WF4313/6413-Fisheries Management

Class 8


In the news &
announcements

Dead fish scattered on the highway as floodwaters recede in North Carolina

By Faith Karimi, CNN

Updated 6:59 AM EDT, Sun September 23, 2018

Two fishes a day keep the mantid coming back to prey: The first fishing praying mantis

Date: September 20, 2018

Source: Pensoft Publishers

Summary: For the first time, a praying mantis is recorded to fish. For five days in a row, an adult male was observed hunting and devouring a total of nine guppies from a pond located in a private roof garden in Karnataka, India. Apart from demonstrating such repetitive behavior, the event is remarkable in the fact that it occurred naturally, without external interference.

Share:

The male praying mantis (*Hierodula tenuidentata*) eating a guppy fish (*Poecilia reticulata*) starting from the tail, while the fish is still alive and breathing in the water.

Credit: Rajesh Puttaswamaiah

Refining Crappie (*Pomoxis spp.*) Aquaculture Techniques

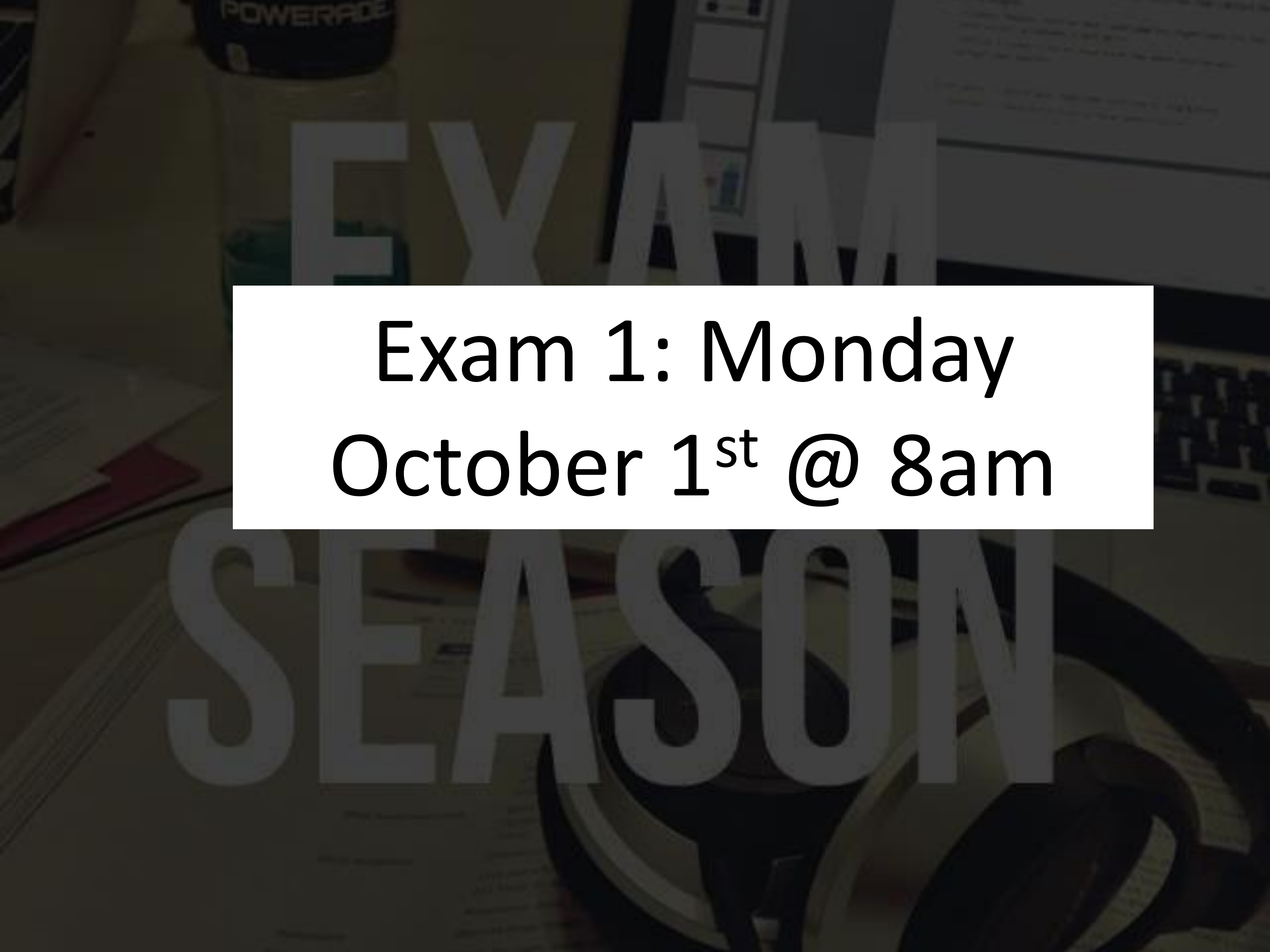
Christian Shirley, M.S. candidate

Thesis seminar

Department of Wildlife, Fisheries and Aquaculture

September 26, 2018 12:30 p.m.

Tully Auditorium



Exam 1: Monday
October 1st @ 8am

Commercial, recreational, and subsistence anglers catch fish as part of a fishery. Managers and researchers also need to catch fish to estimate quantities like relative abundance, size structure, mortality!

THE CATCH PROCESS

Catch process

Abundance or biomass

Catch

$$C = q \cdot f \cdot A$$

Catchability

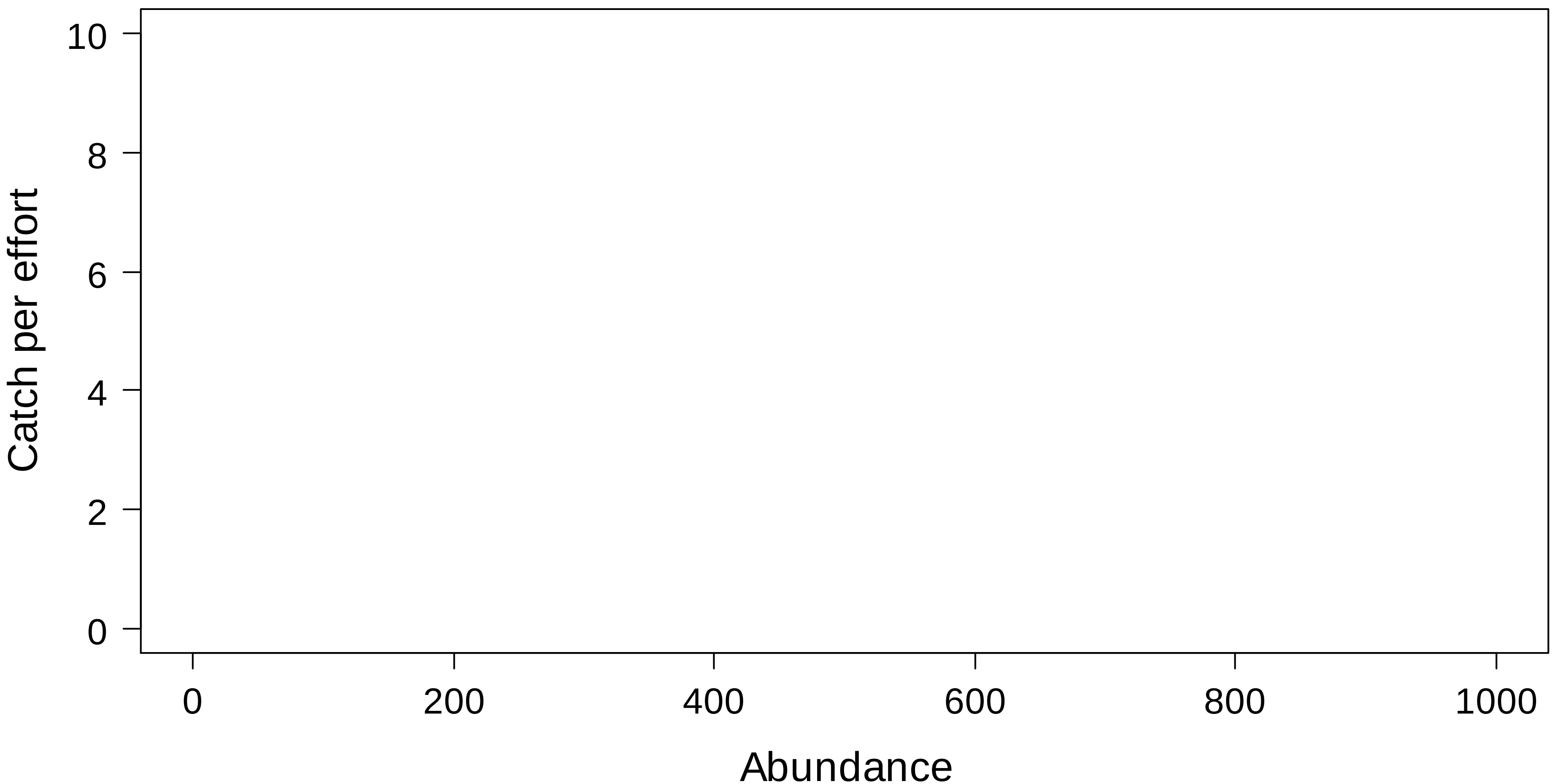
Effort

A neat property

Fishing mortality

$$F = q \cdot f$$

CPE, Catchability, & Abundance



Reasonable Relationship?

- Gear saturation
  - Gear captures so many fish that it can’t capture any more
  - Underestimates number of fish
- Gear avoidance
  - Fish see gear and run away
  - Underestimates number of fish
- Let’s see…

The illusion of plenty

Hyperstability

- Overestimation of abundance & biomass
- Underestimation of fishing mortality

Hyperstability

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$

- Lets assume:
- Catchability = 0.01
- β = 0.85, 0.5
- Biomass = 100, 300, 800, 1000

Example: β = 0.85

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 100^{0.85}$$
$$\frac{Catch}{effort} = 0.14$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 300^{0.85}$$
$$\frac{Catch}{effort} = 0.35$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 800^{0.85}$$
$$\frac{Catch}{effort} = 0.82$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 1000^{0.85}$$
$$\frac{Catch}{effort} = 1$$

Example: β = 0.5

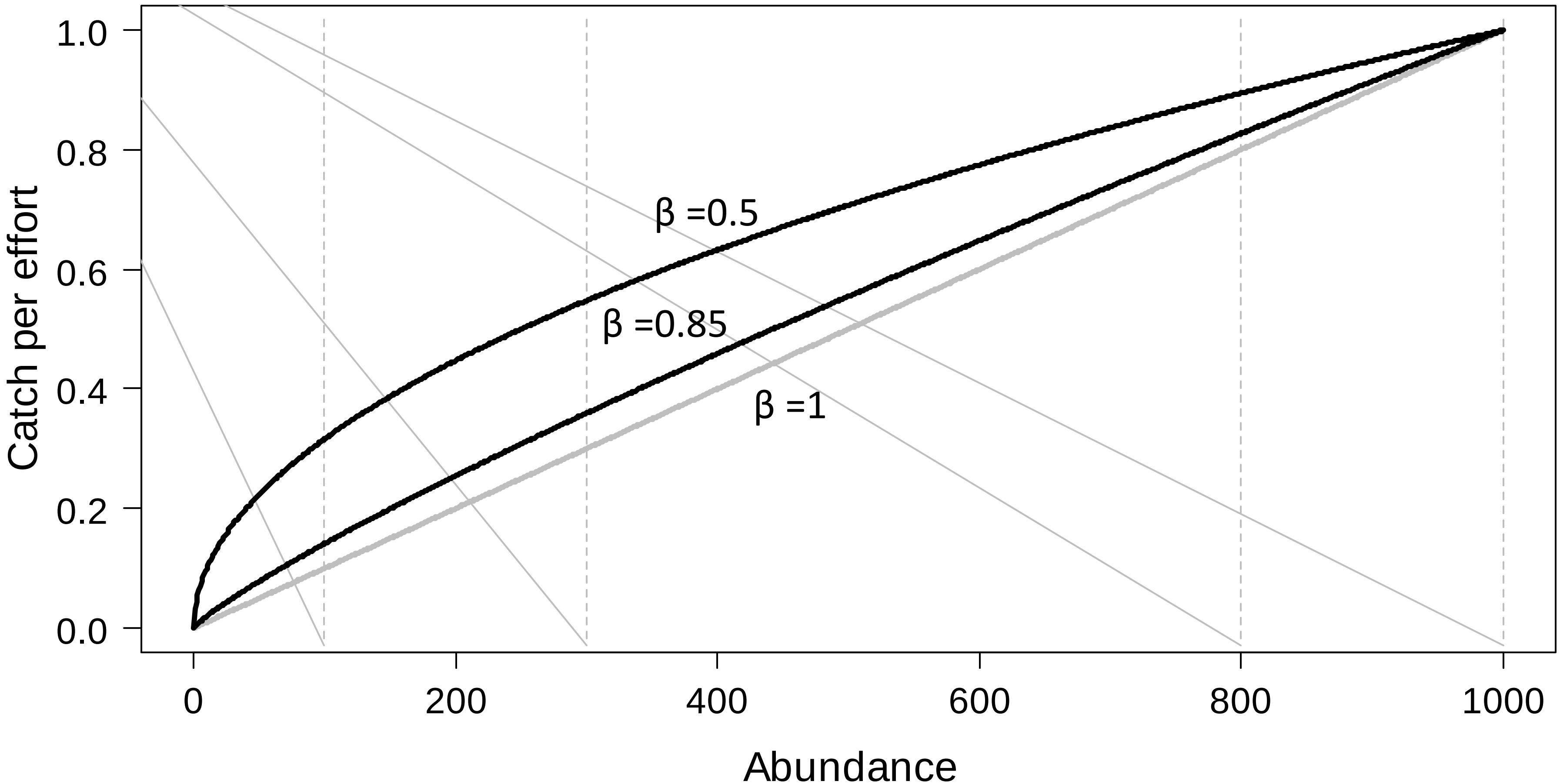
$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 100^{0.5}$$
$$\frac{Catch}{effort} = 0.32$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 300^{0.5}$$
$$\frac{Catch}{effort} = 0.55$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 800^{0.5}$$
$$\frac{Catch}{effort} = 0.89$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 1000^{0.5}$$
$$\frac{Catch}{effort} = 1$$

Hyperstability



Appears worse than it is

Hyperdepletion

- Biomass is underestimated
- Fishing mortality is overestimated

Hyperdepletion

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$

- Lets assume:
- Catchability = 0.01
- β = 1.85, 1.5
- Biomass = 100, 300, 800, 1000

Example: β = 1.5

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 100^{1.5}$$
$$\frac{Catch}{effort} = 0.03$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 300^{1.5}$$
$$\frac{Catch}{effort} = 0.16$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 800^{1.5}$$
$$\frac{Catch}{effort} = 0.71$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$
$$\frac{Catch}{effort} = 0.001 \cdot 1000^{1.5}$$
$$\frac{Catch}{effort} = 1$$

Example: β = 1.85

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$

$$\frac{Catch}{effort} = 0.001 \cdot 100^{1.85}$$

$$\frac{Catch}{effort} = 0.01$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$

$$\frac{Catch}{effort} = 0.001 \cdot 300^{1.85}$$

$$\frac{Catch}{effort} = 0.10$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$

$$\frac{Catch}{effort} = 0.001 \cdot 800^{1.85}$$

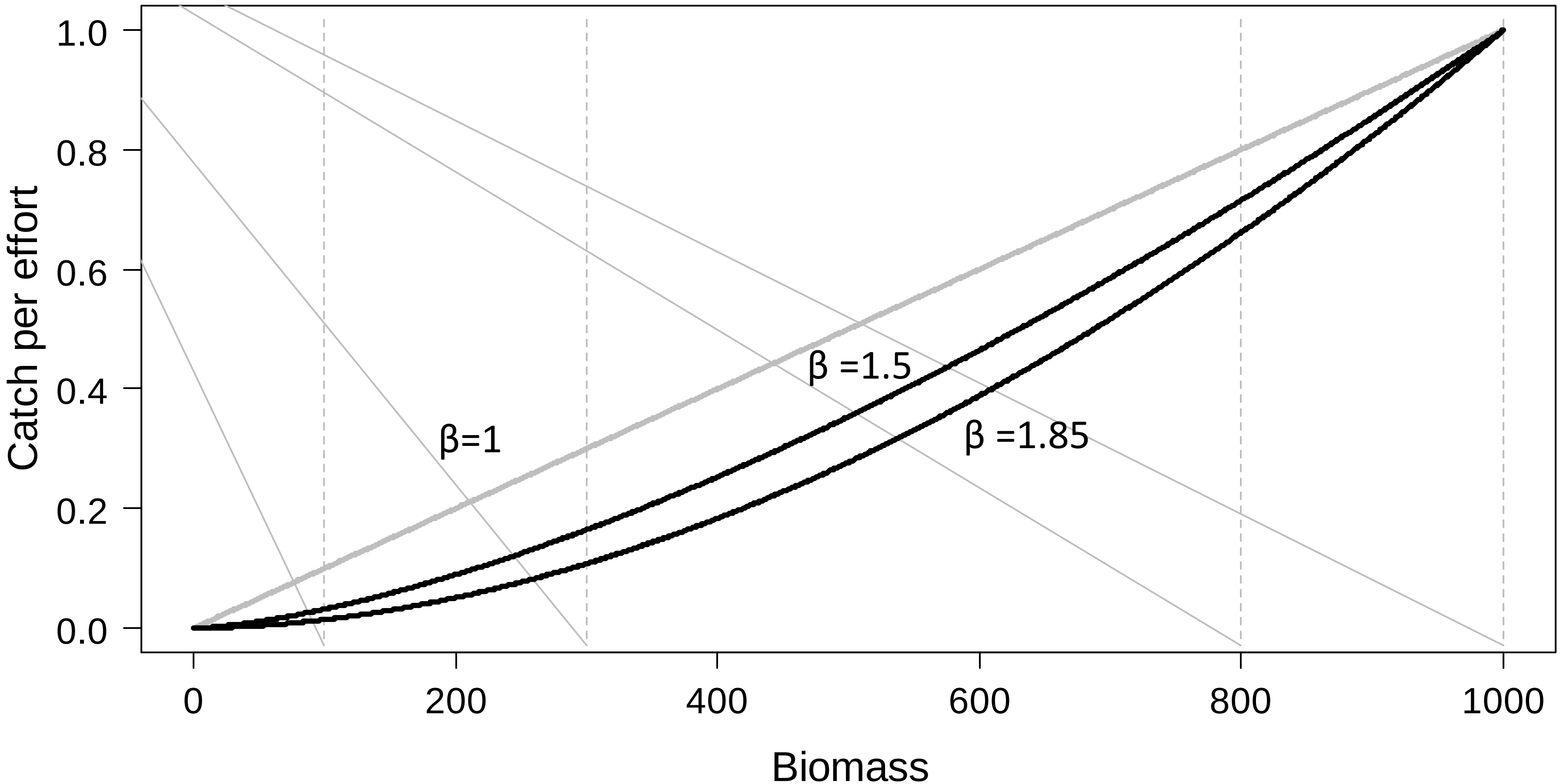
$$\frac{Catch}{effort} = 0.66$$

$$\frac{Catch}{effort} = catchability \cdot Abundance^{\beta}$$

$$\frac{Catch}{effort} = 0.001 \cdot 1000^{1.85}$$

$$\frac{Catch}{effort} = 1$$

Hyperdepletion



Because we rarely know what the population biomass or abundance is we use catch per unit effort to index the relative abundance because it should be proportional to abundance and biomass.

RELATIVE ABUNDANCE: CATCH PER UNIT EFFORT (CPE OR CPUE)

Catch per effort (CPE)

$$C = q \cdot f \cdot A$$

$$\frac{C}{f} = q \cdot A$$

- Lets assume:
- Catchability = 0.001
- Biomass = 100, 300, 800, 1000

CPE- Example

$$\frac{Catch}{effort} = catchability \cdot Abundance$$

$$\frac{Catch}{effort} = 0.01 \cdot 100$$

$$\frac{Catch}{effort} = 1$$

$$\frac{Catch}{effort} = catchability \cdot Abundance$$

$$\frac{Catch}{effort} = 0.01 \cdot 300$$

$$\frac{Catch}{effort} = 3$$

$$\frac{Catch}{effort} = catchability \cdot Abundance$$

$$\frac{Catch}{effort} = 0.01 \cdot 800$$

$$\frac{Catch}{effort} = 8$$

$$\frac{Catch}{effort} = catchability \cdot Abundance$$

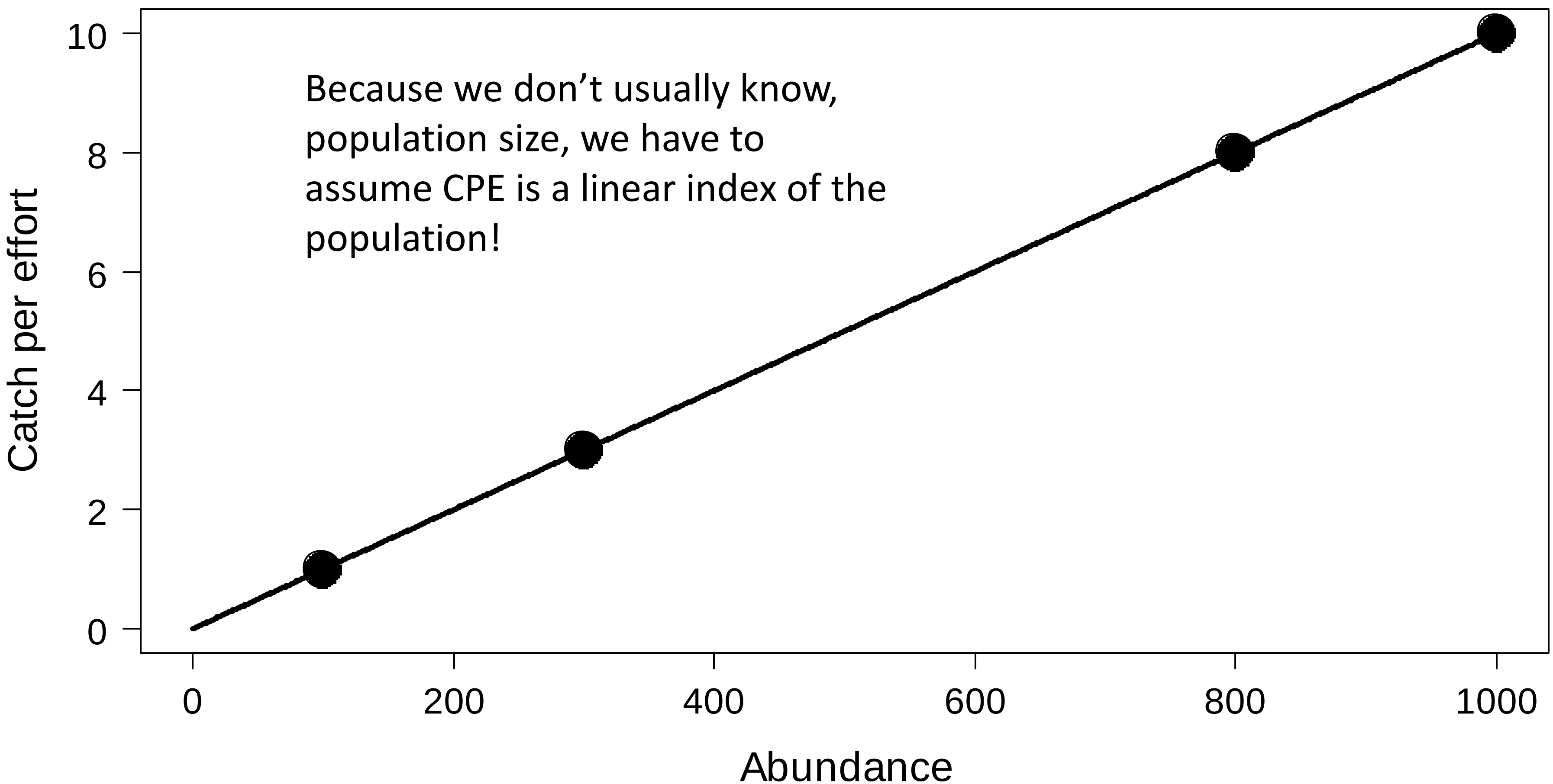
$$\frac{Catch}{effort} = 0.01 \cdot 1000$$

$$\frac{Catch}{effort} = 10$$

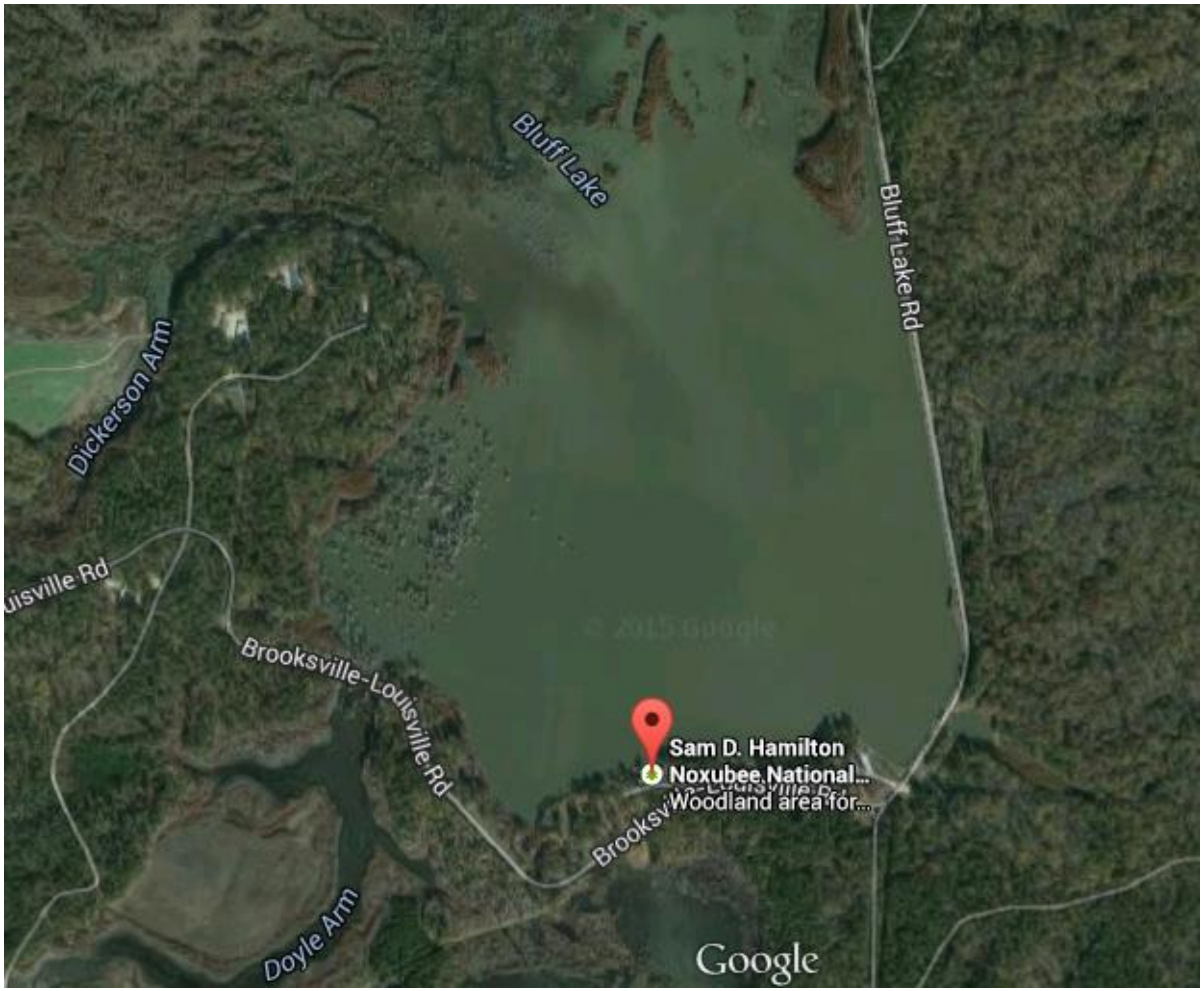
Effort, catchability, and catch

- Catchability assumes that catch per effort (CPE) is linearly related to biomass (or abundance)
- What does this look like?

CPE & biomass

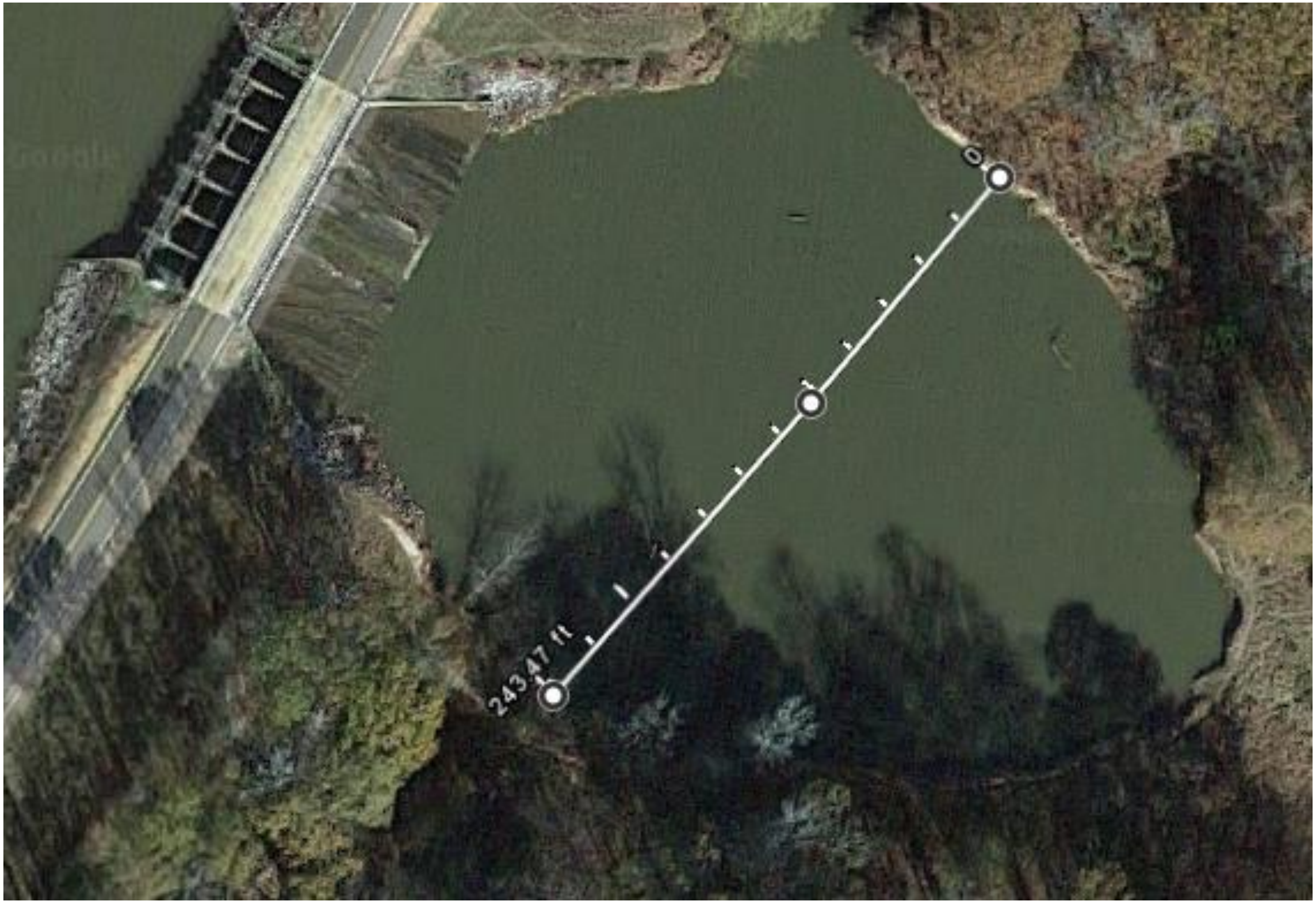

Because we don't usually know,
population size, we have to
assume CPE is a linear index of the
population!
Catch per effort
10
8
6
4
2
0
0
200
400
600
800
1000
Abundance

Just down the road



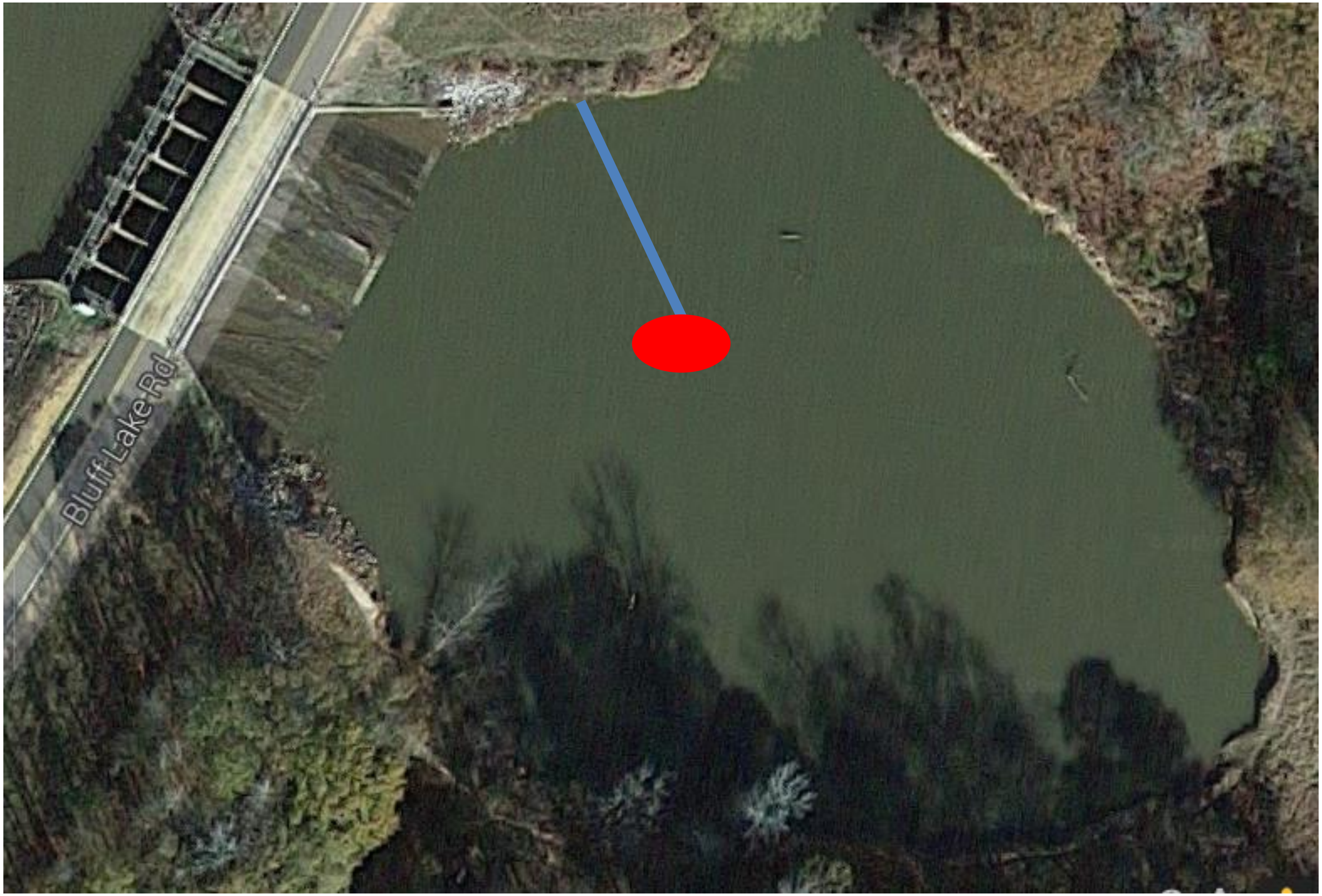
Just down the road

Just down the road



5” Gill net

5” Gill net



[redacted]

Catchability & effort

- Set gill net for 30 minutes x 4
- 100 Paddlefish in pool
- Catch: 3,4,4,2

Example: Catch = 3

$$Catch = catchability \cdot effort \cdot Abundance$$

$$3 = catchability \cdot 30 \cdot 100$$

$$3 = catchability \cdot 3000$$

$$\frac{3}{3000} = catchability$$

$$0.001 = catchability$$

Example: Catch = 4

$$Catch = catchability \cdot effort \cdot Abundance$$

$$4 = catchability \cdot 30 \cdot 100$$

$$4 = catchability \cdot 3000$$

$$\frac{4}{3000} = catchability$$

$$0.0013 = catchability$$

Example: Catch = 2

$$Catch = catchability \cdot effort \cdot Abundance$$

$$2 = catchability \cdot 300 \cdot 100$$

$$2 = catchability \cdot 3000$$

$$\frac{2}{3000} = catchability$$

$$0.00067 = catchability$$

Catch

Catchability ~ 0.009925

Effort = 30 minutes

Population = 200

$$Catch = catchability \cdot effort \cdot Abundance$$

$$Catch = 0.0009925 \cdot 30 \cdot 200$$

$$Catch = 5.955$$

Catch

Catchability ~ 0.009925

Effort = 100 minutes

Population = 200

$$Catch = catchability \cdot effort \cdot Abundance$$

$$Catch = 0.0009925 \cdot 100 \cdot 200$$

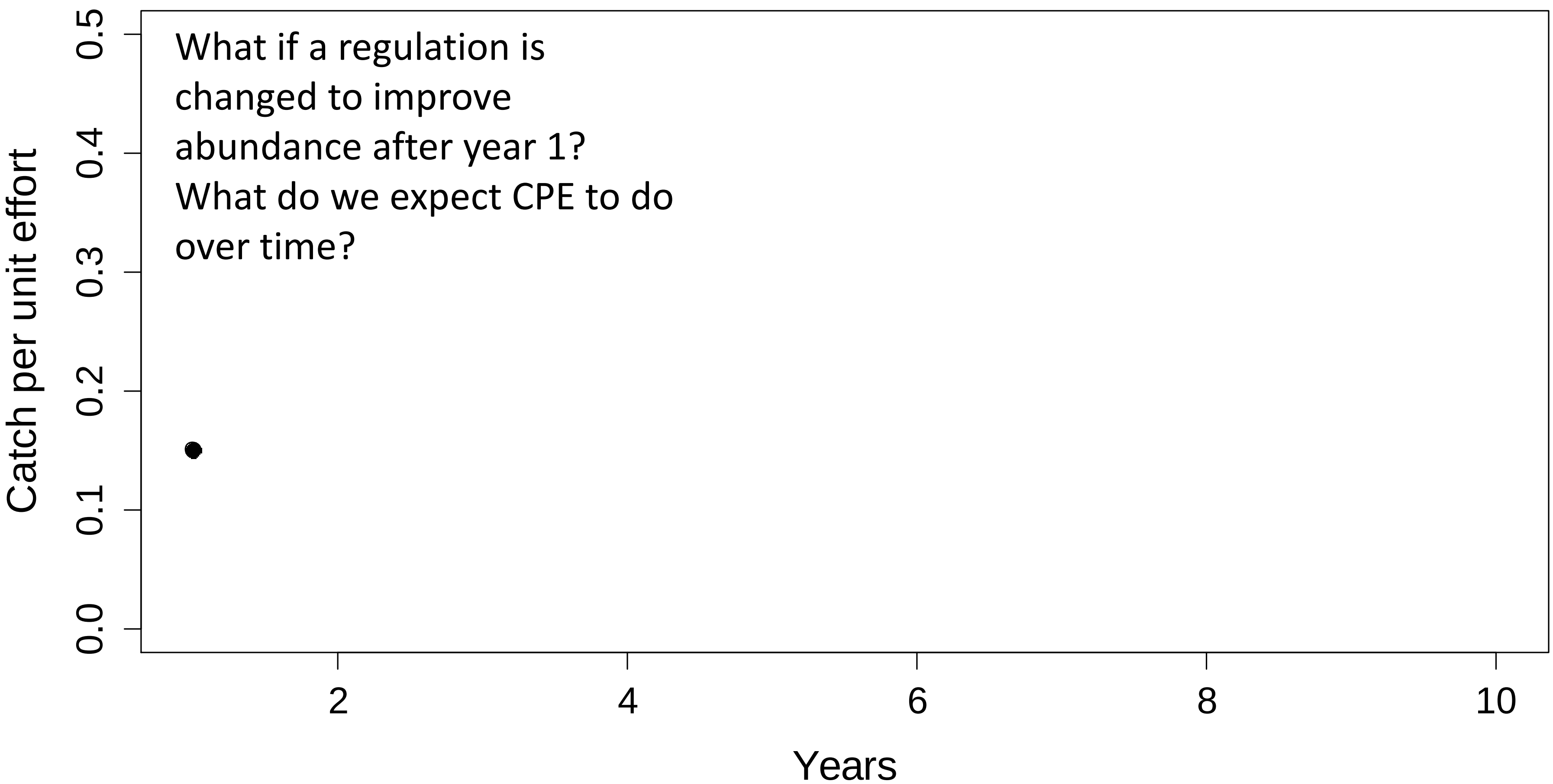
$$Catch = 19.85$$

Catchability & effort

- Passive or active gears
- Links Catch to:
  - Effort
  - Catchability
  - Population

Why is it a good idea to link catch to effort?

Relation to management



The gear used to catch fish typically does not do a good job catch all size classes of fish, but it usually catches some size classes really well & some not as well.

GEAR IS TYPICALLY SIZE SELECTIVE

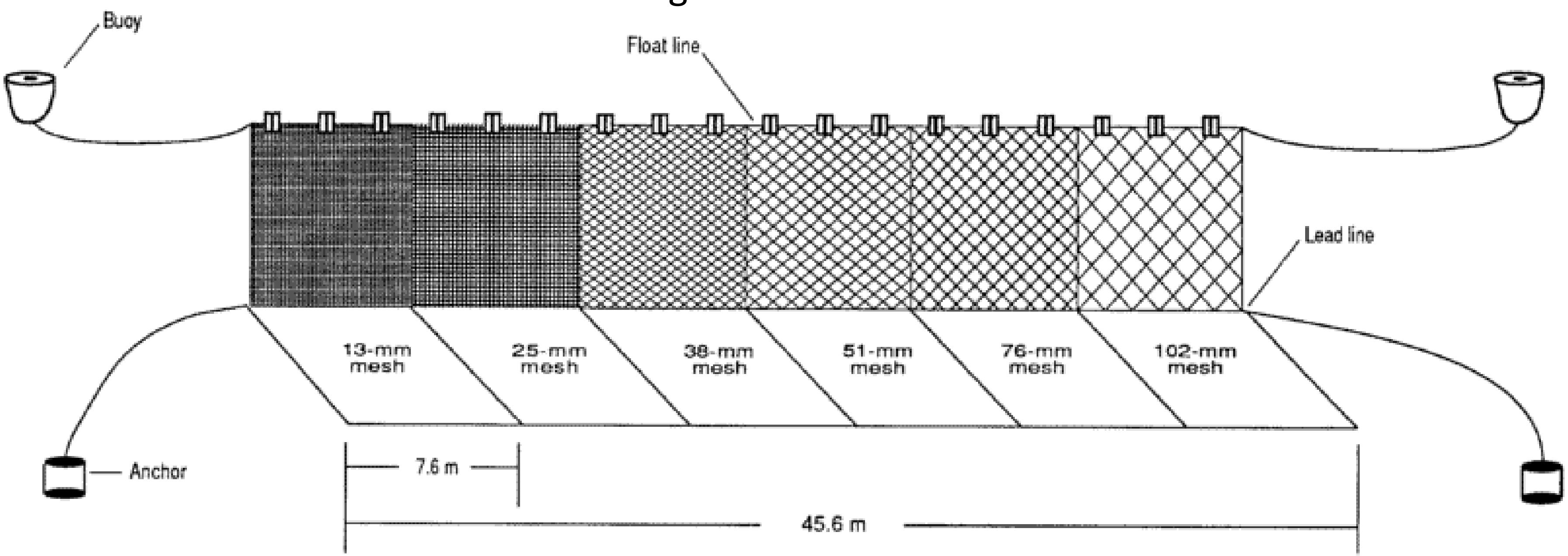
Gear Selectivity

2 approaches to estimate

1. Direct: know in advance the sizes of a fish available to catch (i.e., tagged fish)
2. Indirect: use varying gear sizes fish simultaneously to estimate relative selectivity (most commonly done)

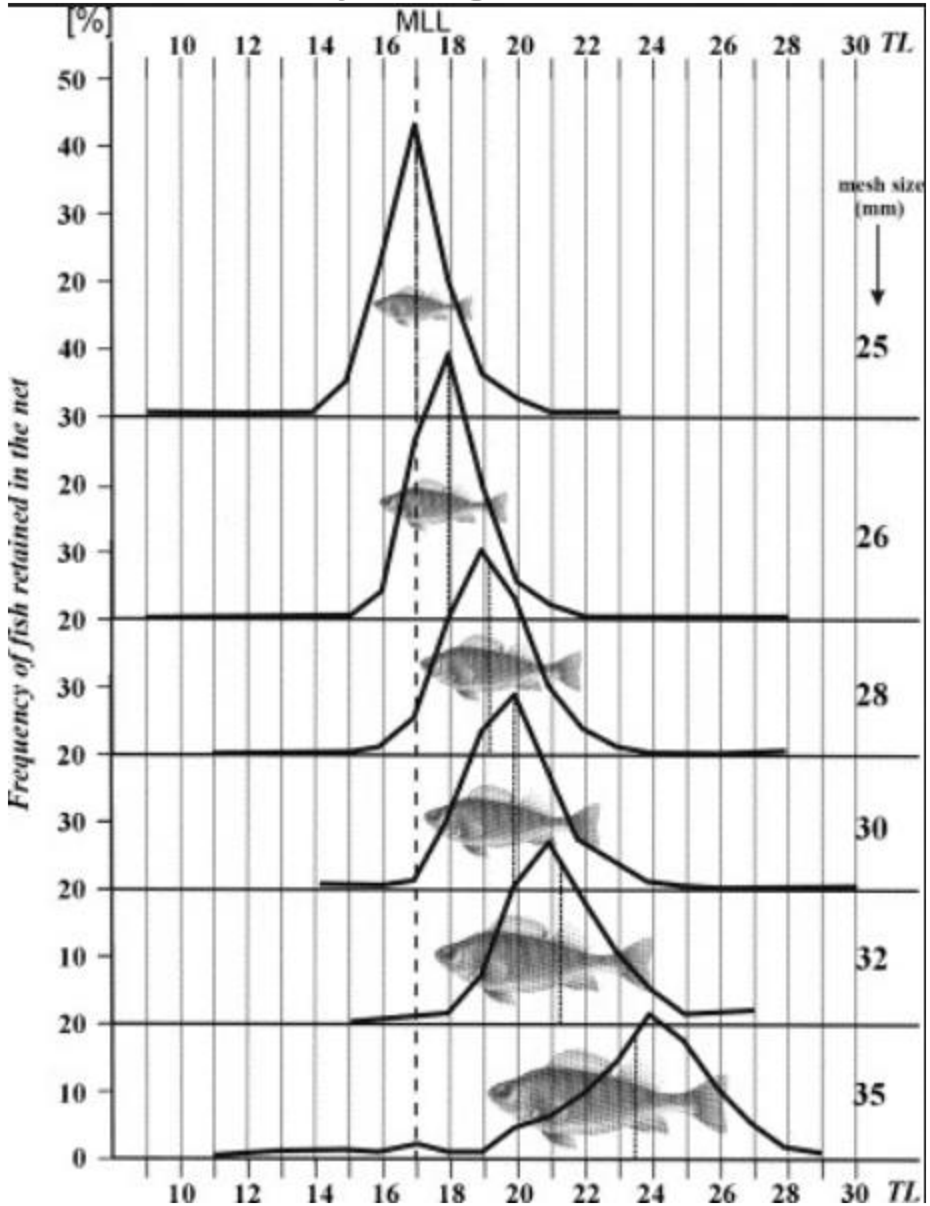
Typical Experimental gill net

Increasing mesh size



Experimental gill nets are the most common gear used to estimate selectivity

What does varying mesh size get us?



Why is size selection important?

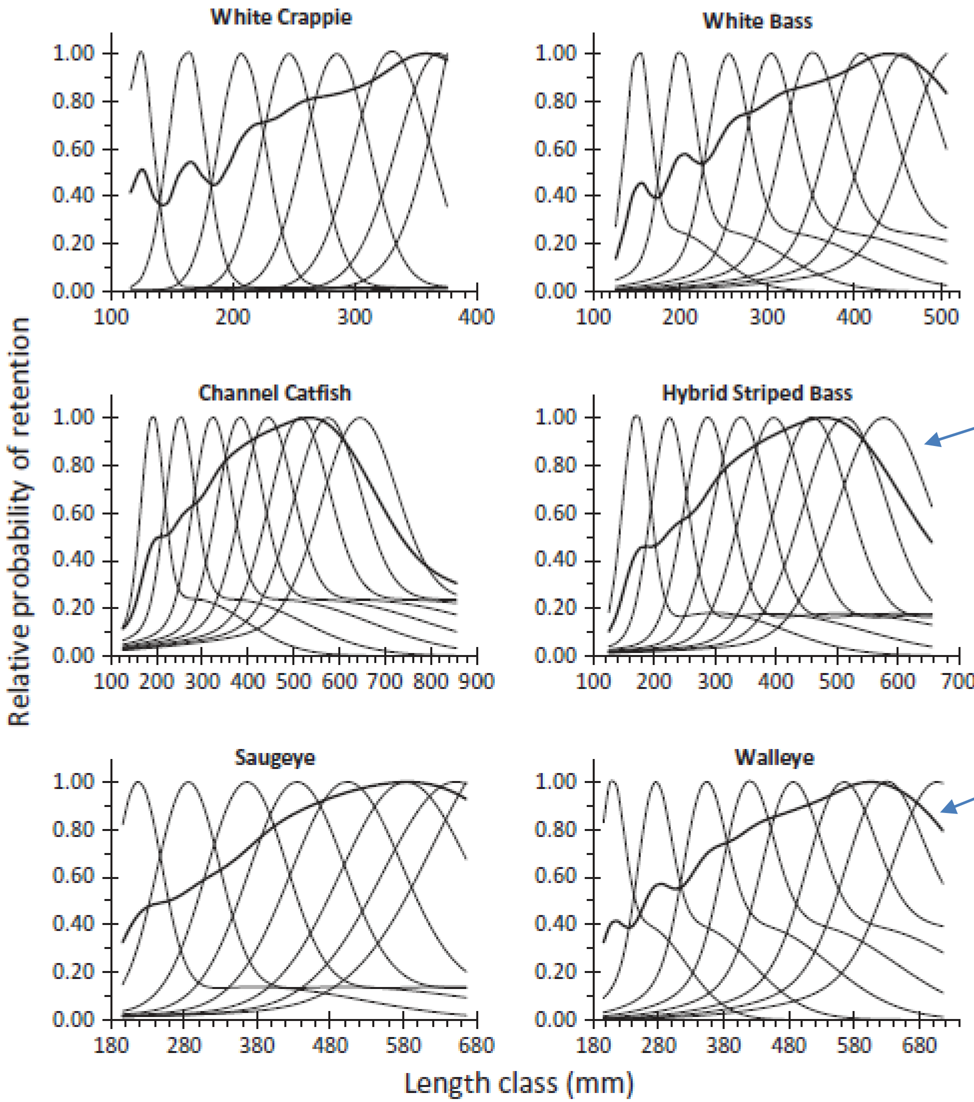


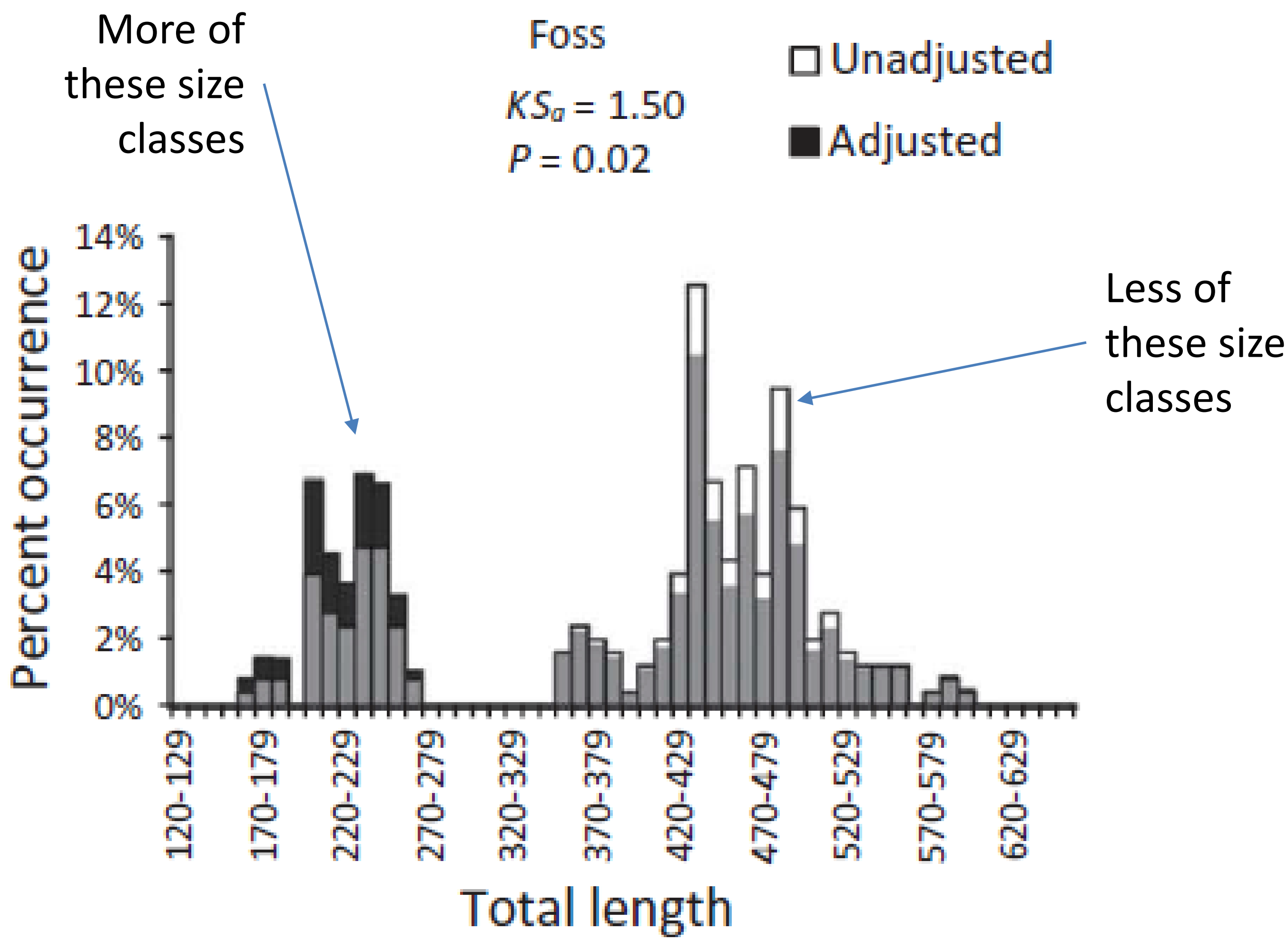
FIGURE 1. Overall selectivity curves (thick dark line) for the North American standard gill net (Bonar et al. 2009) using a bimodal model for six sport fish species based on data from eight reservoirs. The eight individual curves (thin lines) represent relative selectivity of individual meshes (19-, 25-, 32-, 38-, 44-, 51-, 57-, and 64-mm bar mesh from left to right).

Gear size specific gear selectivity

Overall Selectivity curve

Daniel E. Shoup & Ryan G. Ryswyk (2016) Length Selectivity and Size-Bias Correction for the North American Standard Gill Net, North American Journal of Fisheries Management, 36:3, 485-496, DOI: 10.1080/02755947.2016.1141809

When you can account for size selection you can adjust size structure



Adjust PSD Values

TABLE 5. Proportional size distributions (PSD) of six species for unadjusted and adjusted (via bimodal selectivity curves) gill-net catches from eight Oklahoma reservoirs. Changes of more than 5 PSD units, which may be of importance to fisheries managers, are in bold text.

	PSD-Quality		PSD-Preferred		PSD-Memorable	
Reservoir	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
			Channel Catfish			
Canton	91	89	4	5	0	0
Foss	87	85	10	11	0	0
Fort Cobb	61	57	11	12	1	2
Skiatook	47	44	2	3	2	3
Thunderbird	72	68	0	0	0	0
Tom Steed	53	51	14	18	4	7
Waurika	35	31	0	0	0	0
			Hybrid Striped Bass			
Canton	94	90	71	67	7	8
Foss	**78**	**66**	**72**	**61**	10	9
Fort Cobb	**41**	**32**	**41**	**32**	**31**	**25**
Skiatook	97	96	53	50	17	17
Tom Steed	91	87	**60**	**55**	9	10
Waurika	97	96	85	83	25	27

If possible, catch can be adjusted for size selective catch. But in most cases we have to simply admit we do a poor job catching small fish and adjust our analysis to account for this. This will be important as we use catch with age and size structure estimate to estimate total mortality.

TAKE HOME

ESTIMATING TOTAL MORTALITY (*Z*)

Total mortality (Z)

$Z = F + M$

Where,

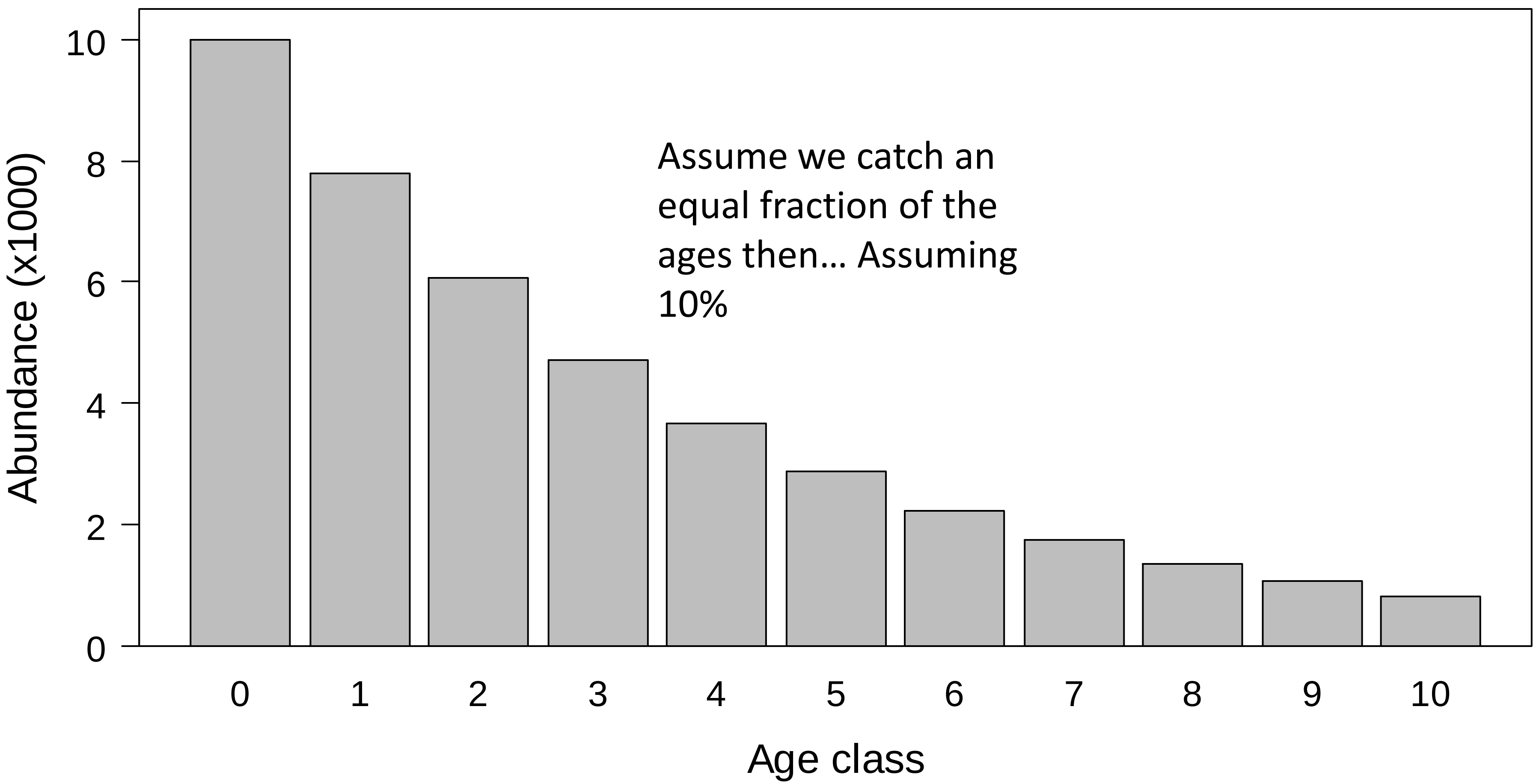
F = Fishing mortality

M = Natural mortality

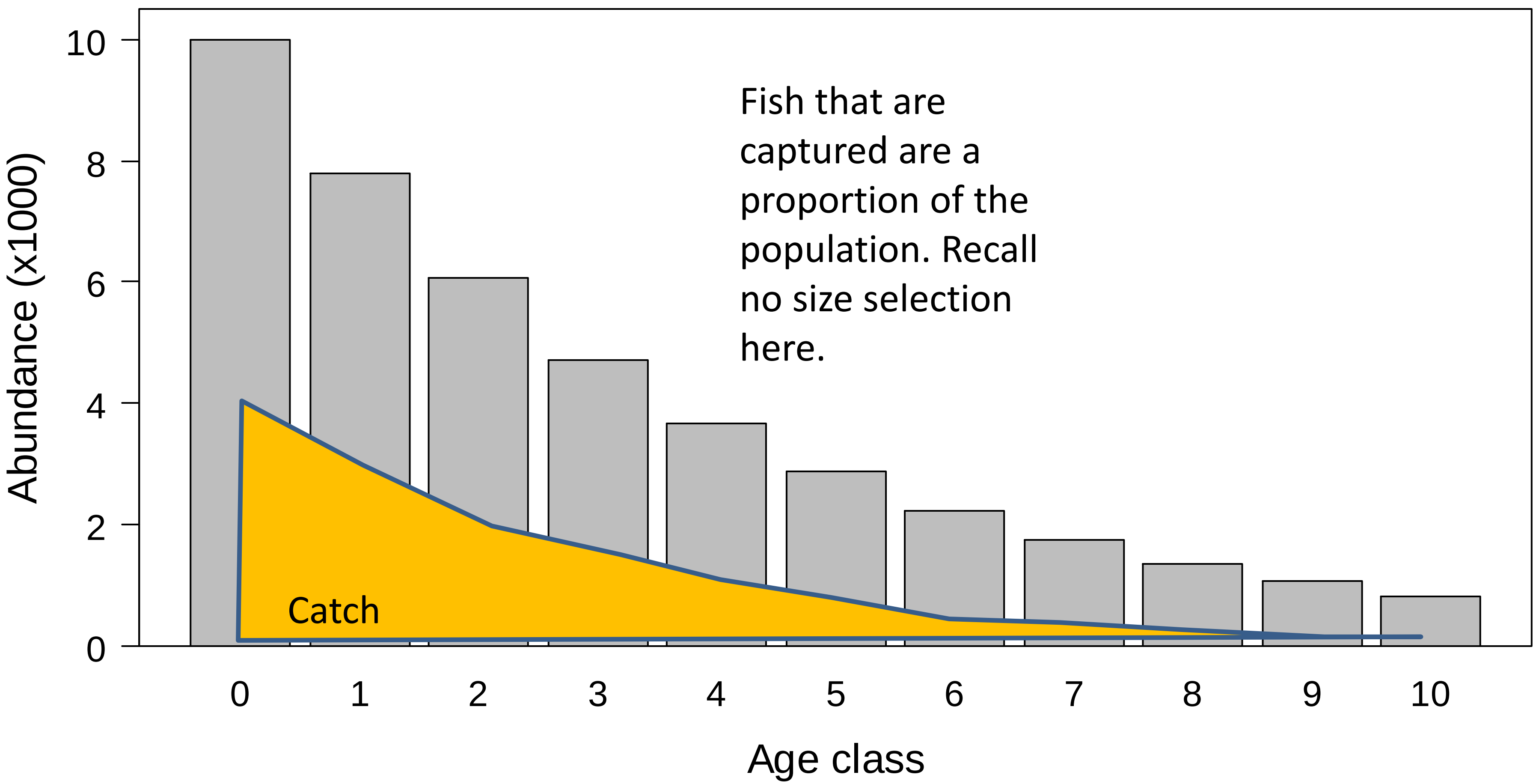
Difficult to estimate F and M

Suppose we go out and capture fish from a lake and age all them. Further assume there is no size selective bias for the gear we are using. What will that age distribution look like? And how can we use that distribution to estimate mortality?

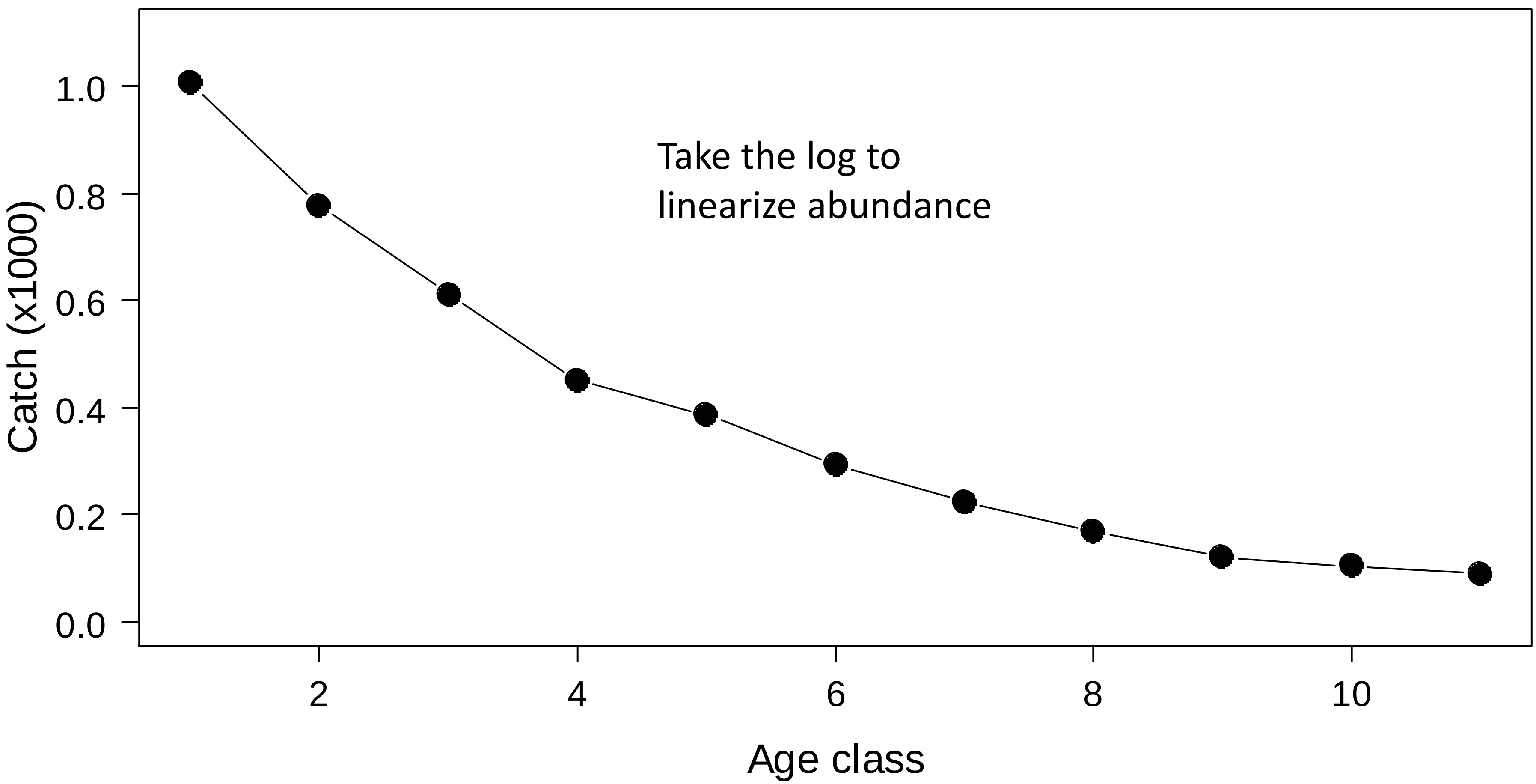
Population Age Structure



Perfect world



Estimating Mortality: Catch curve



Estimating Mortality: Catch curve