METHODS FOR TRAINING AND TESTING OBSERVERS USING DISTANCE AND ANGLE ESTIMATION IN LINE TRANSECT SAMPLING

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INTRODUCTION

At-sea population monitoring for the Marbled Murrelet relies on accurate methods to estimate population densities. Line transect surveys should satisfy three assumptions for precise and accurate density modeling: (1) all birds are detected on the transect line, (2) birds are detected at their initial locations, and (3) measurement of distance from the bird to the transect line is exact (Buckland et al. 1993). These methods delineate a mechanism to test training effectiveness and accuracy of distance and angle estimates that are necessary to satisfy assumption 3.

In 1997 and 1998, we collected data on error rates for distance and angle estimations to assess the accuracy of such estimates and model the effect of errors on density estimates and statistical power to detect trends. We are also investigating the factors that affect accuracy, such as individual variation among observers, magnitude of the true distance or angle, and observer experience.

Accuracy was found to be very high with *trained* observers. Mean distance estimation errors for 11 observers were -2.2 ± 3.2 m ($n = 727$). Mean angle estimation errors for 4 observers were $2.1 \pm 10.4°$ ($n = 209$). Distances were measured against a known tape measure distance and therefore represent a true error. Angle errors, however, were measured as the difference between angle boards and digital compasses, and therefore only represent an estimate of error between the two methods. Angle errors may also suggest the measurement error when measuring the same angle twice. In either case, we consider the angle tests to be a useful, although not absolute, estimate of error. We welcome another design for robust angle tests.

The high accuracy of these results suggests that training can be highly effective and should be conducted systematically during the survey season. Additionally, periodic blind testing will allow an assessment of error which can be used to improve training or assess the reliability of survey data. Following is a methodology for conducting training and testing throughout the field season.

MATERIALS

Angle board, tape recorder, 120 m tape measure with small buoy at end, data sheets, Apelco personal digital compass. The 120 m tape measure can be made using a standard 100 m forestry supply measuring tape and attaching another 20 m of tape cut from a second measuring tape. It can be connected with super glue.

METHODS

Evaluation of the accuracy of line transect distance sampling estimates involve determining the differences between the distance or angle estimated by observers from

the boat or transect line to a floating object, and the object's actual distance or angle. Two observers and one trainer/tester are needed to participate in this work.

Summary of Methods

1) Distance Training: Each day, observers estimate the exact distance to a float on the end of a tape measure and then are corrected by the tester. The distances are randomly selected from 1 m to 120 m and all information is shared aloud. This is repeated 6 - 8 times each day.

2) Distance Testing: Observers are tested in a similar manner to (1) but are not corrected by the tester. Testing should occur at the beginning of the field season and at least once a week thereafter. All responses are spoken into a tape recorder out of hearing range of the other participants. Tests should consist of ten estimations for each observer divided equally among 0-40 m, 40-80 m, and 80-120 m.

3) Angle Training: A similar procedure of training and testing applies for angle estimations using measures from an angle board that are then compared to an electronic compass. Estimations are made from the transect line or an object of reference to any seabird with the angle board and then with the electronic compass. All information is shared aloud. Discrepancies are investigated and discussed by the trainer and observer.

4) Angle Testing: Observers estimate angles with angle boards and record their answer into a tape recorder. The observers then take the same measurement with an electronic compass, but hand it to the tester without looking at it to be entered into the tape recorder. In this manner, the observers are unaware of their inaccuracies during the testing session. Ten tests should be done per observer divided equally among 0-30°, 30-60°, and 60-90°.

Distance Estimation Training

Observers are trained to estimate the exact distance to an object each day, which requires approximately 10 minutes. A Marbled Murrelet sized float (20 cm) is attached to the end of a 120 m rolling measuring tape. Observers are trained simultaneously by the trainer. The trainer lets out the tape to random distances, known only by the trainer, while the boat moves slowly forward (2 km/hr) to keep the tape in a straight line. Each observer independently makes an estimate of distance without knowing the other observer's estimates. The examiner then informs the observers of the actual distance to the float. This procedure is repeated 6-8 times per day and then 4-6 times before a testing sequence. The practice session immediately prior to each testing sequence simulates the practice training that should occur before an actual survey.

Distance Estimation Testing

Testing the accuracy of distance estimates should be done for each observer at least once a week (≥ 8 times during the field season). Procedures for testing the accuracy of distance estimates are similar to training sessions but more structured. After the float is let out to a random distance between 1 and 120 m from the boat, the examiner and each observer records the distances into a microcassette recorder out of each other's hearing range. During tests, observers are not corrected or given any information and the examiner is not aware of their estimates. Tests consist of estimating ten distances divided equally among 0-40 m, 40-80 m, and 80-120 m.

Angle Estimation Training

An Apelco electronic digital compass with an accuracy of ± 2 degrees is used to evaluate the accuracy of angles estimated from angle boards. The electronic compass is equipped pistol sights, and therefore is very stable and accurate. The electronic compass can measure the true angle between the transect line and an object by taking the difference between the bearing of the transect line and the bearing to the object.

Observers practice with angle boards constructed by laminating a paper protractor outline with 5° increments stapled to a 2 x 16 x 26 cm board. Small (2 cm) nails are placed at each 10° increment around the board to aid in obtaining the degree reading. Readings are made while holding the angle board flat and facing straight (the zero degree mark) towards a reference landmark used as a surrogate for the transect line. A landmark is used in lieu of the transect line since it is a concrete object with a known location. The observer then uses the nail heads to sight a murrelet or other bird on the water and reads the declination from zero (the landmark/transect line). Observers are trained by estimating the angle between the landmark and the bird with the angle board and then immediately taking the same measurement with the digital compass. Results are immediately shared and corrections are made. This should be repeated ten times per practice session.

Angle Estimation Testing

Testing for accuracy of angle estimates is similar to training efforts. First, observers report the angle estimated from the angle board into a micro-cassette tape recorder. Then the observer takes the same bearings with the digital compass, but hands it to the examiner to record without looking at it. Observers are always unaware of the actual measurements and of the angle estimates of other observers. Each test consists of estimating ten angles divided equally among 0-30°, 30-60°, and 60-90°.

Data Recording and Transcribing

In addition to the data, the following information should be recorded:

Date:	Date
Location of Test:	2 letter abbrev. for location if several are used.
Beaufort State:	0 - 20
Vessel:	2 letter abbrev. for each vessel used.
Trainer and observer:	Initials

LITERATURE CITED

Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: estimating the abundance of biological populations. Chapman and Hall, London.