surveys

Nest location data is often required to assist in resource development planning and to avoid violations of the Bald Eagle Protection Act. For this reason nest surveys usually fall under the category of censuses.

Fixed wing: Fixed wing surveys for Bald Eagle nest structures are very effective in cottonwood or balsam poplar habitat during the period when leaves are not present. Fixed wing nest surveys are not recommended for locating nests in conifer trees especially in the heavy coastal forests.

Helicopter: Helicopters may be used to locate nests in heavy coastal forests but it is likely that numerous passes over the habitat will be required to locate a high percentage of the nests. Nest surveys should be flown in a manner similar to population surveys but at a slower airspeed and often at a lower elevation.

Boat: Boat surveys for nests are usually superior to other survey modes because of the very slow speeds and the careful scrutiny which can be given to the forest. Exceptions include areas where nests are removed from shore and impossible to view from the water. The ground based observer has time to carefully plot the location of each nest on a detailed map.

This turbine powered beaver, N-754, was designed for conducting aerial surveys. Photo courtesy of USFWS.

Timing: Nest surveys must be done before leaf-out in cottonwood and balsam poplar habitat. Aerial surveys of nests in coniferous forests are best done during incubation because adults on the nest platform facilitate the detection of active nests. During the early part of the nesting season boat surveys can benefit from the excited behavior of adults near their productive nest.

Sources of error: Non-detection of nests is caused by inadequate coverage of the study area or the concealed nature of some nests. Observer training is critical to a good survey.

Productivity Surveys

Productivity surveys provide a measure of effort on the part of nesting pairs to produce offspring. They may occur at any time between nest initiation in spring and fledging in late summer.

Fixed wing: Productivity surveys by fixed wing aircraft are generally unsuccessful. Fully feathered young can be observed in openly exposed nests, but this excludes most nests in cottonwood trees or under the canopy of large coastal trees. Fixed wing surveys of feathered young are possible to a limited extent in Interior coniferous forests and in treeless areas such as the Aleutian Islands and the Alaska Peninsula. Incubating adults can be observed before leaf-out in cottonwood stands or to a limited degree in conifer stands.

Helicopter: Helicopter is the preferred means of conducting productivity surveys (Hodges 1984). Eggs may be counted if the adult flushes from the nest, although purposely flushing the adult is not recommended because eagles taking sudden flight can damage the eggs. Young of all ages can be seen if foliage does not block the observer's view of the nest. Nestlings under three weeks of age may be difficult to count if they are huddled close together. Helicopter surveys should not be used to count young after they have reached the age of 8 weeks because the young may prematurely fledge from the nest if frightened by the helicopter.

Caution and vigilance on the part of the helicopter pilot are necessary for safely hovering in the vicinity of an active eagle nest. Some eagles can be expected to attack the helicopter. Evasive action requires moving away from the eagle rapidly and if possible directing the downwash of the helicopter towards the eagle.

Boat: Boats are usually not useful for conducting productivity surveys. However, they can be used in a rudimentary fashion to locate nests that are actively defended by adults. This behavior is usually an indication of the presence of young or eggs. If the young are more than 7 weeks old they can often be observed from a boat.

Nest climbs: Trees may be climbed to count the young before they reach the age of 8 weeks. After this age the young may prematurely fledge at the sight of the climber gaining access to the nest. Nests with eggs should not be climbed because of the high likelihood of causing nest desertion by the adult (Cain 1985).

Surveys of Concentration Areas

When food becomes available in large quantities, Bald Eagles concentrate in large numbers. These concentrations can have as many as 3000 eagles in a 4 km section of river feeding on spawning salmon, or 200 eagles in a 2 km section of shoreline feeding on spawning herring or 100 eagles in 100 m of beach feeding on a humpback whale carcass.

Survey technique is a matter of placing the observer in a position or series of positions in which he/she can count all eagles present. Ground access and the use of a spotting scope are preferred. Fixed wing aircraft have been used in areas inaccessible for ground access. Helicopters are not recommended because of the higher disturbance level that flushes a large percentage of the eagles.

Documentation of communal roosts in Alaska is limited to a few areas where wintering eagles concentrate on a food source that is close to a stand of heavy coniferous timber. More work in this area is needed.

Age ratios: Good age ratio information for large numbers of adult and immature eagles is easily obtained at feeding concentrations. Further breakdown of the immature segment of the population is possible if the observer can get close enough to the birds. The plumage, beak color and eye color are all used to split the immatures into age classes (Wheeler and Clark 1995). How well these classes correspond to year classes is not known. Bald Eagles mature at differing rates possibly due to food availability and/or social interactions with other eagles.

Design

The goals of a good survey should be to achieve accuracy and repeatability. A complete census accomplishes this best but is not often possible. Random plots have been successfully used in coastal Alaska and British Columbia (King et al. 1972 and Hodges et al. 1984). Random segments of shoreline have also been used (Robards and King 2008).

In northern areas square grids do not work well as the basis for a plot design. At the corners of a large study area the plots become highly skewed relative to the cardinal directions. Also, the square grid pattern is difficult to repeat by another researcher at a later date without the use of the original design maps. An alternative system has been used to survey Bald Eagles from Unimak Island in Alaska to Vancouver, British Columbia which eliminates these two problems. The north and south boundaries of all plots are parallel to the lines of latitude and the east and west boundaries are parallel to the lines of longitude. Each plot is nearly square in shape, the north boundary being slightly narrower than the south boundary. The plots are all the same height and the same width at the center. Another researcher can exactly duplicate the plots by simply knowing the plot number and the two formulas shown in Figure 2.

Straight line transects can be used to sample habitats that tend to be uniformly distributed throughout the study area. For example, in the instance of a broad river plain with intricate patterns of small lakes, a fixed transect width is chosen, such as 200 or 400 m. The long transects are subdivided into segments of fixed length. Sightings are preferably recorded by exact location but alternatively by segment.

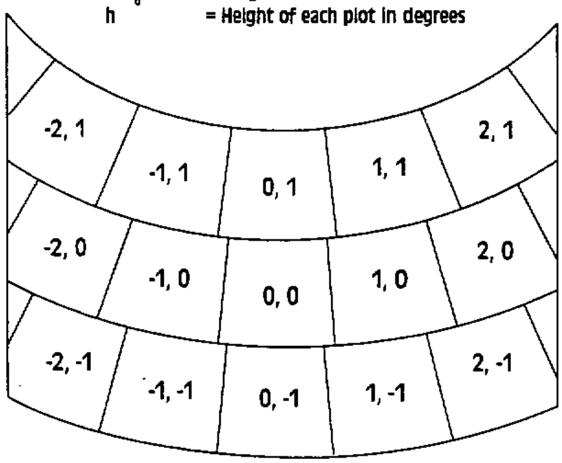
Figure 2. Suggested plot design for northern latitudes. This design insures that every plot is oriented north and south, and is repeatable with only the plot number and the two formulas shown.

Compute Center point (I, J) as:

$LAT_J = LAT_0 + h \cdot J$

$LON_I = LON_0 + I\,(h/\cos(LAT_J))$

where, (I, J) = Column I and Row J
LAT_0 = Latutude for Row 0
LON_0 = Longirude for Column 0
h = Height of each plot in degrees



Observer Bias

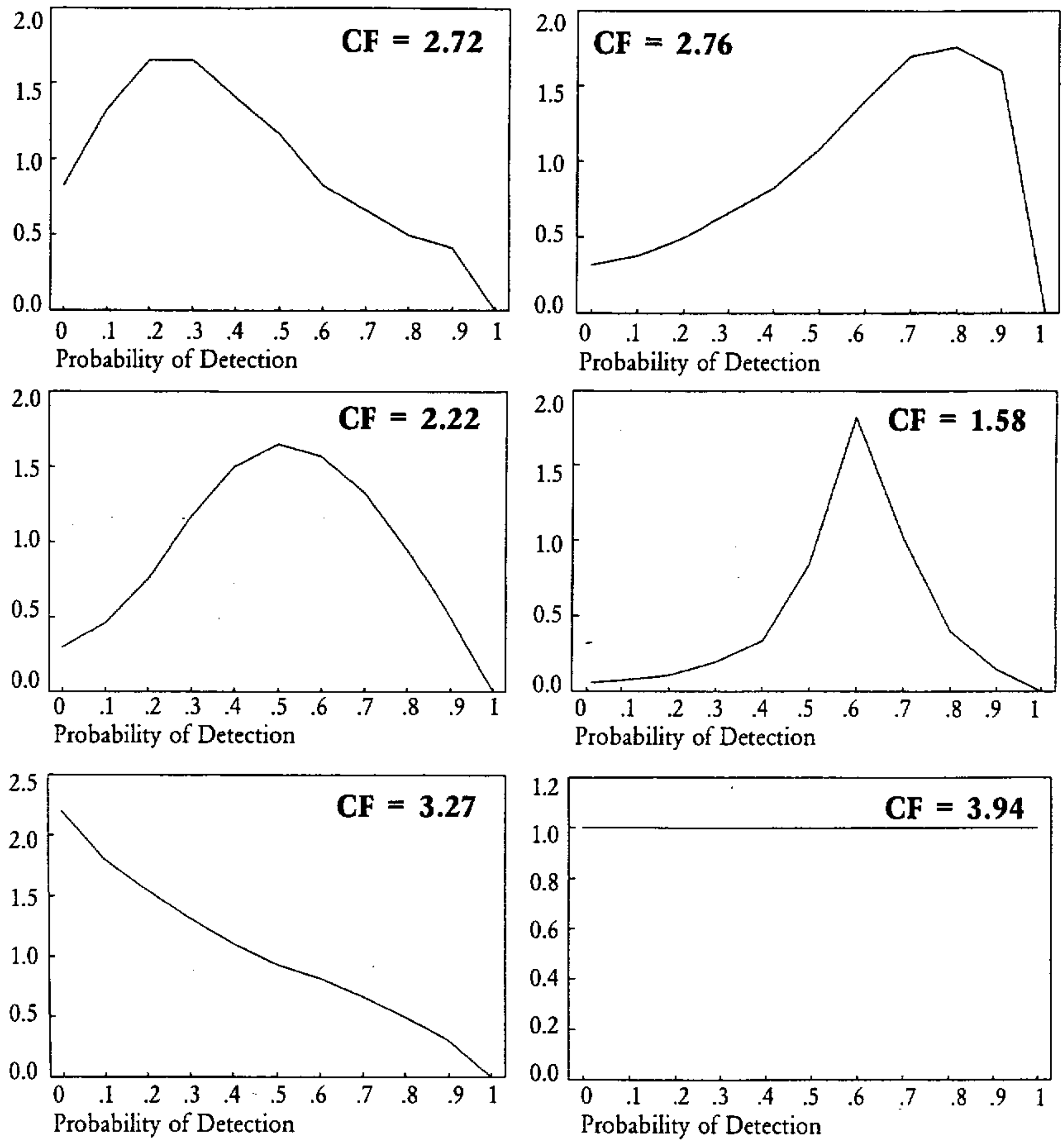
Observer differences can have potentially serious effects on the accuracy of surveys. Observer training is highly desirable even if an attempt is made to adjust survey results to account for observer bias. For example, estimating the number of missed nests is of no value if the nest locations are needed for planning habitat protection.

Three methods will be discussed to measure the amount of observer bias in the aerial survey setting. The first method is comparison of a complete ground count with an aerial count. This is the preferred method. Ground counts in Alaska are usually conducted from a boat. Boat observers must be well trained and dedicated and must see all of the eagles. Ideally the air and ground counts would be conducted at exactly the same time, but realistically the boat surveys require much more time and the assumption that the same number of eagles are present for both surveys becomes increasingly suspect.

The second method for measuring observer bias uses a form of the Peterson Index to determine the number of eagles missed by two observers in one aircraft or boat (Magnusson et al. 1978). This method will not estimate eagles that were impossible for either observer in the craft to see. The assumptions are (1) that sightings by both observers occur independently; and (2) that the probability of spotting each object is the same for all objects, but can vary between observers.

The first assumption is met by having the front seat observer record the rear seat observations as well as his own. If the front seat observer sees an eagle he waits to record it until it has passed the wing tip. If the rear seat observer sees an eagle, he communicates the sighting just as the eagle passes the wing tip. The front observer records an eagle as having been seen by both of them if he saw the eagle and he also heard the rear observer call out the eagle. The front observer records an eagle as having been seen by him alone if he sees the eagle and fails to hear the rear observer call it out as it passes the wing tip. The front observer records an eagle as having been seen by the rear observer alone if he hears an eagle called out but has not seen it. The formula for the estimated number of eagles that both observers missed (M) is where:
F = Number seen by front seat observer only.
R = Number seen by rear seat observer only.
B = Number seen by both observers.

Figure 3. Correction factors (CF) to use in the Petersen Index method of estimating observer bias for six possible probability of detection curves. The estimated number of animals missed by both observers is multiplied by CF.



The second assumption of equal detection probability for each animal is unlikely to hold true in wildlife surveys. Magnusson et al. (1978) concluded that this assumption was not critical for their alligator nest surveys but in general the error in estimating M increases as the probability distribution of detectability deviates from a single point. Species that are difficult to detect have a larger segment of the population in the missed by both category (M) and thus the accuracy in estimating M becomes more critical.

Six hypothetical detection probability distributions (Figure 3) were chosen to determine the inaccuracy in estimating M. It was assumed that the probability distribution was identical for both observers. The correction factor (CF) needed to make the estimate of M unbiased in each case was significant. Bald Eagles, for example, might have a distribution which is weighted toward birds which are likely to be observed and would require using CF = 2.76 in the equation for M.

In the absence of good information on the true detection probability distribution of the population being surveyed one should use a correction factor of CF = 2.5 when estimating M. This strategy would certainly be superior to ignoring the correction factor as suggested by Magnusson et al. (1978).

Another approach for handling deviations from the second assumption of equal probability of detection for all animals is to stratify the observations based on an estimate of each animal's detectability. For example, eagles could be classed into three strata by the observers, (A) obvious or easy to see, (B) not obvious but not difficult to see, (C) difficult to see. The analysis would occur separately by stratum. This will help improve the estimate of M for all strata combined if a significant proportion of the population is not difficult to see.

The third method of estimating observer bias involves the use of radiotagged eagles. First, the radioed eagle is visually located while one of the observers remains blindfolded. Then the blindfold is removed and a normal flight path is flown to determine if the observer having no prior knowledge of the radioed eagle's location is able to locate the eagle. An important advantage of this technique is that it includes eagles that have zero probability of being seen from the survey aircraft in normal survey mode.

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