FISH 621 Homework #4: Distance Sampling and CPUE

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Instructions

Please make sure to follow the instructions in the homework and, to the extent you can, feel free to **work with others to learn from each other**. If you get stuck on a problem and can't figure out how to proceed on your own, feel free to e-mail others in this class or your peers. For homework purposes, perhaps you can work together via e-mail, Zoom, Google Hangouts, or whatever works best for you. However, each of you will need to submit your own completed homework assignment for evaluation.

Please post to the Canvas Discussion Forum, and feel free to e-mail me if you get stuck and have exhausted your immediate options (google, classmates, friends). No need to bang your head against the wall, first ask your peers for help and if all else fails feel free to email me directly.

This homework assignment is due by 11:59 pm on Friday April 22, 2022.

Please submit all components of the homework assignment (i.e. word, R script, or Excel file) via Canvas, and name each file with the homework number and your first and last name (e.g. **Hwk4_FirstName_LastName.docx**, **Hwk4_FirstName_Last.xlsx**, **Hwk4_FirstName_LastName.R**). In the word document please describe your results and answer any questions posed in the homework document, along with any useful and/or necessary model output or figures. Please ensure that the R script you submit would allow anyone with the same input files to recreate your analysis, and include comments as necessary to guide review of your work.

In the event you are unable to submit your completed assignment via Canvas, please email it to me at: cjcunningham@alaska.edu. Late homework assignments will be penalized 2 points per day overdue. Please contact me ***ahead of time*** if there are circumstances requiring late submission.

Evaluation

This homework assignment will be graded out of ***40 possible points***.

Homework Contents

- **621_Homework 4.pdf** (this file)
- **wren.csv** Line transect observations with associated distances for wrens from Buckland, S. T. (2006) songbird surveys.

- **ducks-area-effort.csv** Distance sampling data for duck nests from the Monte Vista National Wildlife Refuge, Colorado from 1967-1968.
- **Scallop CPUE.xlsx** Harvest data for the weathervane scallop fishery in Alaska, from Jackson et al. (2022).

Problem 1 – Distance Sampling for Wrens (12 points)

In late March and early April of 2004 line transects were sampled at Montrave Estate near Leven in Fife, Scotland to estimate the abundance of songbird species including the Winter Wren (*Troglodytes troglodytes*). In total **19 transects** were sampled. For each wren detected, detection distances were estimated with the aid of a laser range-finder. For more information see: Buckland, S. T. (2006) *Point-transect surveys for songbirds: robust methodologies*. The Auk 123 (2): 345–357.

The file `wren.csv` includes detection data for wrens including:

- The total population area (A) in km^2: `$Area` .
- The total effort (length) of each transect in km: `$Effort` .
- The perpendicular distance from the transect line at which each wren was detected in meters: `$distance` .

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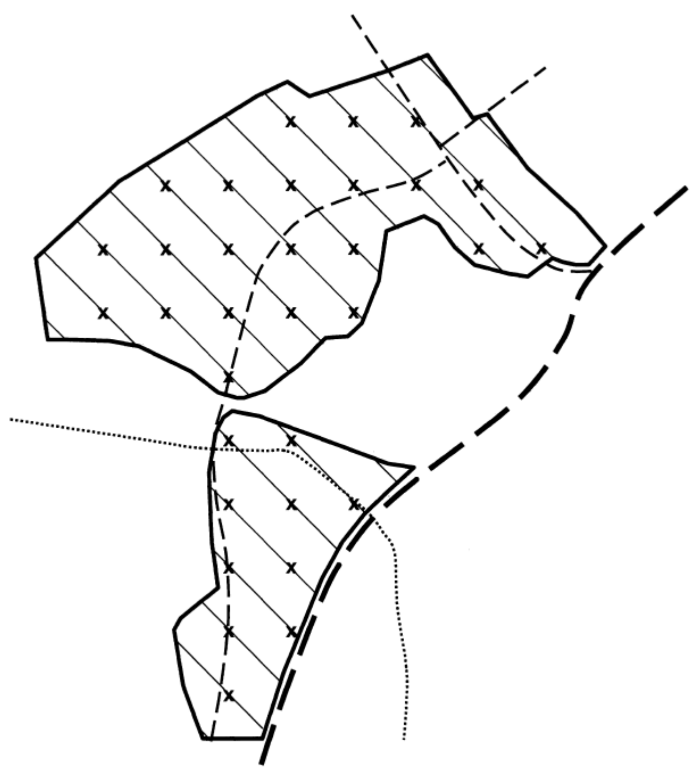


Fig. 1. The study site at Montrave in Fife, Scotland. The dotted line is a small stream, the thin dashed lines are tracks, and the thick dashed line is a main road. The 32 points used for methods 1–3 are indicated by crosses and are laid out at the corners of squares with 100-m sides forming a systematic grid. The diagonal lines are the transects used for method 4.

Based upon this dataset please do the following:

1. Plot a histogram of detection distances.
2. Use boxplots to visualize detection distances by transect.
3. Create a bar or column plot showing the total number of wren detections by transect number.
4. Fit three alternative models to estimate abundance and density from these distance sampling data. Three alternative sighting models (detection functions) should be explored modelling detection probability as a function of distance from the transect:
   a. Half-normal
   b. Hazard-rate
   c. Uniform with a cosine adjustment
5. Plot a comparison of the fitted detection functions to the distance data.
6. Create a summary table comparing density estimates, CV's and lower/upper confidence intervals, across the three alternative models. ***Be sure to consider the units for this metric.***
7. Create a figure showing the density estimates from the three models and associated uncertainty.

8. Create a summary table comparing abundance estimates for the entire estate, CV's and lower/upper confidence intervals, across the three alternative models.
9. Create a figure showing the abundance estimates from the three models and associated uncertainty.
10. Please identify which model you believe most reliable and provide your justification for this choice.

Please summarize your results and inference in the word (.docx) document you submit for this assignment along with your R script. This should include figures and tables requested above, as well as your insights from comparing models.

Problem #2 – Duck Nests: Strip vs. Line Transect (20 points)

In this problem we will revisit the dataset of duck nests from Monte Vista National Wildlife Refuge in Colorado. As a reminder line transect surveys of duck nests occurred in 1967 and 1968, wherein the distance of each detected nest within 2.4 meters of each transect were recorded. The file `ducks-area-effort.csv` includes data from these surveys, including the total population area (A in km^2, `$Area`) and the effort (l_i in km, `$Effort`).

As we observed in lab, the frequency of detections remains fairly high out to a distance of ~ 1.25 m and a question was raised as to whether a reasonable abundance estimate could be generated using strip transect methods. In this problem we will explore this idea further.

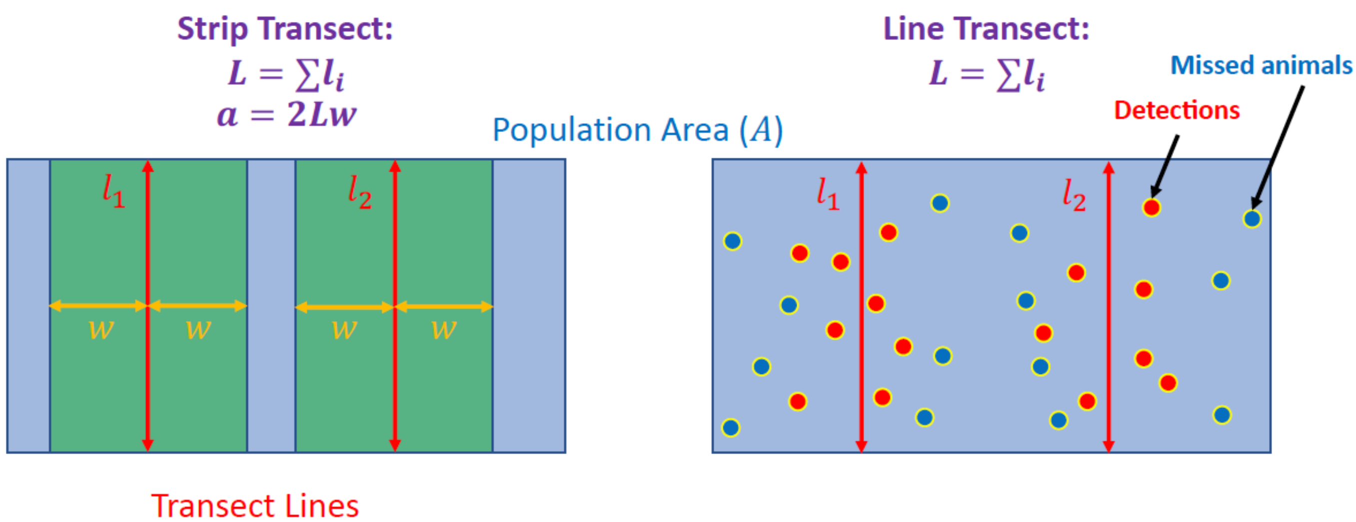
To compare strip and distance estimators, please:

1. Estimate density and abundance for duck nests using distance methods and a half-normal detection (sighting) function.
2. Calculate the area sampled by each strip transect (a), in km^2, if you were to treat each line transect as a strip transect and use nest sightings out to 1.25 meters on each side of the transect.
3. Estimate density and abundance, if you treat each line transect as a strip transect and use nest sightings out to 1.25 meters on each side of the transect.
    a. Note: You can effectively treat the sampled area as one large transect, which is the sum of individual transects.
4. If $n = 20$ is the total number of transects sampled, given the area sampled by each transect a, calculate the effective number of transects that could be sampled N.
    a. Note: This may not be a whole number, but that is inconsequential for the equations to follow.
5. Assuming the strip transects are randomly placed, please use simple random sampling theory to calculate an estimate of the variance and the coefficient of variation (CV) for the total abundance estimate.
    a. Note: This will be similar to the caribou aerial survey example we have discussed previously.
6. Next, please repeat this process, if we only considered nest sightings out to 1.0 meters on each side of the transects. Treating our transects as strips and assuming transects are randomly placed, please calculate:

a. Total density estimate
b. Total abundance estimate
c. Estimate of the variance in the abundance estimate.
d. Estimate of the coefficient of variation in the abundance estimate.

7. Please describe in the word document you submit, why treating our line transect data as strip transects and applying estimators under simple random sampling may or may not be appropriate.

Please summarize your results and inference in the word (.docx) document you submit for this assignment along with your R script.



Problem #3 – CPUE Standardization (8 points)

In this problem we will consider commercial fishery catch rates for weathervane scallops (*Patinopecten caurinus*) across several regions within Alaska. The file `Scallop CPUE.csv` contains catch information for the commercial fishery, including:

- The harvest region.
- The season.
- The season total harvest weight for meat in pounds.
- The season total harvest in round pounds (entire organism).
- The number of dredge hours for the season, or effort.

These data come from the 2022 Scallop Stock Assessment and Fishery Evaluation (SAFE) report: Jackson et al. (2022).

These data may be useful in calculating indices of abundance reflecting trends in the scallop stock across time. Please do the following to quantify trends in the weathervane scallop stock:

1. Calculate catch per unit effort (CPUE) for both meat and round weights.

2. Plot the timeseries (i.e. across seasons) of CPUE by region for both meat and round weights.
3. Use a GLM to calculate a model-based index of abundance for scallops based on ***meat weight***, not controlling for region.
4. Use a GLM to calculate a model-based index of abundance for scallops based on ***meat weight***, this time controlling for region. Use the ***Shelikof*** region as your reference region when generating the index.
5. Plot a comparison of the ***meat weight*** indices from models with and without a region effect.
6. Use a GLM to calculate a model-based index of abundance for scallops based on ***round weight***, not controlling for region.
7. Use a GLM to calculate a model-based index of abundance for scallops based on ***round weight***, this time controlling for region. Use the ***Shelikof*** region as your reference region when generating the index.
8. Plot a comparison of the ***round weight*** indices from models with and without a region effect.
9. Please plot a comparison of fishery-dependent indices of abundance for scallops based on round and meat weights, using models that include the region effect. Summarize the differences you observe.

Time Allocation

At the end of the word (.docx) document you submit for this assignment, please estimate the amount of time you spent in total on this assignment.