WFA4313/6313 LABORATORY 05 - ESTIMATING STREAM FISH RELATIVE & ACTUAL ABUNDANCE

2 October 2018

Lab overview

This lab is designed to set the foundation for upcoming field experiences and estimate abundance of a stream fish. Estimating the number of fish in a stream reach and an entire network can be important considering Mississippi has 123,000 miles of streams [1] and some of the highest biodiversity of stream fishes in North America. In many cases, little is known about the occurrence and abundance of fish species in Mississippi streams. The effects of stream habitat fragmentation has influenced stream fish abundance and in some cases lead to petitioning by the USFWS to list stream fish species under the Endangered Species Act. However, many times listing is petitioned because of lack of information about species abundance. Therefore this lab will illustrate how to use multiple pass stream electrofishing to estimate relative abundance and actual abundance.

Lab objectives:

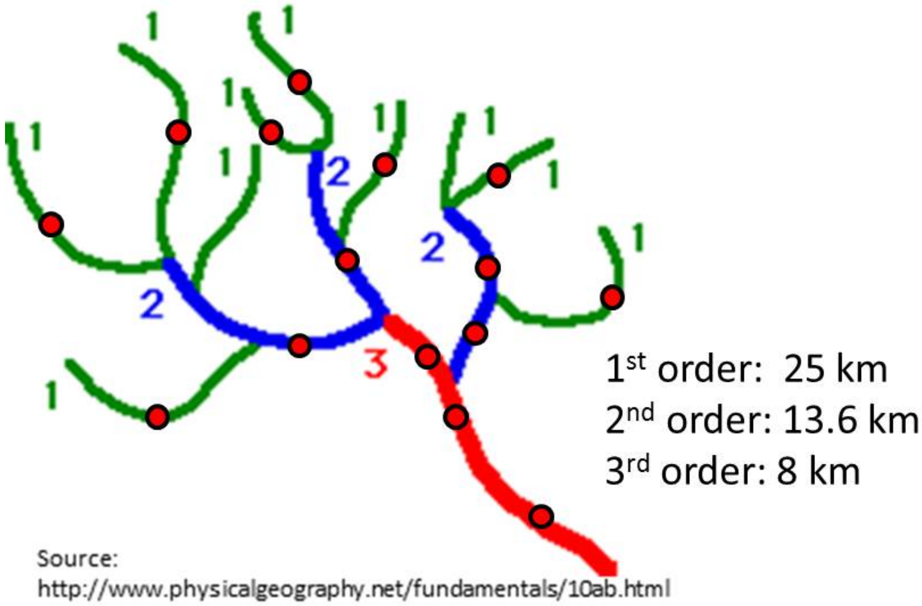
1. Estimate relative abundance at the stream reach level
2. Estimate actual abundance at the stream reach level
3. Understand the pros and cons of relative and actual abundance estimates
4. Understand the effect of capture probability on abundance estimates
5. Use actual abundance estimates to estimate actual abundance at the stream network level
6. Improve proficiency in Excel

Background

Gulf strain walleye are a species of conservation need in Mississippi. They inhabit tributaries to the Tombigbee River. Landscape alterations and habitat fragmentation have resulted in species declines. It is unknown how many gulf strain walleye there are one of the tributaries, Luxapallila Creek Creek. Luxapallila Creek Creek has been intensive stocked with hatchery origin gulf strain walleye. The state agency has tasked the fisheries manager to estimate the number of walleye in this stream network to:

1. Provide population information for potential listing purposes and
2. Provide feedback for conservation stocking efforts.

A stream network can be divided in steams of varying order, as illustrated below. Sample sites can then be randomly selected within each stream order. For this effort the agency could allocate enough person hours to sample 15 sites. Sites are allocated proportional to the amount of stream of each order. Therefore there are 8 sites on 1st order streams, 4 on 2nd order streams, and 3 on 3rd order streams. This is a stratified random design, which is commonly used in steam surveys because fish abundance is typically a function of the amount of stream habitat, which is related to stream order.



Laboratory assessment

Responses to questions, at the end of this document, are due by 5pm, 1 week from today's lab. Responses are to be entered
here (https://goo.gl/forms/5TqDGfxnpLmleR6E3). This lab is worth 15 points.

Exercise 1. Estimating stream fish catch per effort

In fisheries, it is very common to estimate a relative abundance because it requires less effort. Relative abundance has pros, it has cons, and it has assumptions. The assumptions can influence management decisions. This exercise will evaluate the consequence of the assumptions on varying management decisions.

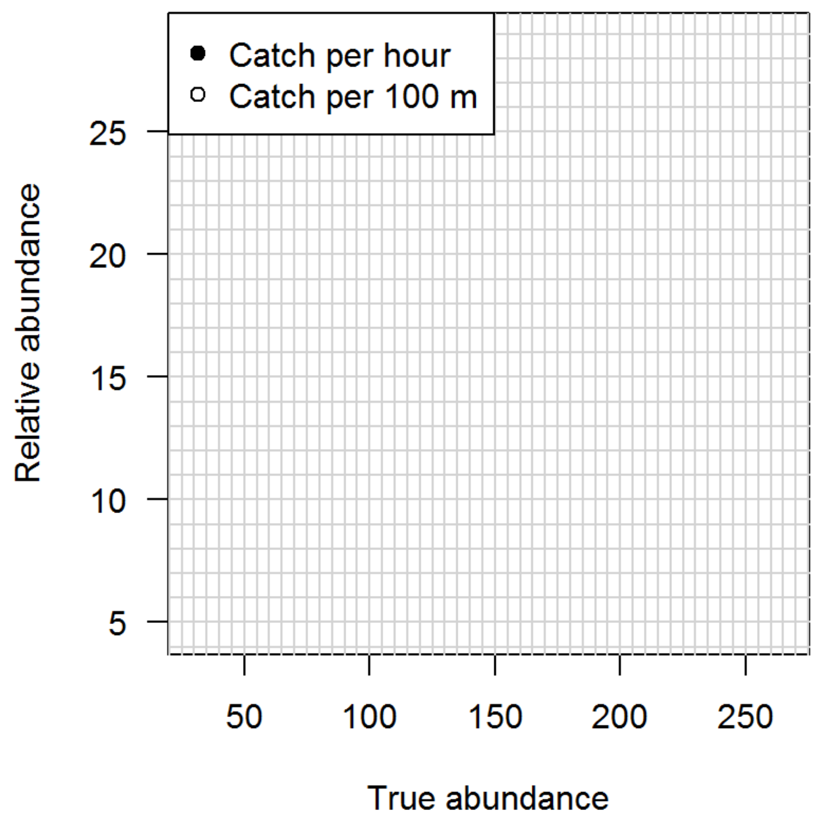
There are 2 ways to calculate relative abundance when dealing with stream fish data: a) catch per effort and b) catch per meter. This exercise will work through the calculation of each relative abundance value for the 15 sites.

In this dataset the field crew went to each site and electrofished a distance of stream once, in fisheries terminology a single pass. Ok, Let's begin!

1. Open the excel workbook `lab-05.xlsx` located on your desktop.
2. The first worksheet contains data for this exercise (Exercise 1 worksheet).
3. Calculate catch per effort in `column F` by dividing the first pass catch by first pass effort and multiplying by 60. It is common to normalize values to 1 hour.
4. Calculate the total catch per 100 meters in `column G` by dividing the first pass catch by the reach length and multiply by 100. It is common to normalize values to 100 meter.
5. Record the values in the table below

Site	Stream order	Reach length (m)	Pass 1 effort (min)	Pass 1 catch	True abundance	Catch per effort	Catch per 100 m
1.1	1	95	90	7	30	______	______
1.2	1	113	70	12	32	______	______
1.3	1	99	52	7	34	______	______
1.4	1	116	77	11	39	______	______
1.5	1	118	115	12	40	______	______
1.6	1	87	82	9	29	______	______
1.7	1	103	87	9	33	______	______
1.8	1	116	95	10	34	______	______
2.1	2	238	237	44	115	______	______
2.2	2	228	189	37	100	______	______
2.3	2	280	239	36	137	______	______
2.4	2	228	176	38	112	______	______
3.1	3	329	262	95	266	______	______
3.2	3	322	208	65	226	______	______
3.3	3	292	167	78	213	______	______

5. Use the graph below to make a plot of `True abundance` on the x-axis and `Catch per effort` and `Catch per 100 m` on the y-axis.



Exercise 2. Estimating stream fish abundance

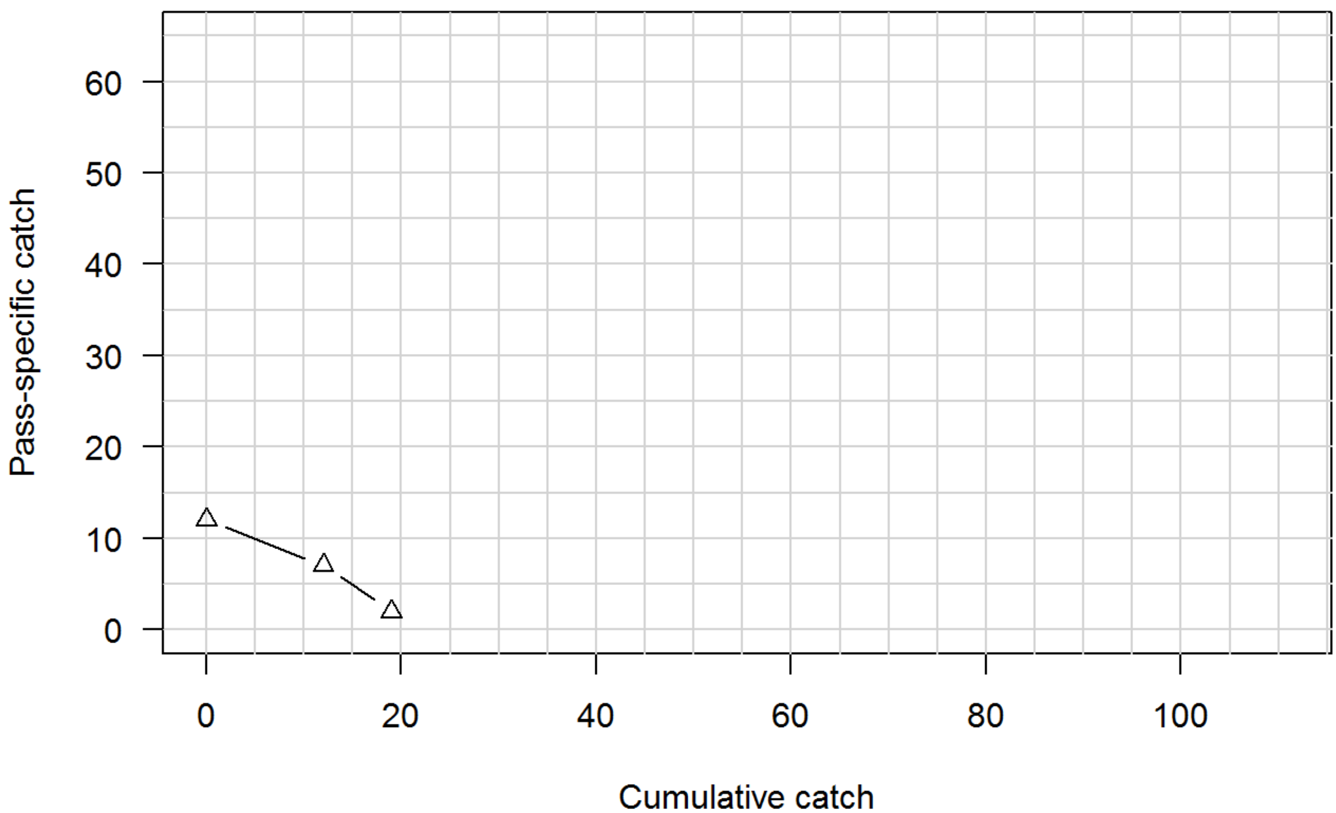
It is common in stream fish assessment to use multiple passes to catch the fish you may have missed on the first pass, known as a depletion count. The assumption of the depletion count is that the capture probability among passes is constant. If it is constant you can get an unbiased estimate of capture probability and abundance. Pretty cool right? Let's use this approach to estimate the number of fish in each of the 15 sample reaches.

1. Open the excel workbook `lab-05.xlsx` located on your desktop.
2. The first worksheet contains data for this exercise: `Exercise 2 worksheet`.
3. The first thing we need to do is calculate the cumulative catch for each site.
4. The first cumulative catch is done for you, it is 0.
5. Calculate the cumulative catch for pass 2 in column H as `cumulative catch 1 + Pass 1 catch`
6. Calculate the cumulative catch for pass 3 in column I as `cumulative catch 2 + Pass 2 catch`

7. Fill in the table below with the cumulative catch numbers

Site	Stream order	Reach length (m)	Pass 1 catch	Pass 2 catch	Pass 3 catch	Cumulative catch Pass 1	Cumulative catch Pass 2	Cumulative catch Pass 3
1.2	1	113	12	7	2	0	______	______
2.2	2	228	37	15	13	0	______	______
3.2	3	322	65	46	31	0	______	______

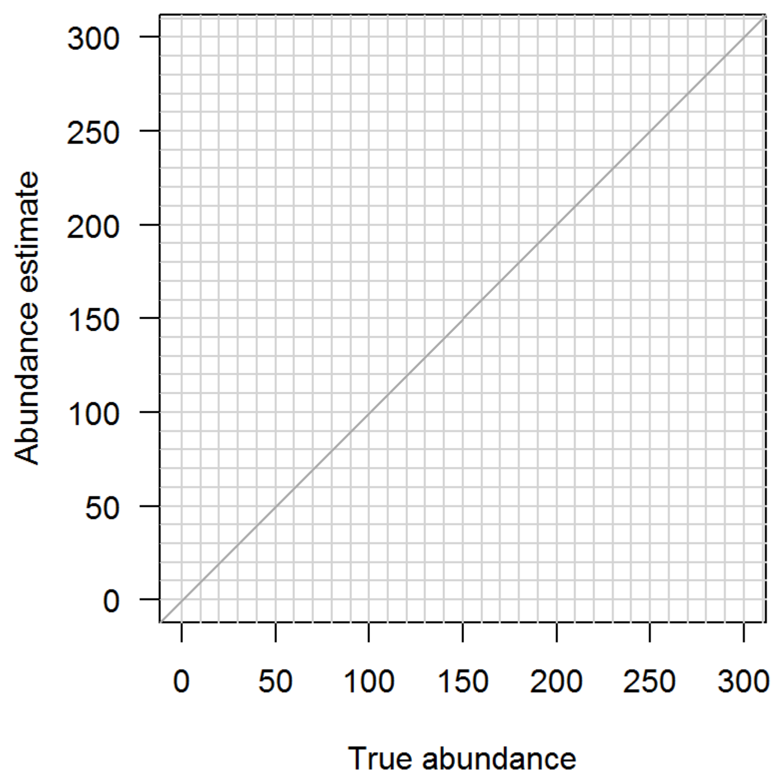
8. Now plot, for sites 1.2, 2.2, and 3.2 above, the cumulative catch (x-axis) versus the number captured (y-axis) below and see if it looks linear. The first site is done for you to illustrate for site 1.2.



9. To estimate the population we need to fit a linear model (intercept and slope) to the lines in the figures above but for all the sites!
10. Fit a intercept to the data for each site in `Exercise 2a worksheet` using the `= intercept(y,x)` function in excel. See supplemental information about how to do this.
11. Fit a slope to the data in `Exercise 2a worksheet` using `= slope(y,x)` function in excel. See supplemental information about how to do this.
12. Calculate capture probability as -1*Slope
13. Record the estimates of abundance (N = Intercept/p) in the table below for `Abundance estimate`.

Site	Stream order	Reach length (m)	True Abundance	Abundance estimate
1.1	1	95	30	______
1.2	1	113	32	______
1.3	1	99	34	______
1.4	1	116	39	______
1.5	1	118	40	______
1.6	1	87	29	______
1.7	1	103	33	______
1.8	1	116	34	______
2.1	2	238	115	______
2.2	2	228	100	______
2.3	2	280	137	______
2.4	2	228	112	______
3.1	3	329	266	______
3.2	3	322	226	______
3.3	3	292	213	______

14. Plot the true abundance (x-axis) and estimated abundance (y-axis) for estimates assuming p is homogeneous.



Exercise 3: Estimating stream network abundance and biomass

The practical reality is that we need to estimate the number of fish in the entire stream network per the agency request and to assess whether the population is sufficiently large to preclude petitioning for listing. To do that we need to estimate the mean number of fish in each stream order. But the problem is that each sample site is a different stream length! The way to work around this is to calculate the number of fish per meter or kilometer just like you did for the relative abundance but by dividing estimated abundance by the reach length. Let's give it a shot.

1. Calculate the fish per m (i.e., density) by dividing the abundance estimate by the reach lengthUsing abundance estimates you calculated for data in `Exercise 2a worksheet.`
2. Multiply the value by 1000 to convert to fish per km.
3. Calculate the mean density for each stream order and enter below. Use the `=average()` function in excel.
   - 1st order; μ_{1st} = ______
   - 2nd order; μ_{2nd} = ______
   - 3rd order; μ_{3rd} = ______
4. Now you can calculate the proportion of each stream order to weight the means by. Specifically there are 46.6 km of stream miles in the stream network. Weight is the distance/total distance.
   - 1st order; 25.0 km = ______ = W_{1st}
   - 2nd order; 13.6 km = ______ = W_{2nd}

- 3rd order; 8.0 km = ______ = W_{3rd}

5. Now you can calculate the weighted mean using the equation: $\widehat{N} = 46.6 \cdot \sum_{order=1}^{3} W_{order} \cdot \mu_{order}$
6. The equation above is easier than it looks. It is simply:
   $\widehat{N}_{abundance} = 46.6 \cdot (W_{1st} \cdot \mu_{1st} + W_{2nd} \cdot \mu_{2nd} + W_{3rd} \cdot \mu_{3rd})$.
7. Calculate the number of fish in the stream network using the equation above and enter it below
   - $\widehat{N} =$ ____________
8. Now you have an estimate of the total number of fish in the entire stream network! Go ahead and give your self a pat on the back.
9. Now, suppose you multiply $\widehat{N}$ by the mean weight of a fish ($\overline{weight} = 0.45$ kg) and you can get an estimate of biomass. Pretty cool, right?
   - $\widehat{Biomass} = \widehat{N} \cdot \overline{weight}$ = ____________

Supplemental information

Estimating the intercept and slope of a linear model using excel

Pass 1 catch	Pass 2 catch	Pass 3 catch	Cumlatve catch 1	Cumlatve catch 2	Cumlatve catch 3
150	105	74	0	150	255
		Intercept	Slope	p	N
		=INTERCEPT(L4:N4,O4:Q4)	=SLOPE(L4:N4,O4:Q4)	=-1*O7	=N7/P7

Note the y values (cumulative catch) are first and the x values (actual catch) are second

Pass 1	Pass 2	Pass 3 catch	Cumlatve c	Cumlatve	Cumlatve catch 3
150	105	74	0	150	255
		Intercept	Slope	p	N
		149.9200913	-0.298174	0.29817	502.795

These are the estimates of capture probability (p) and abundance (N)

Questions

Exercise 1

1.1. The USFWS has determined that if the population is less than 500 individuals they will be petitioned for listing under the Endangered species act. Given the data and estimates of relative abundance what can you say about the population abundance? Do you think gulf strain walleye should be listed? Why or why not? (4-points)

Exercise 2

2.1. Do you think it is reasonable to assume that capture probability is homogeneous among passes? Do you think it is biologically reasonable? What do you think would influence any differences in capture probability? Do some speculation here, you will get to see first hand when we go out and sample some stream in the next labs. (4 Points)

2.2. What is the consequence if you over estimate capture probability? HINT N = intercept/p. (4 Points)

Exercise 3

3.1. Recall from question 1.2 that if the population was less than 500 individuals it would be petitioned for listing. What was your population estimate and should it be petitioned for listing? (2 points).

3.2. If the population is less than 25,000 then the agency will continue stocking gulf strain walleye. Given your abundance estimate, should they continue stocking? (1 point).

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1. https://www.mdwfp.com/fishing-boating/public-waters.aspx (https://www.mdwfp.com/fishing-boating/public-waters.aspx)↩