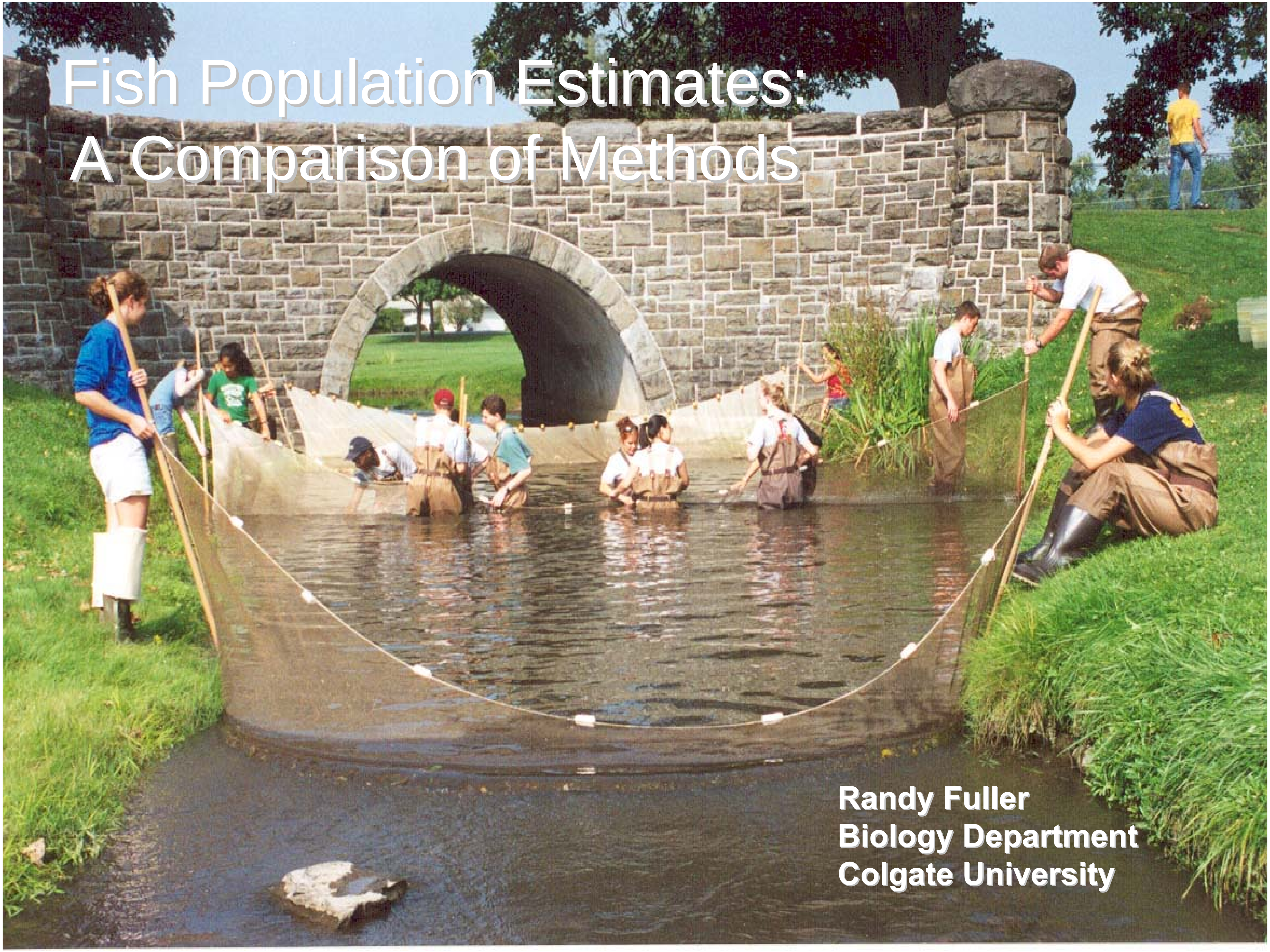

Fish Population Estimates: A Comparison of Methods

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Why Do I Like This Exercise?

- Favorite way to begin my ecology course
- Gets students outside doing ecology in the first week.
- It is a quantitative exercise (not a walk in the woods), and it sets the stage for rest of course.
- Forces the students to confront variability when quantifying population parameters.

- This exercise gives estimates that vary widely from one day to the next.
- Each method makes certain assumptions that students must consider when using each one to estimate population sizes.
- They must evaluate how a violation of each assumption might affect their estimate.
- Lastly, with the use of 2 methods, they get two estimates that may not agree and they have to evaluate which method is most appropriate for our situation.

What do we do?

- Capture-Mark-Recapture Method and the Removal Summation Method for estimating fish population size in a pool.
- With 2-3 lab sections (one per day), each section goes to the same pool and samples the fish using 3-4 seines – 2 used as blocking nets and 1or 2 nets sweep through the pool catching fish.

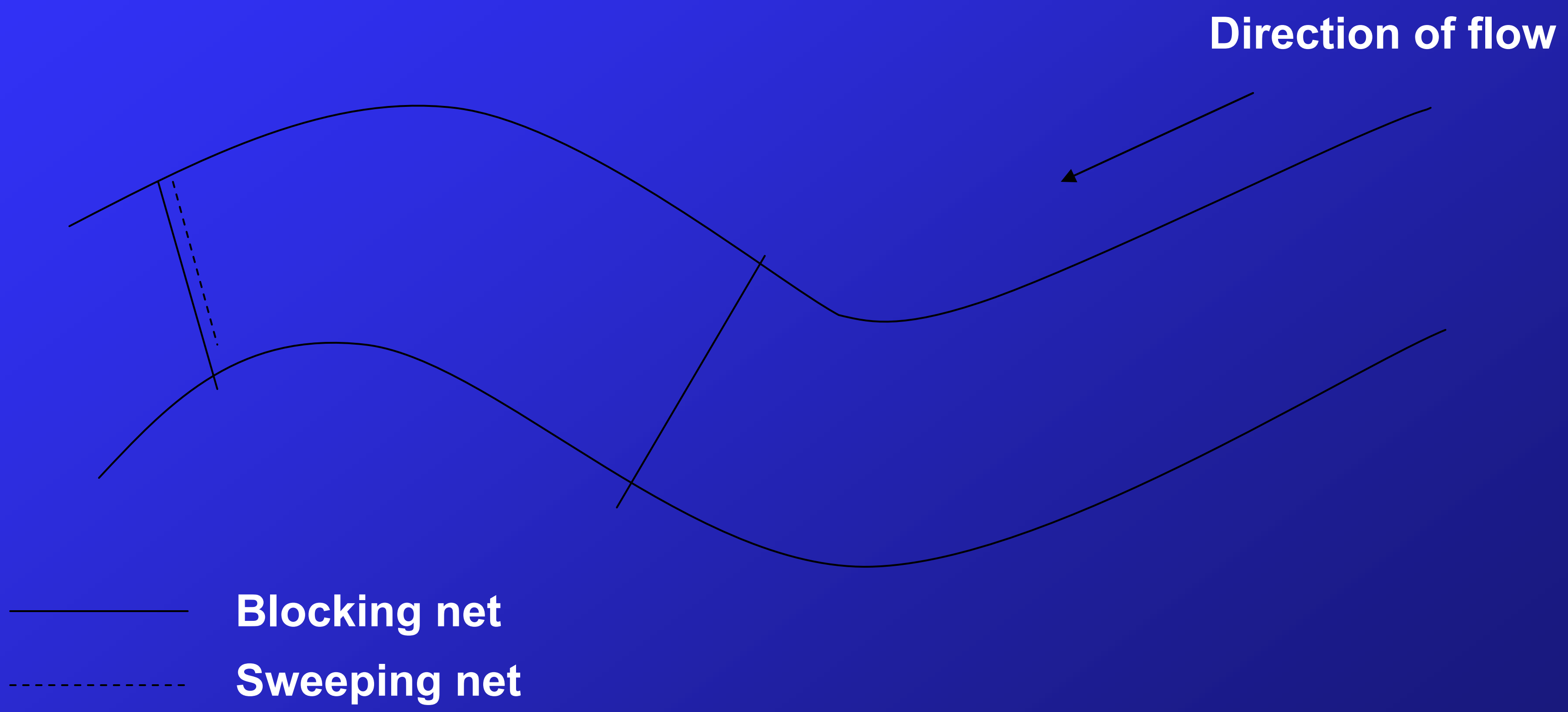
Materials Needed

- 3-4 Minnow Seines – 4' X 20'
- Lots of hip boots or waders – 16 pairs
- 16 or more buckets
- 8 aquarium fish nets
- Pictorial key to the most common fishes
- Scissors – 6-8 pairs to do fin clips
- Clip boards with Rite in the Rain paper

Logistics

- Spend 5 minutes in lab describing basic principles of each method and how to sample the pool.
- Impress upon them the importance of keeping all fish caught in a particular “catch” in one place. (Number the buckets 1-4 and keep all similarly numbered buckets together!)
- Briefly describe fin clip method.
- Then go out in the field!

Pool Layout



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Remember to pick a sunny day!

Removal-Summation Method

- I do 4 catches or sweeps through the pool keeping the fish from each catch separate.
- The basic principle behind this method is you remove a fixed proportion of the fish from the population with each catch.

Removal-Summation Method – with a decrease in individuals with each successive catch, you can use a linear regression analysis to estimate total population size.

Assumptions:

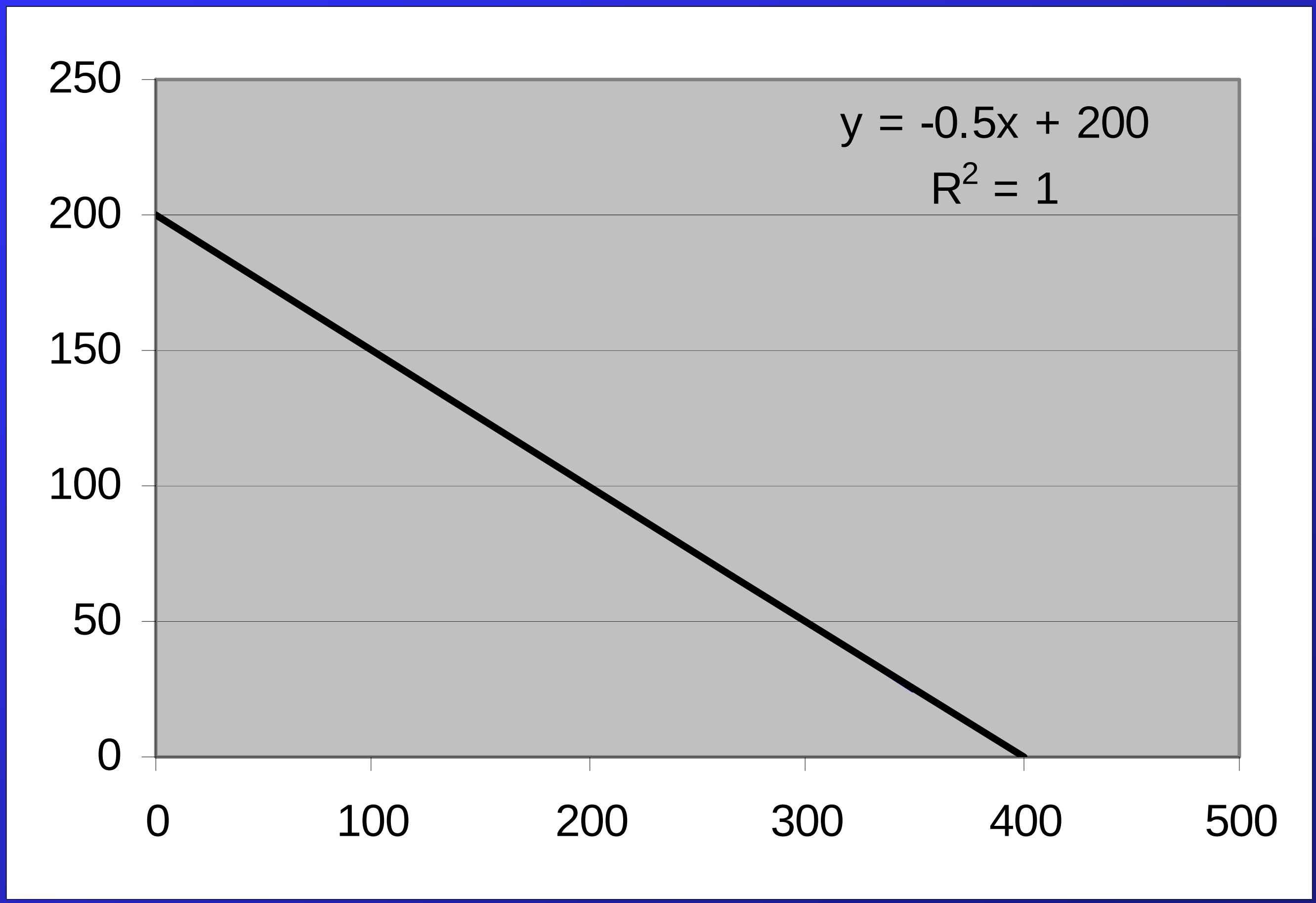
1. Each individual has an equal chance of being caught.
2. Population size does not increase or decrease between catches.
3. The probability of capture is constant from one catch to the next.

The following example shows a population that is captured at a rate of 50% for each sample taken. The table below shows the number caught for each sample (Y) and the total number previously caught (X).

Catch	**1**	**2**	**3**	**4**
Number caught (Y)	200	100	50	25
Total number previously caught (X)	0	200	300	350

To get your population estimate, use the equation for the line from your regression analysis and solve for X when Y equals zero. **In other words, the X-intercept is the estimate of your population size.**

Hypothetical Results for Removal Summation Method




Processing the catches!

Data for First Day

Catch	Shiner	Sucker	Other	Total
1	714	55	4	**773**
2	378	47	3	**428**
3	105	18	12	**135**
4	86	62	5	**153**
TOTAL	**1283**	**182**	**24**	**1489**

Marked	Shiner	Sucker		
1	352	55		**407**
2	129	47		**176**
3	0	18		**18**
4	86	62		**148**
TOTAL	**567**	**182**	**749**	

Day 2 Catches

Unmarked fish

Catch	Shiner	Sucker	Other	Totals
1	93	34	17	**144**
2	81	62	10	**153**
3	20	6	11	**37**
4	28	14	0	**42**
TOTAL	**222**	**116**	**38**	**376**

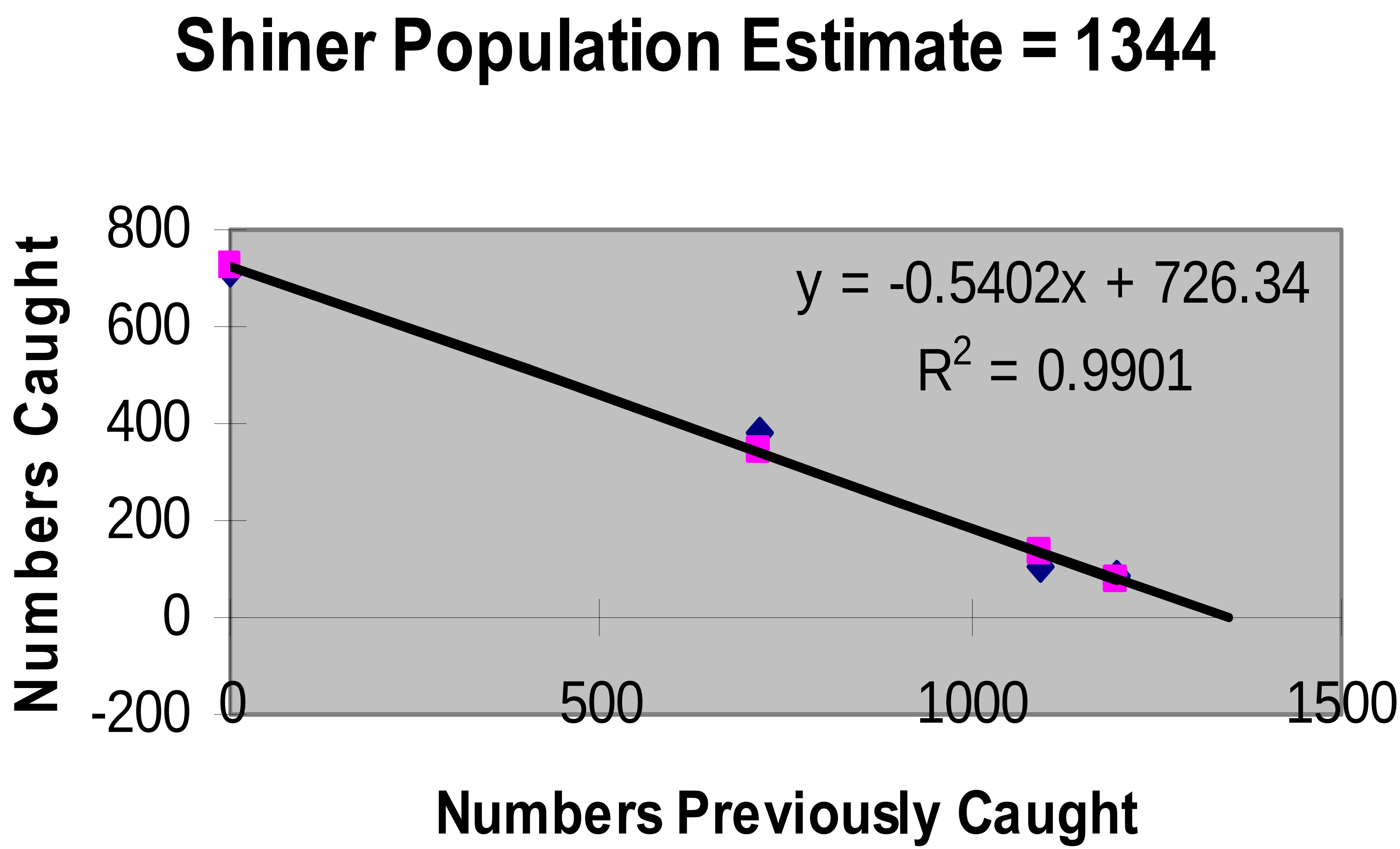
Day 2 Catches - continued

Marked fish

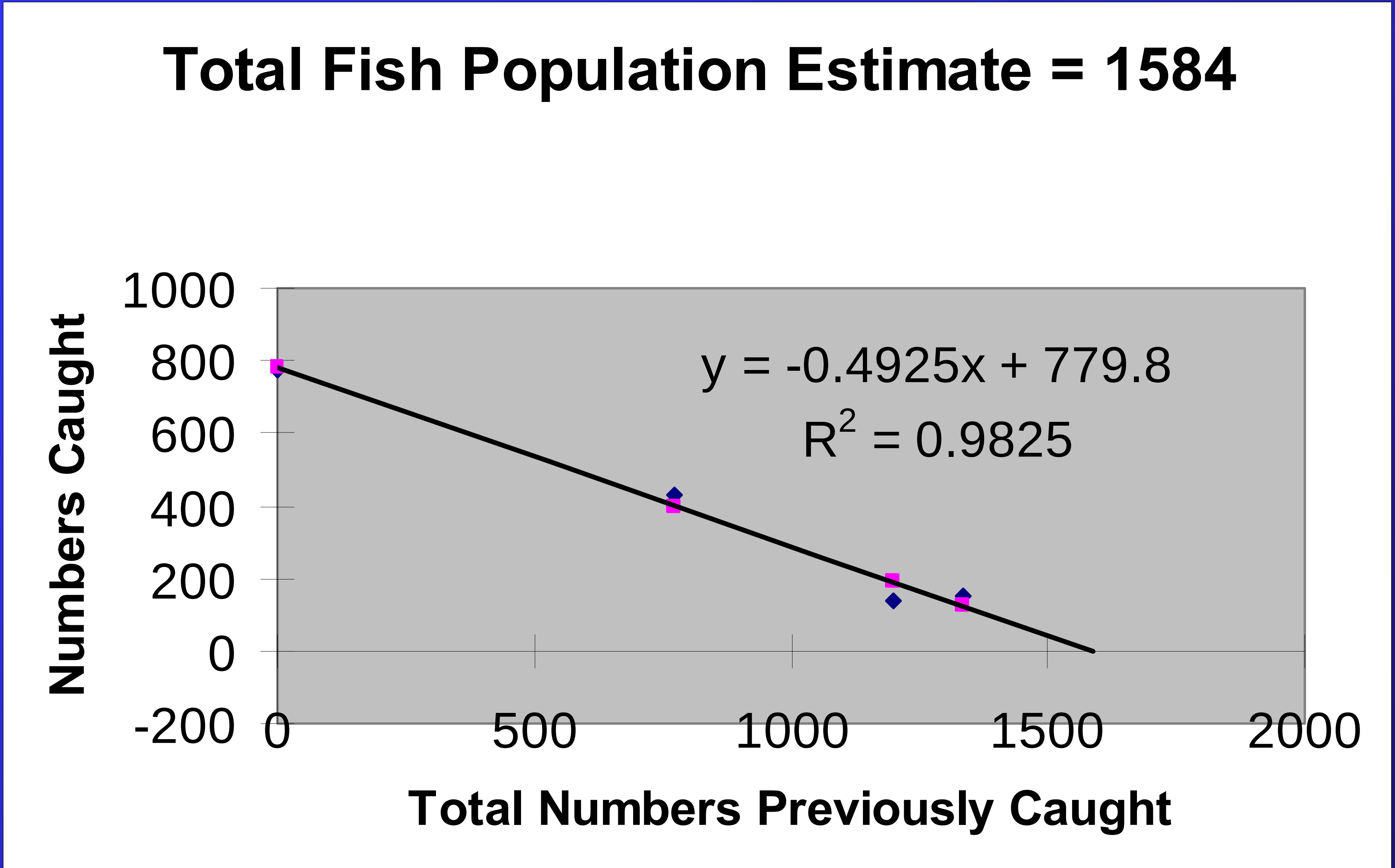
Catch	Shiner	Sucker	Other	Totals
1	124	8		**132**
2	57	29		**86**
3	21	5		**26**
4	30	7		**37**
TOTAL	**232**	**49**	**0**	**281**

Thursday	**Catch 1**	**Catch 2**	**Catch 3**	**Catch 4**
Totals/Catch	**276**	**239**	**63**	**79**

Some of my best data!



Total Fish Population Estimate for Day One



Capture-Mark-Recapture Estimates

$$\frac{n}{N} = \frac{R}{M}$$

Where,

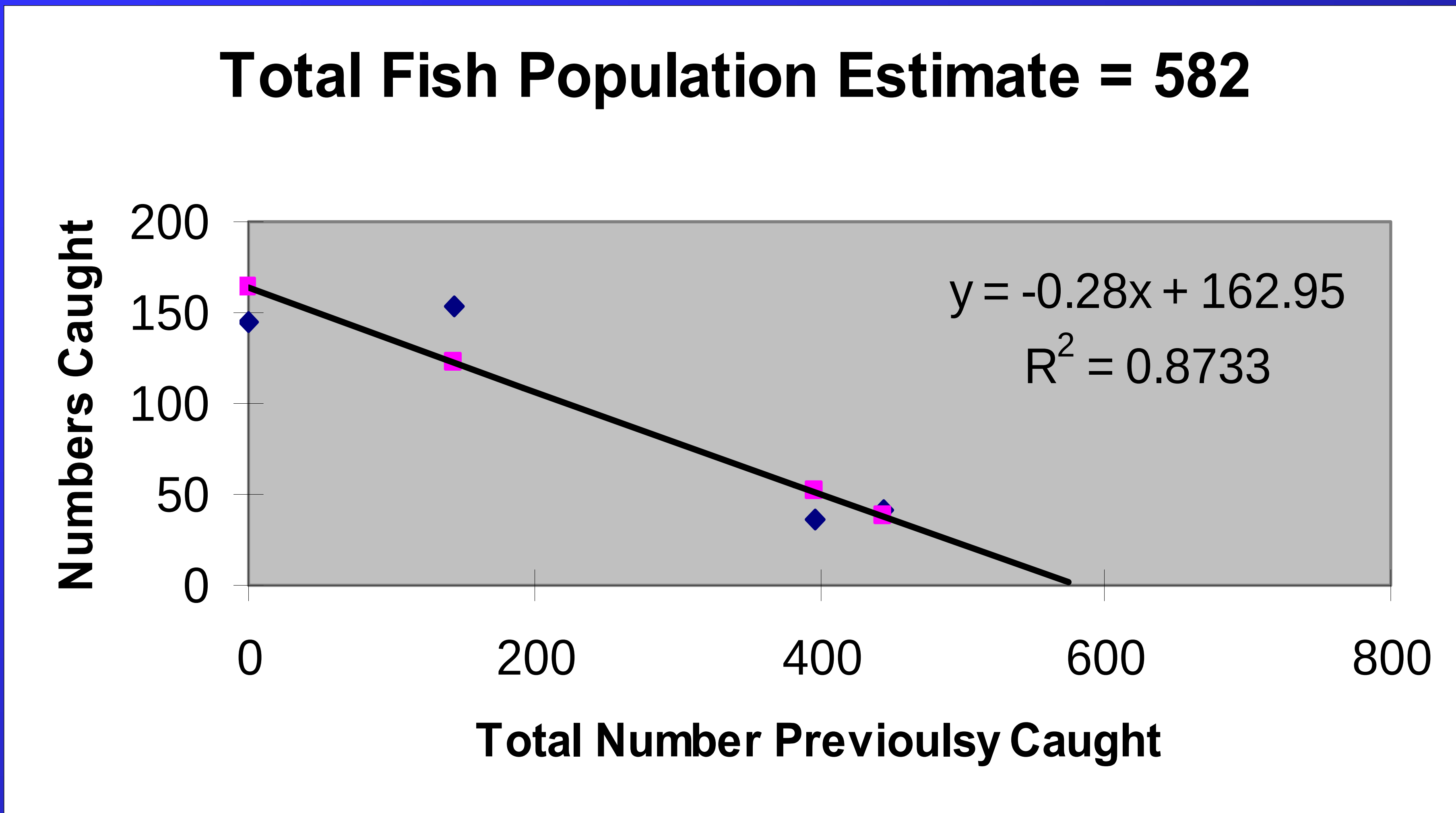
- n = number caught in second sample (marked and unmarked),
- N = total population estimate,
- R = number of marked organisms recaptured.
- M = total number marked in the first sample,

$$N = \frac{Mn}{R}$$

This formula often overestimates the actual population size. Using marked and unmarked beads, mathematical ecologists have shown that a more accurate population estimate is obtained using the following formula:

$$N = \left[\frac{(M + 1)(n + 1)}{(R + 1)} \right] - 1$$

Total Fish Population Estimate for Day Two



When we estimate any population parameter there is always some error or variability associated with our estimate. The following formula allows us to estimate the variability in our population size estimates for the CMR method.

$$SE = \sqrt{\frac{(M+1)(n+1)(M-R)(n-R)}{(R+1)^2(R+2)}}$$

You can calculate the 95% confidence intervals for your population estimate using t for α =0.05 and degrees of freedom = ∞, which is 1.96.

$$N \pm SE * t$$

Capture-Mark-Recapture Estimates

N = 1751

$N_{corrected}$ = 1749

SE = 62.45

N ± 95% Confidence Limits

1749 ± 122

Comparison of Estimates

Removal Summation – **Day One = 1744**

Day Two = 582

Capture-Mark-Recapture – Day Two = 1749

± 122

Which value for Day Two do you have the most confidence in?

Write an **Abstract** and **Results** section describing your study. Also, answer the following questions on a separate sheet of paper.

1) **How do our estimates of fish population size differ between the Capture Mark-Recapture method and the Removal Summation Method? Do our estimates change for each day we sampled? If so, give a rational explanation for this difference?**
2) **When the assumptions for the removal-summation method are met, the number caught in each sample decreases. Did this happen in our sampling? If not, why not? Try combining the first two samples for a population that had a larger second than first sample and recalculate N with three sample points. How does this change your estimate of N?**
3) **What might you do differently if you were to do this again?**


Wade right in
Research at Colgate