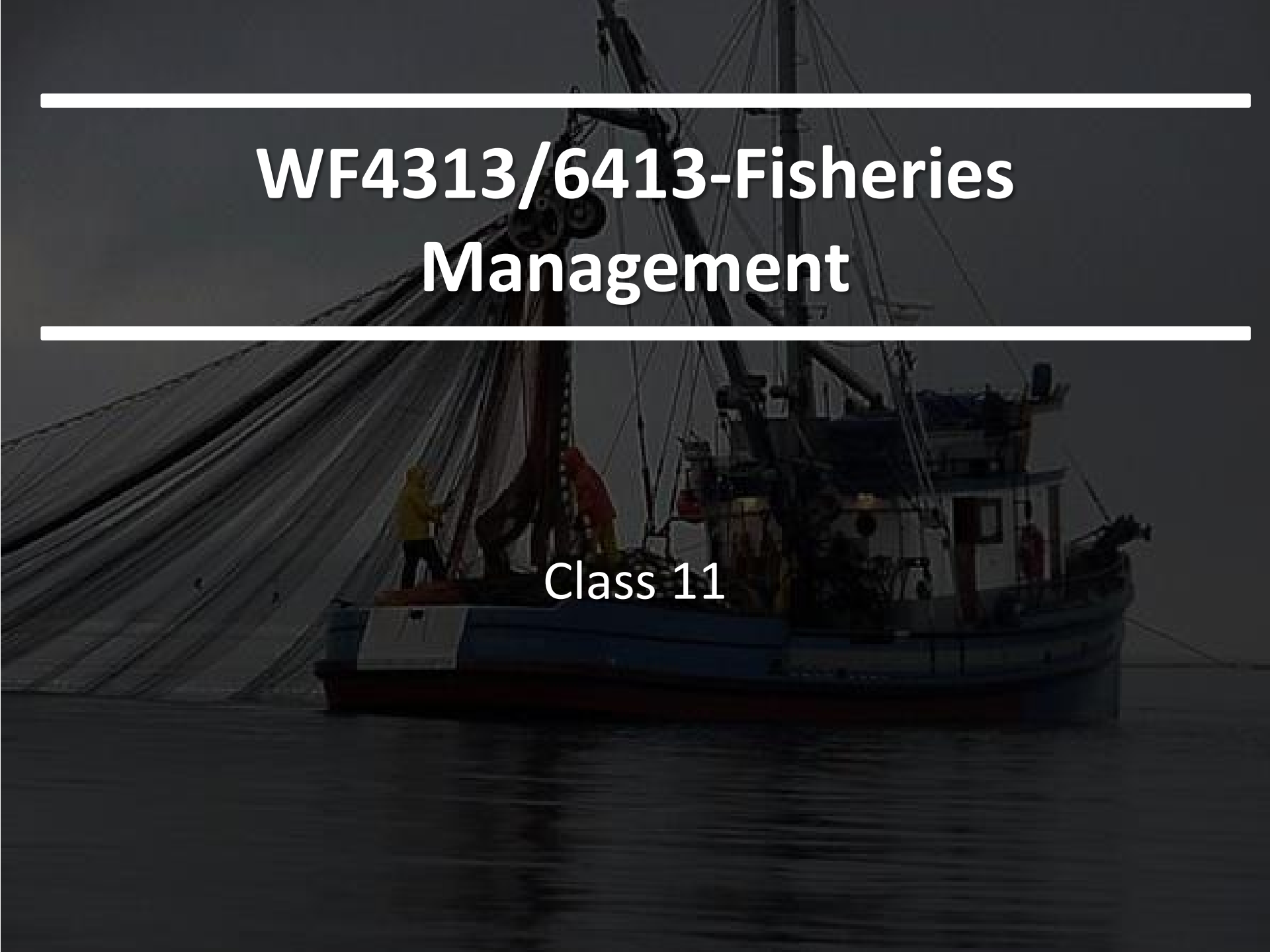
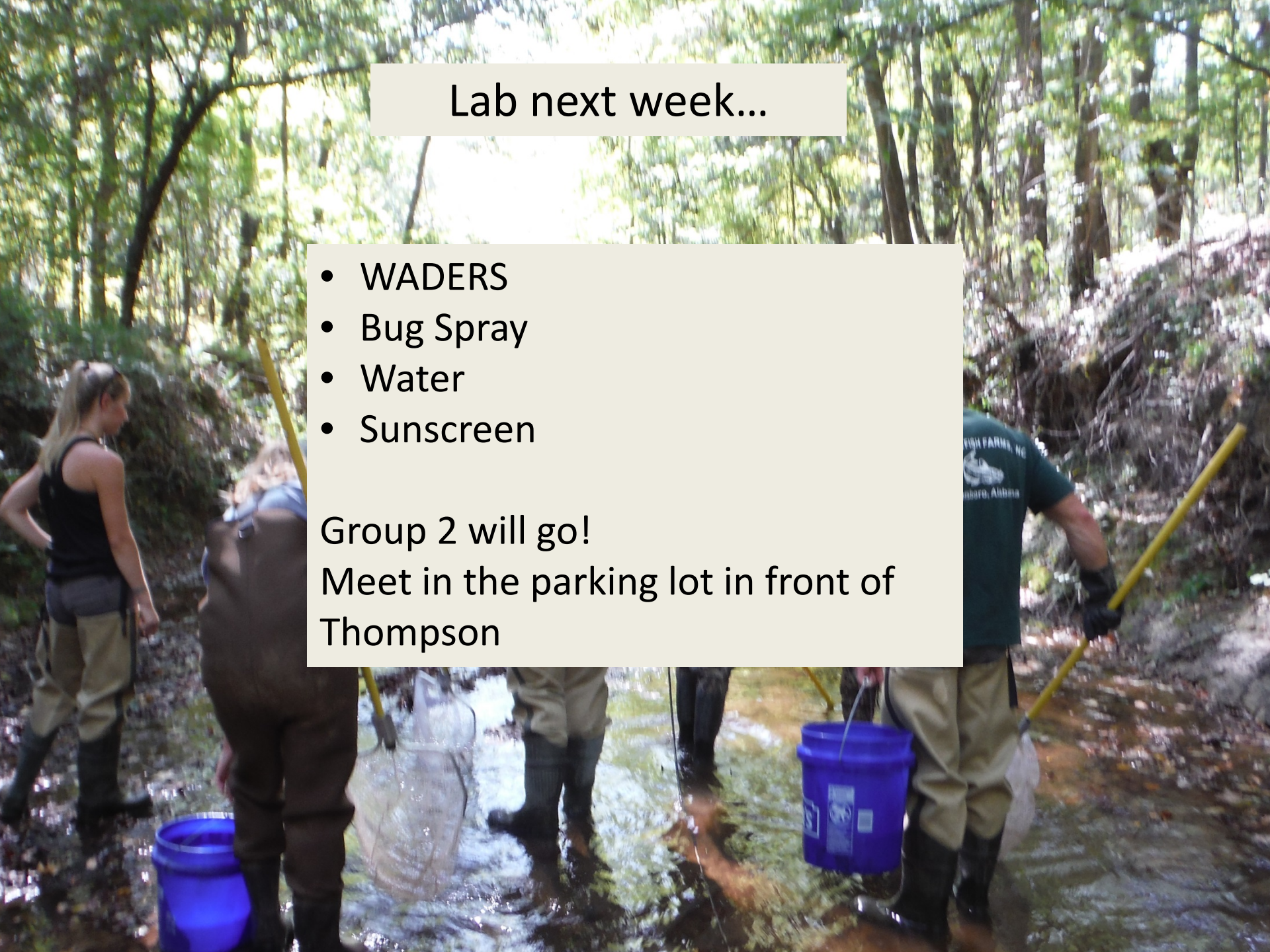


WF4313/6413-Fisheries Management

Class 11

In the news & announcements

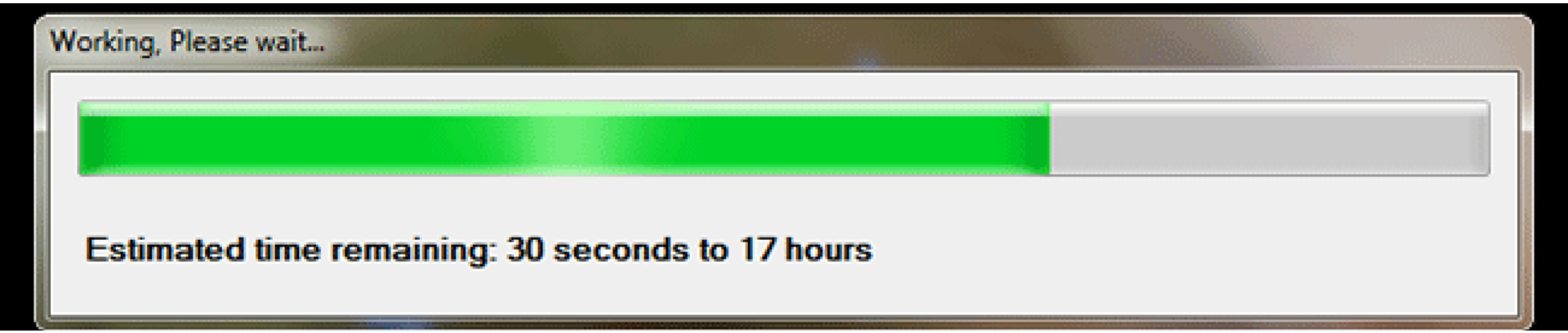


Lab next week…

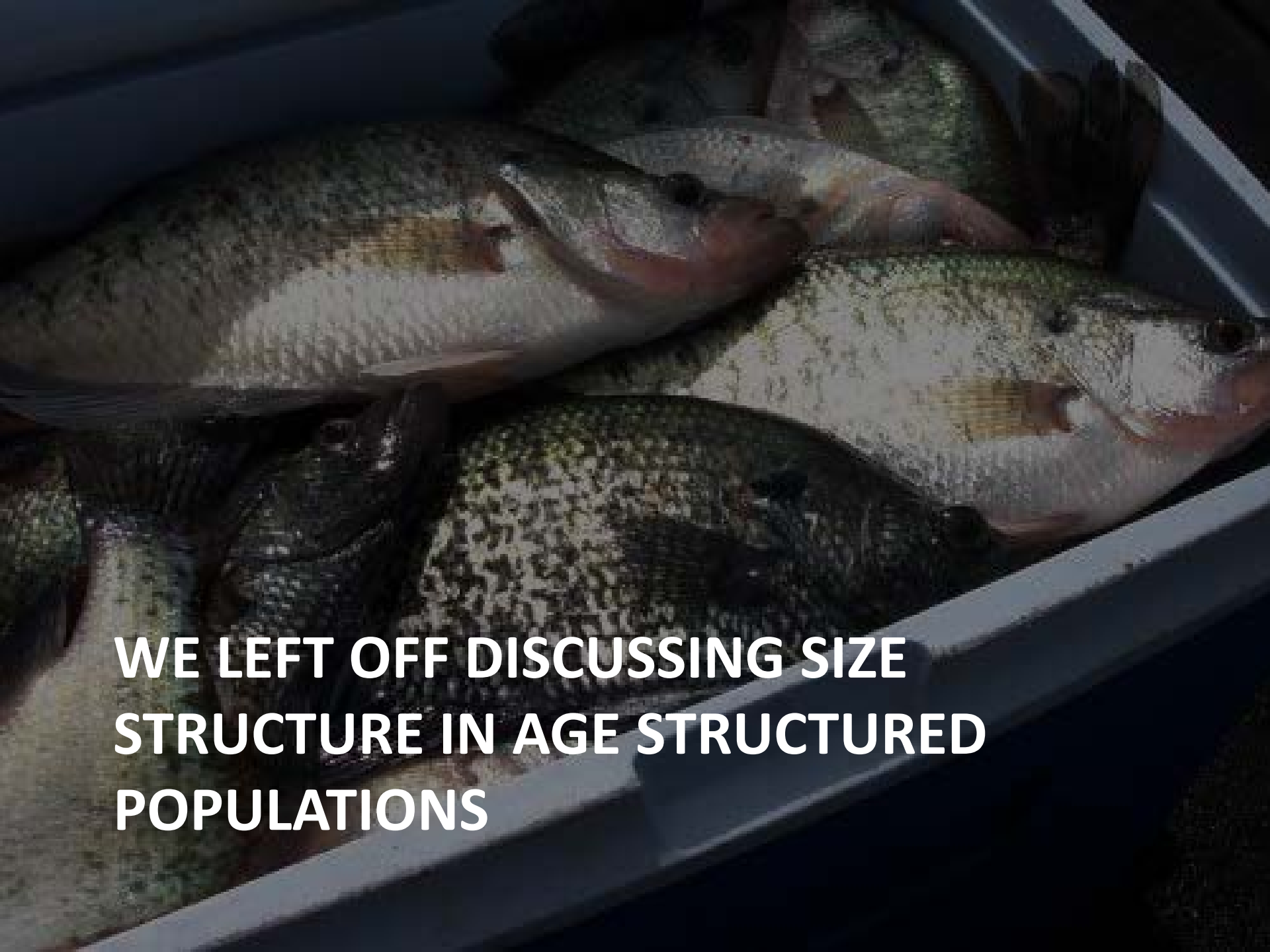
- WADERS
- Bug Spray
- Water
- Sunscreen

Group 2 will go!
Meet in the parking lot in front of Thompson

Exam I



75% done
Should be done
by Wednesday…



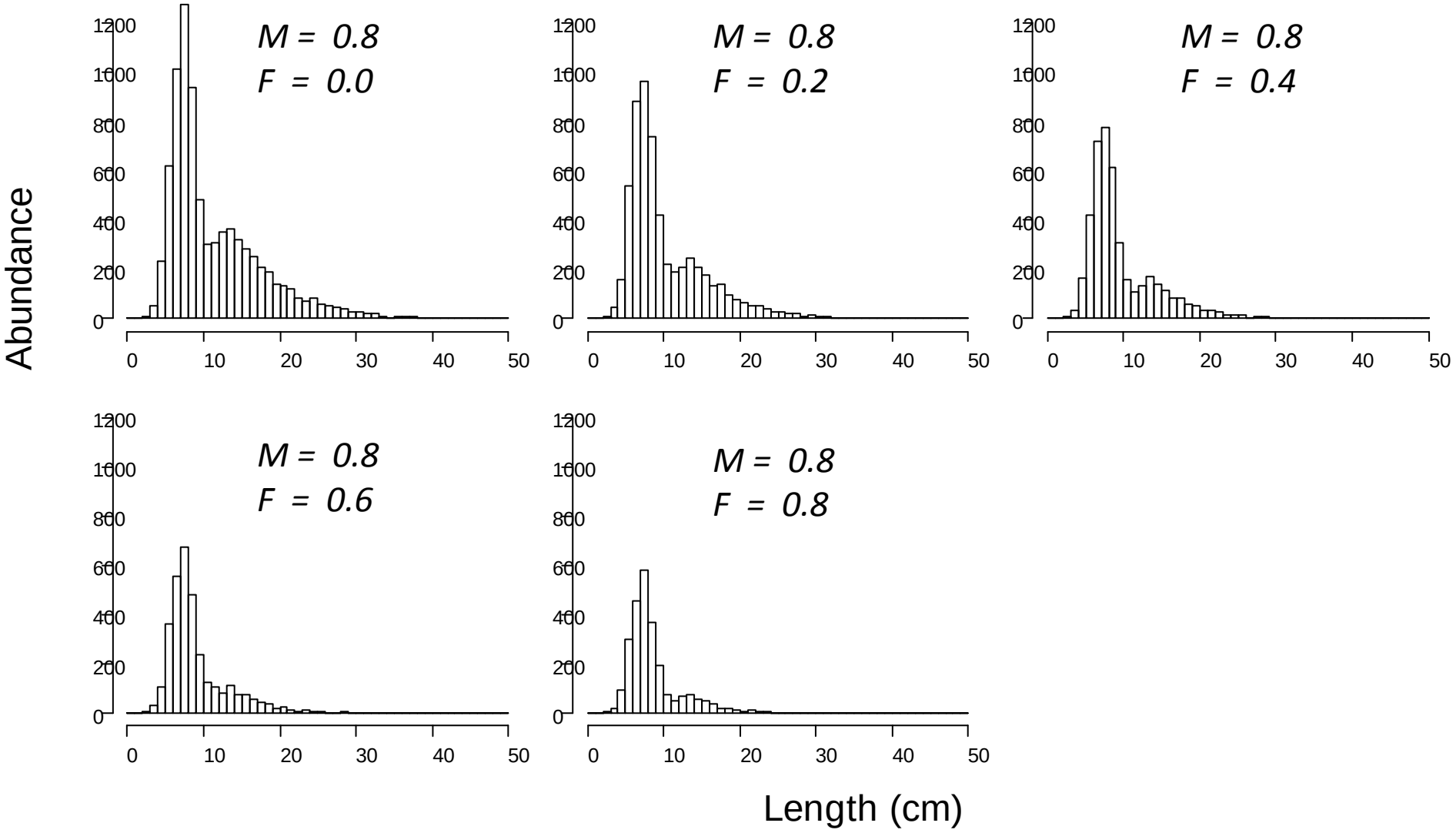
WE LEFT OFF DISCUSSING SIZE STRUCTURE IN AGE STRUCTURED POPULATIONS

Commercial versus Recreational

Value: Biomass

Value: Size

Size structure erodes with *F*



What do we use YPR models for?

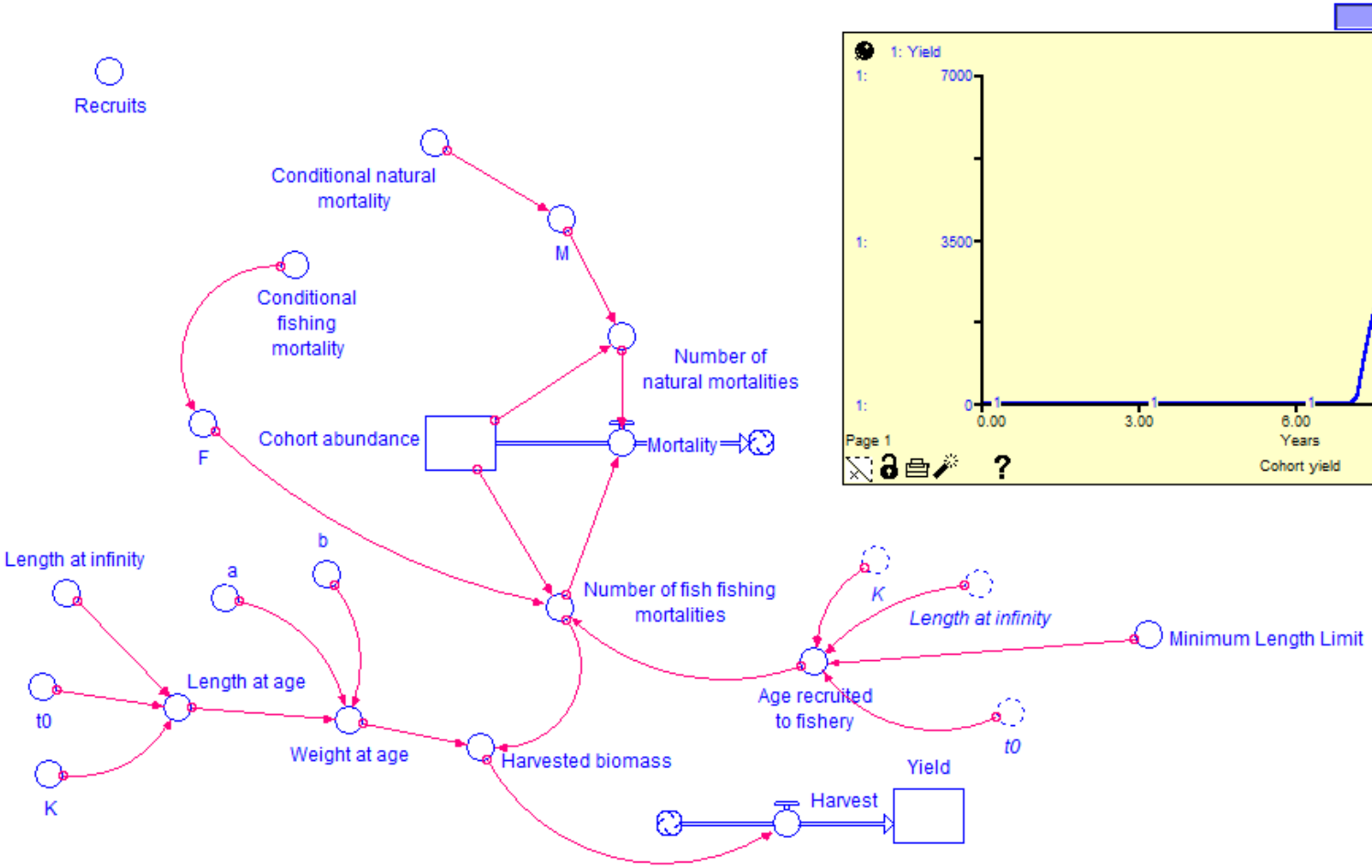
- Manage size structure
- Manage biomass

Both contribute to minimizing overfishing.

In a nutshell-Length limits can potentially be used to create a desired size structure in a population

MANAGING SIZE STRUCTURE IN AGE STRUCTURED POPULATIONS

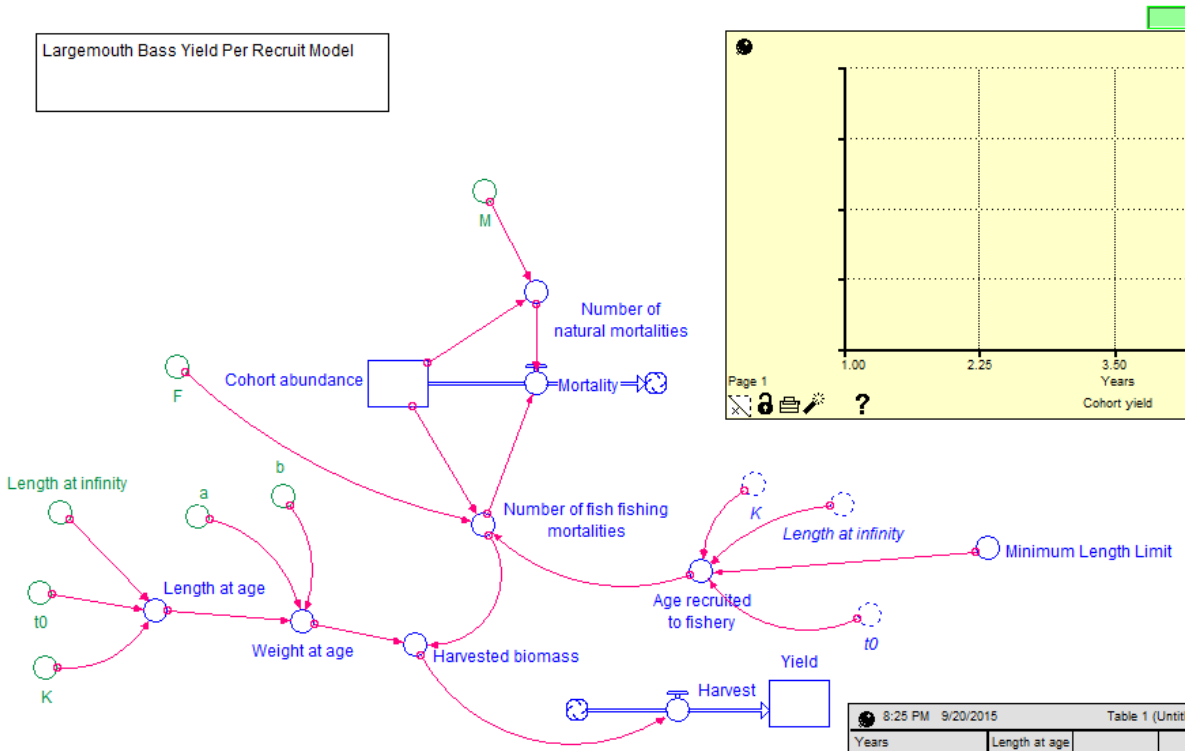
Yield per recruit & size structure



PSD (which specifically indicates Quality/Stock) is a basic measure of size structure

STOCK DENSITY INDICES

Yield and PSD



8:25 PM 9/20/2015 Table 1 (Untitled Table)

Years	Length at age
Initial	94.65
1	173.79
2	232.42
3	275.85
4	308.03
5	331.87

Largemouth Bass PSD Values

Stock	200
Quality	300
Preferred	380
Memorable	510
Trophy	630

Predicted number at length

10 Inch Minimum Length Limit

		F			
Initial	Length	0	0.1	0.3	0.5
0	106.77	1,000	1,000	1,000	1,000
1	194.18	175	175	175	175
2	265.75	**31**	**30**	**30**	**29**
3	324.35	**5**	**5**	**4**	**3**
4	372.32	**1**	**1**	**0**	**0**
5	411.6	**0**	**0**	**0**	**0**
6	443.75	**0**	**0**	**0**	**0**
7	470.08	**0**	**0**	**0**	**0**
8	491.64	**0**	**0**	**0**	**0**
9	509.29	**0**	**0**	**0**	**0**
10	523.74	**0**	**0**	**0**	**0**
11	535.57	**0**	**0**	**0**	**0**

Predicted number at length

12 Inch Minimum Length Limit

		F			
Initial	Length	0	0.1	0.3	0.5
0	106.77	1,000	1,000	1,000	1,000
1	194.18	175	175	175	175
2	265.75	**31**	**31**	**31**	**31**
3	324.35	**5**	**5**	**5**	**4**
4	372.32	**1**	**1**	**1**	**0**
5	411.6	**0**	**0**	**0**	**0**
6	443.75	**0**	**0**	**0**	**0**
7	470.08	**0**	**0**	**0**	**0**
8	491.64	**0**	**0**	**0**	**0**
9	509.29	**0**	**0**	**0**	**0**
10	523.74	**0**	**0**	**0**	**0**
11	535.57	**0**	**0**	**0**	**0**

PSD Values-Traditional

F	Stock	Quality	PSD
0.00	37	6	18
0.10	37	6	16
0.30	34	1	12
0.50	32	0	1

10 Inch Minimum Length Limit

F	Stock	Quality	PSD
0.00	37	6	18
0.10	37	6	17
0.30	36	5	15
0.50	5	0	9

12 Inch Minimum Length Limit

PSD Values-Incremental

F	Stock	Quality	PSD
0.00	37	6	82
0.10	37	6	83
0.30	34	1	88
0.50	32	0	99

10 Inch Minimum Length Limit

Interesting result. Outcomes does not vary with MLL! 10 or 12” gives you the same size structure

F	Stock	Quality	PSD
0.00	37	6	82
0.10	37	6	83
0.30	36	5	85
0.50	5	0	99

12 Inch Minimum Length Limit

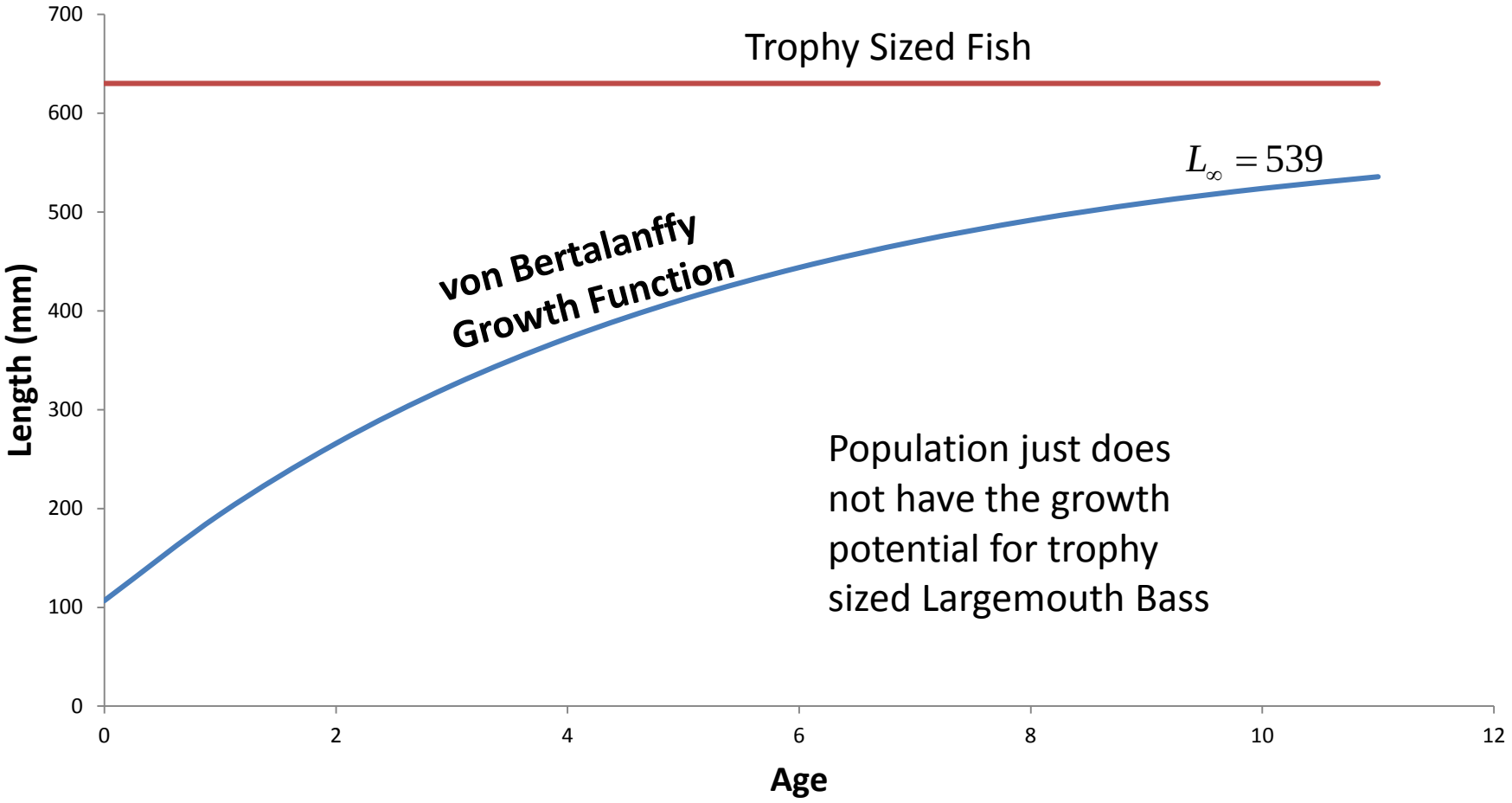
Where are the trophy fish?

12 Inch Minimum Length Limit

		F			
Initial	Length	0	0.1	0.3	0.5
0	106.77	1,000	1,000	1,000	1,000
1	194.18	175	175	175	175
2	265.75	**31**	**31**	**31**	**31**
3	324.35	**5**	**5**	**5**	**4**
4	372.32	**1**	**1**	**1**	**0**
5	411.6	**0**	**0**	**0**	**0**
6	443.75	**0**	**0**	**0**	**0**
7	470.08	**0**	**0**	**0**	**0**
8	491.64	**0**	**0**	**0**	**0**
9	509.29	**0**	**0**	**0**	**0**
10	523.74	**0**	**0**	**0**	**0**
11	535.57	**0**	**0**	**0**	**0**

630 mm!

Where are the trophy fish?



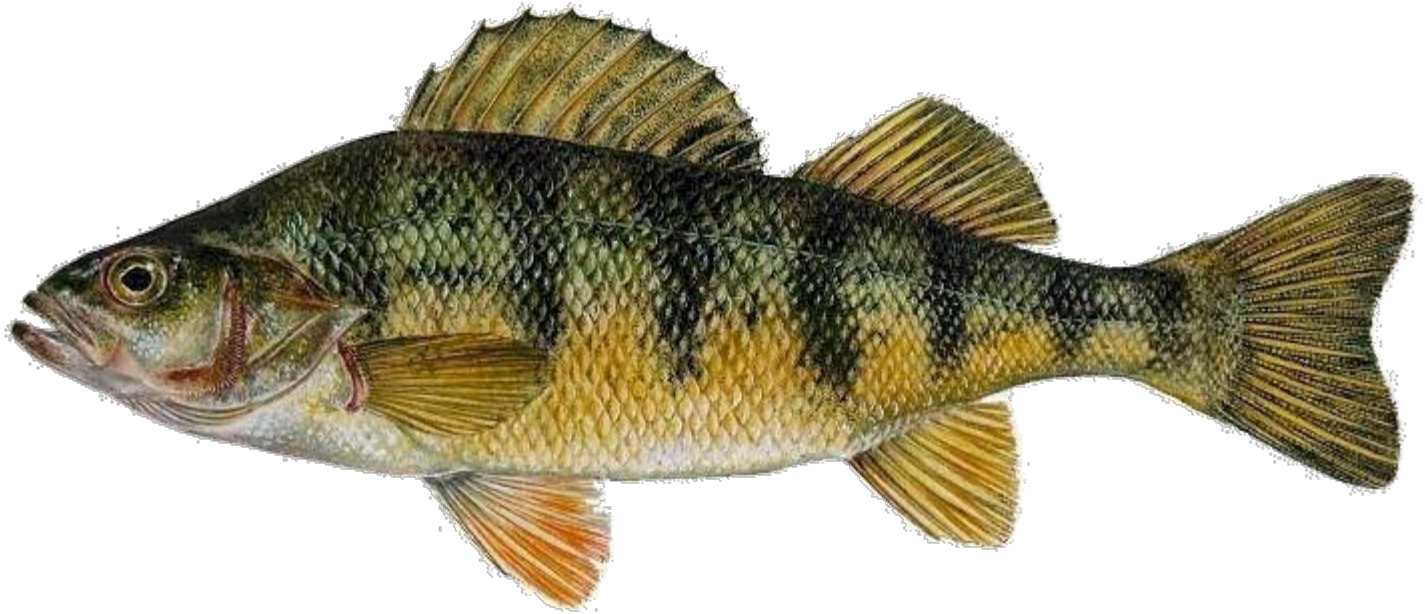
We can potentially manage size structure but if we overfish the population, size structure is the least of our concerns. We also need to preventing or minimizing growth overfishing!

MANAGING YIELD IN AGE STRUCTURED POPULATIONS

What is growth overfishing?

Harvest fish before they have time to grow

Example:



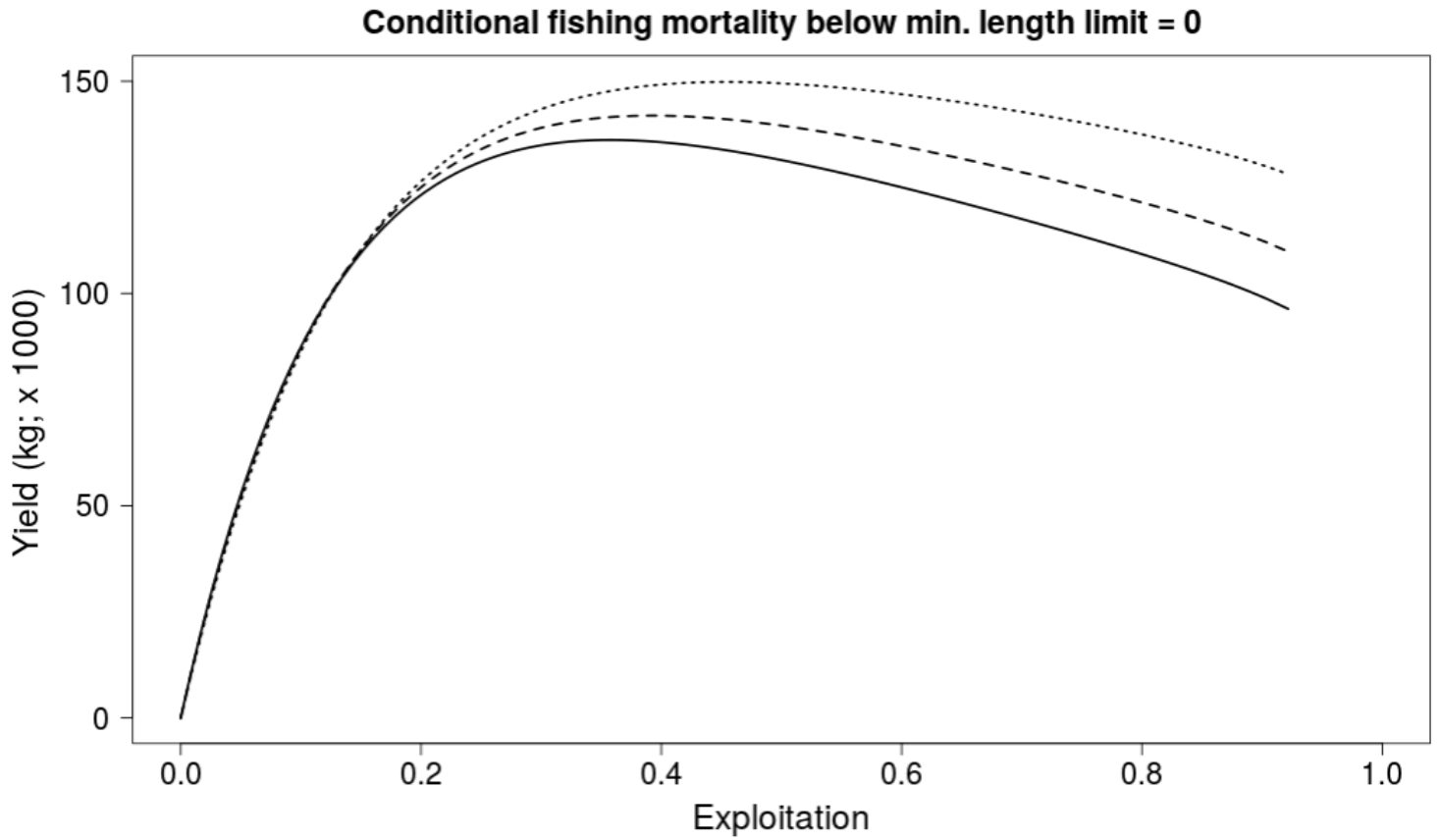
Growth process in fish

The assimilation of food as biomass (i.e., tissue). Primarily refers to somatic tissue but also includes gonad tissue.

- Fish adding **weight** over **time**
  1. **Relate time (age) to length**
  2. **Relate length to weight**

Yield per recruit model!

Plot: Yield per recruit



Diagnosing growth overfishing

Growth overfishing

No growth overfishing

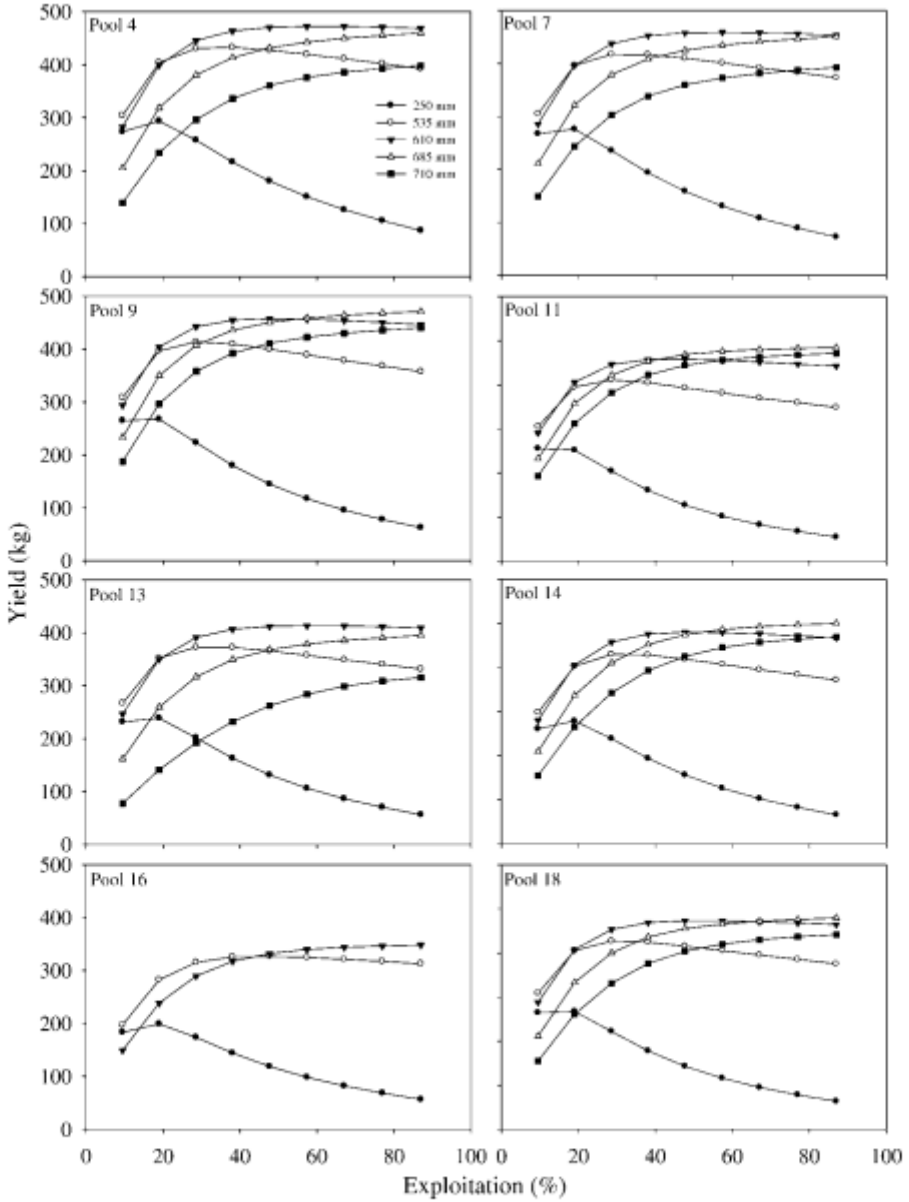


FIGURE 3.—Simulated yields for selected shovelnose sturgeon populations in the upper Mississippi River with a conditional natural mortality of 10%. The simulations were conducted with five different minimum length limits except in the case of Pool 16, for which only three minimum length limits were simulated because the 685- and 710-mm length limits exceeded the asymptotic maximum length of the fish in the pool.

Diagnosing growth overfishing

Growth overfishing

No growth overfishing

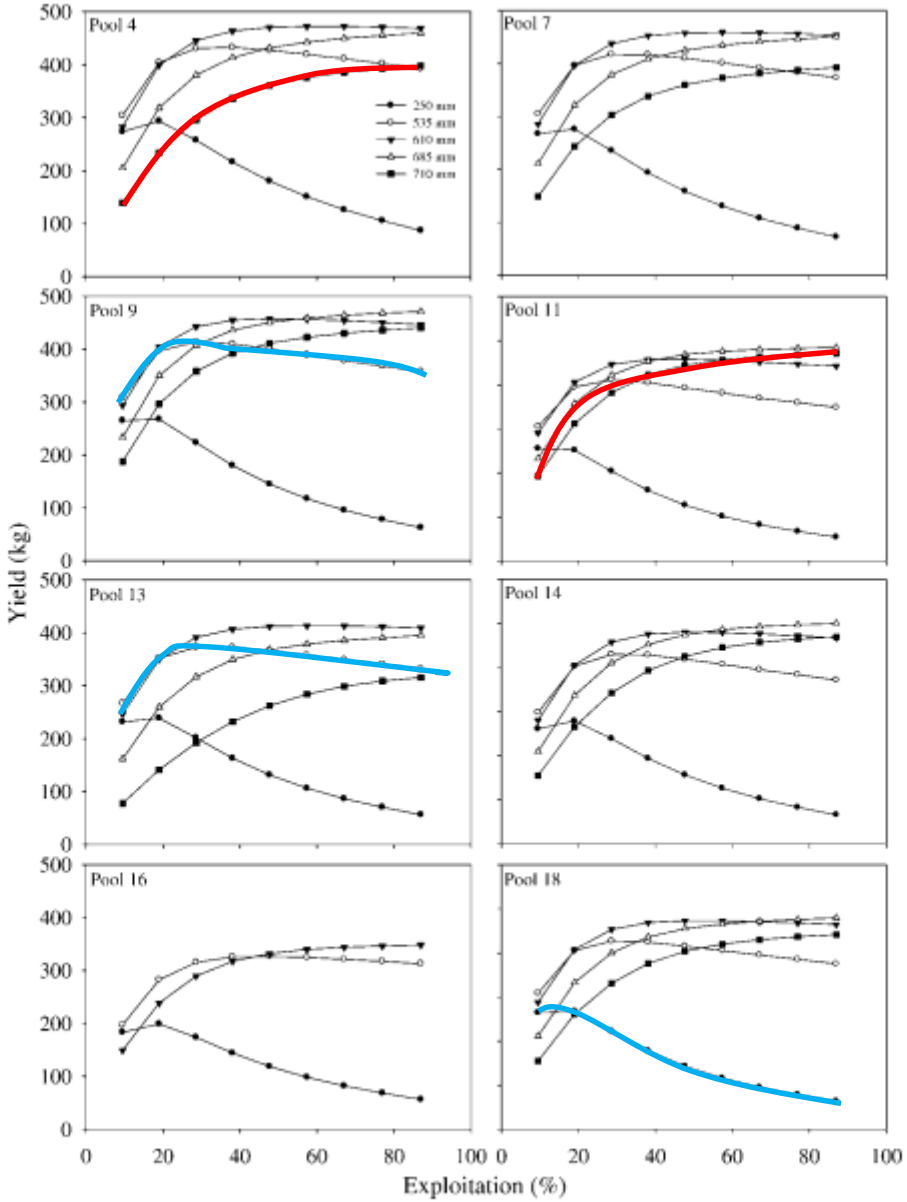


FIGURE 3.—Simulated yields for selected shovelnose sturgeon populations in the upper Mississippi River with a conditional natural mortality of 10%. The simulations were conducted with five different minimum length limits except in the case of Pool 16, for which only three minimum length limits were simulated because the 685- and 710-mm length limits exceeded the asymptotic maximum length of the fish in the pool.

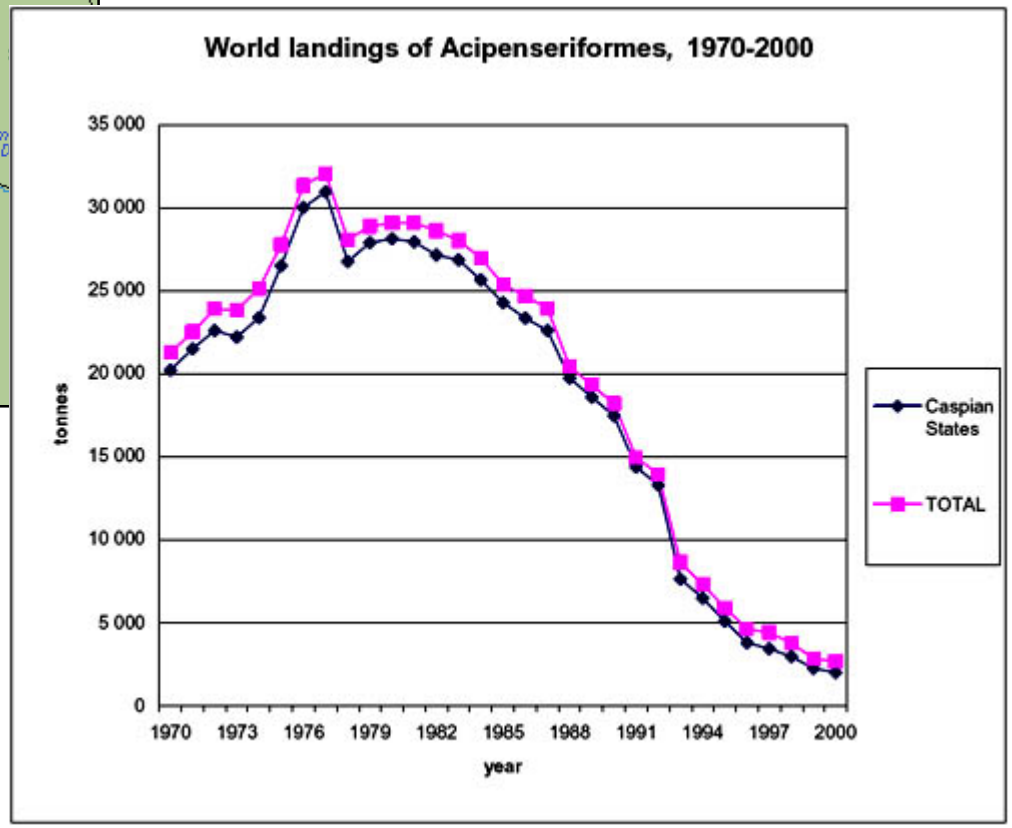
CASE STUDY-PADDLEFISH ROE HARVEST


Recall that Yield Per Recruit models are used to explore varying length limits on growth overfishing.

Caviar sources

- Salmon
- Mullet
- Herring
- Carp
- Bowfin
- Acipenseriformes
  - Sturgeon
  - Paddlefish

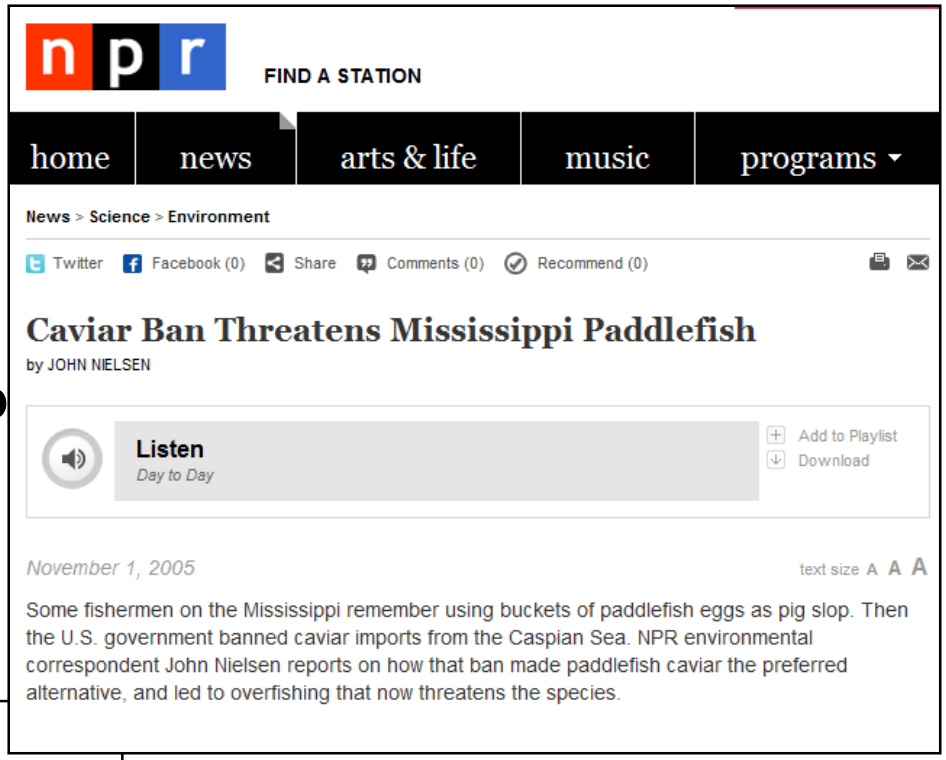
Eurasian caviar stocks decline



http://www.fao.org/docrep/006/Y5261E/y5261e06.htm

NA Acipensiformes harvest

- High market price
- Increased harvest in North America
- At-risk to overfishing?



220 $/kg roe; 500-650$ per fish

Yield-per-recruit (YPR) models

- Predicts fishery yield
- Age structured
- Evaluate varying:
  - Fishing mortality
  - Length limits
  - Natural mortality

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DOI: 10.1080/02755947.2012.686956

ARTICLE

Differences in Paddlefish Populations among Impoundments of the Arkansas River, Arkansas

Frank J. Leone
Arkansas Game and Fish Commission, 2 Natural Resources Drive, Little Rock, Arkansas 72205, USA
Joseph N. Stoeckel

North American Journal of Fisheries Management 22:537–549, 2002
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Potential Influence of Harvest on Shovelnose Sturgeon Populations in the Missouri River System

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Received: June 15, 2006
Accepted: December 20, 2006
doi: 10.1111/j.1439-0426.2007.00886.x

Effects of harvest and length limits on shovelnose sturgeon in the upper Wabash River, Indiana

By A. J. Kennedy and T. M. Sutton

North American Journal of Fisheries Management 29:84–100, 2009
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DOI: 10.1577/M08-115.1

Effects of Commercial Harvest on Shovelnose Sturgeon Populations in the Upper Mississippi River

Paddlefish harvest

Transactions of the American Fisheries Society 134:1285–1298, 2005

DOI: 10.1577/T04-161.1

[Article]

Population Characteristics and Assessment of Overfishing for an Exploited Paddlefish Population in the Lower Tennessee River

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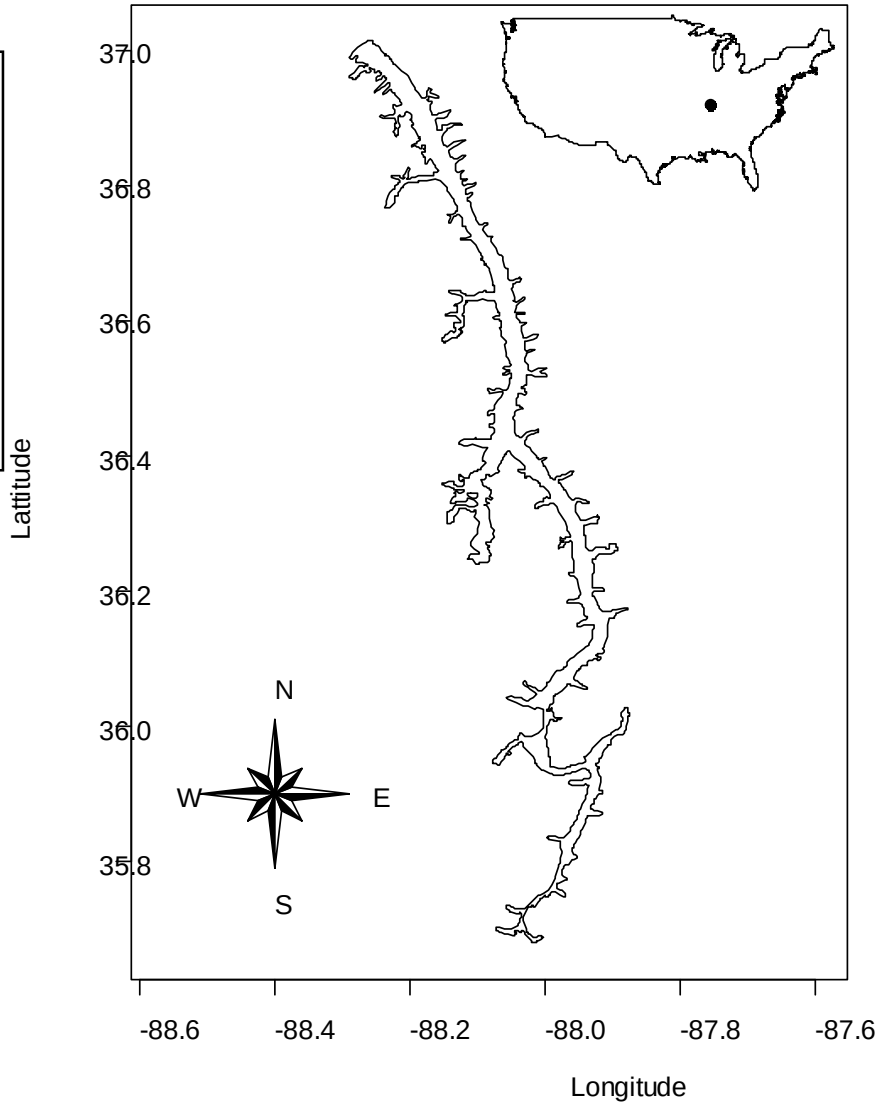
Tennessee Cooperative Fishery Research Unit,[2] Tennessee Technological University, 205 Pennebaker Hall, Cookeville, Tennessee 38505, USA

PHILLIP W. BETTOLI

U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, 205 Pennebaker Hall, Cookeville, Tennessee 38505, USA

Can roe yield be increased by delaying recruitment to the fishery?



Potential for overfishing?

- Growth overfishing
  - 864-mm
  - Exploitation > 30%
  - Weak at 965
- Suggests increasing length limit

<u>But, commercial fishery targets ovarian tissue not biomass!</u>

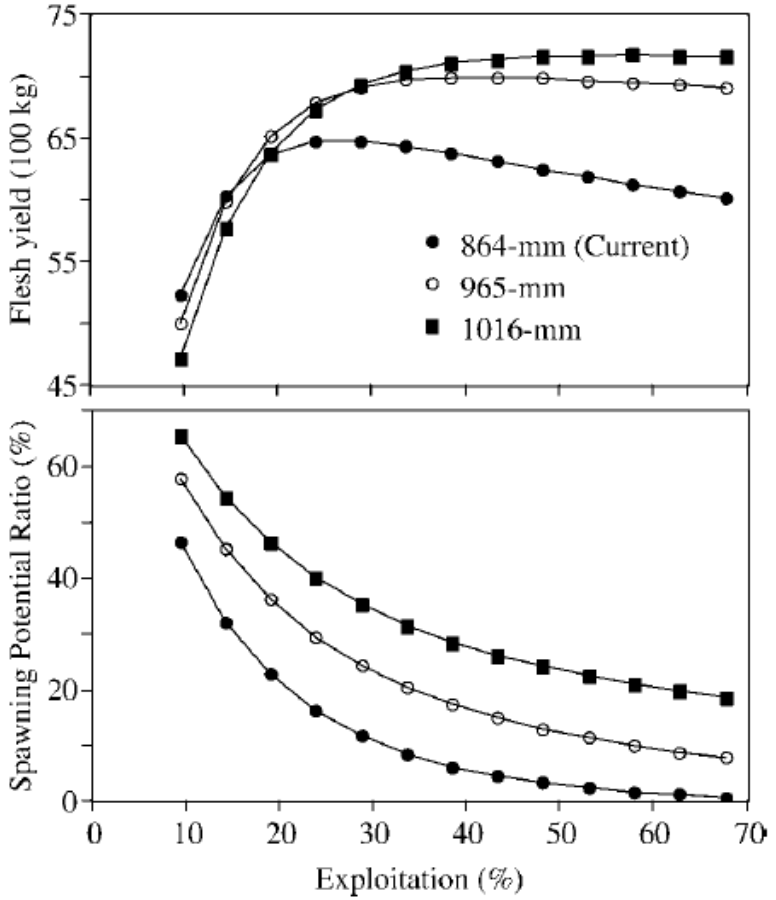
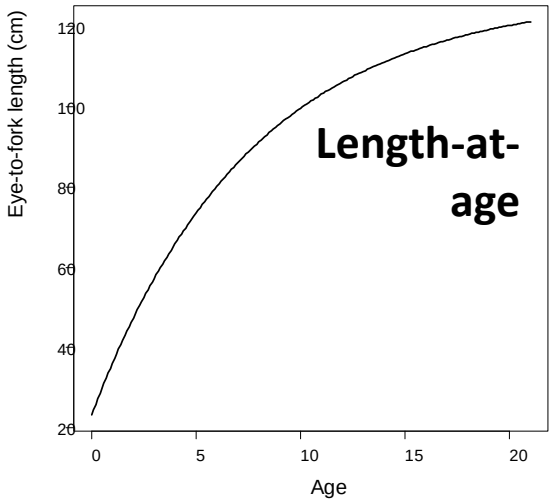
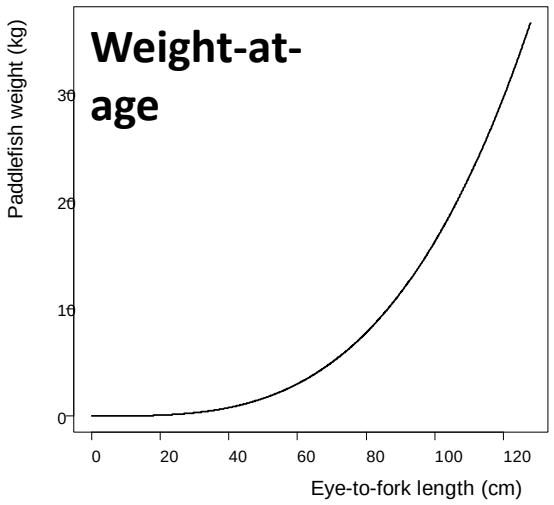


FIGURE 6.—Predicted paddlefish flesh yield (per 1,000 recruits; top) and spawning potential ratio (bottom) versus exploitation for three different minimum length limits in Kentucky Lake in 2003–2004.

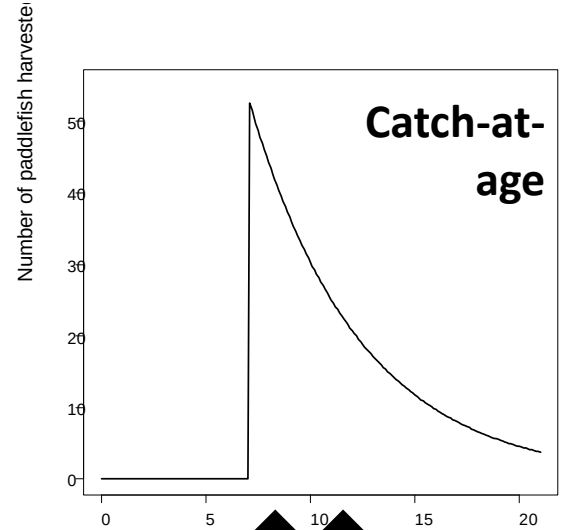
Weight-at-age

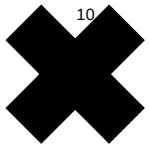


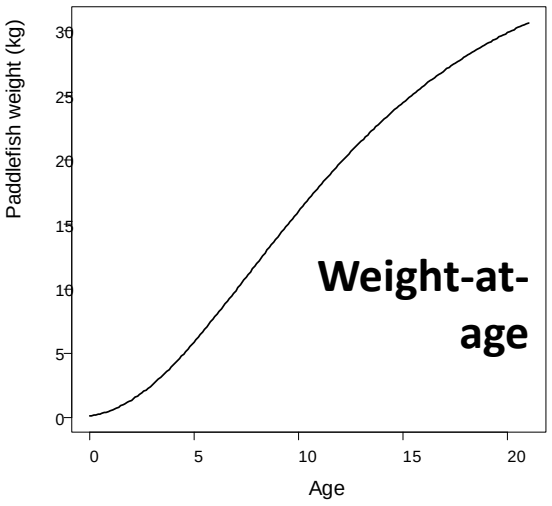


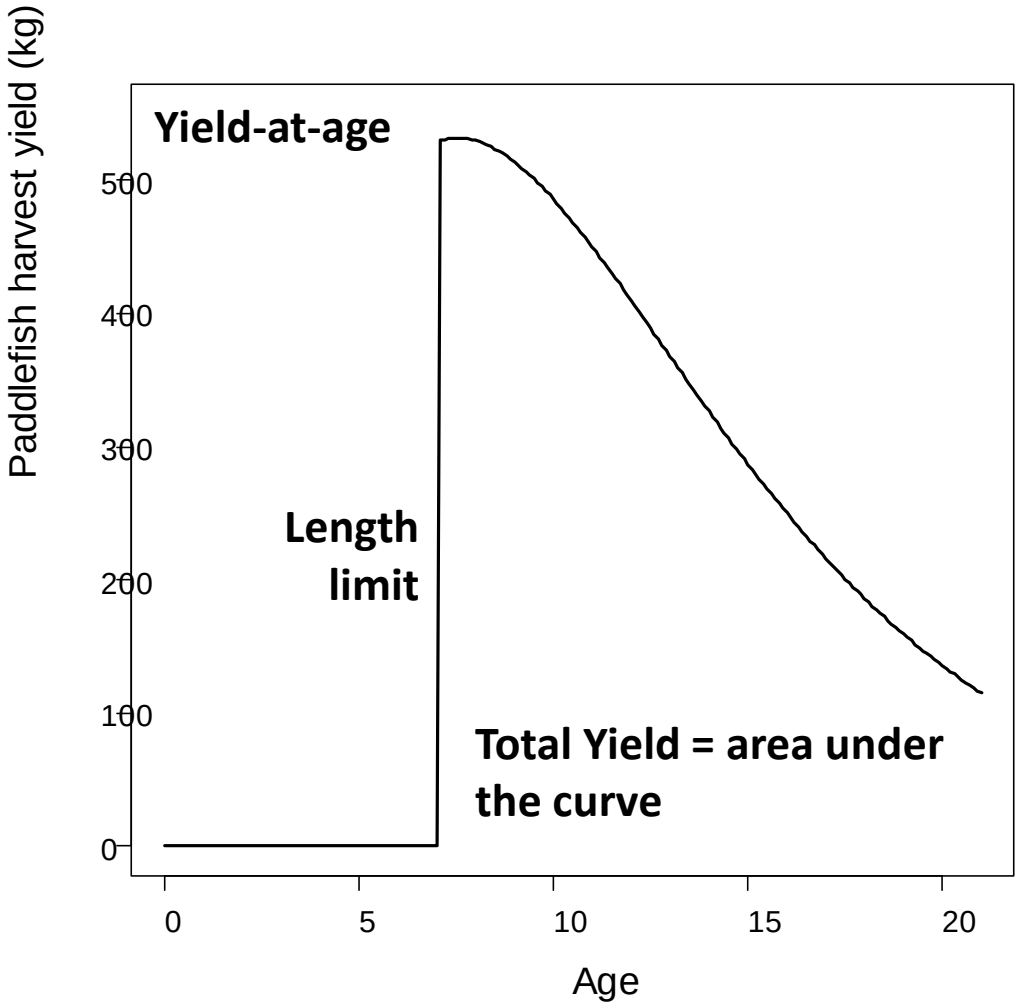
$$W_{fish}(age) = 10^{-5.711} \bullet (1{,}279 \bullet (1 - e^{-0.131 \bullet (age + 1.527)}))^{3.307}$$

Putting it all together

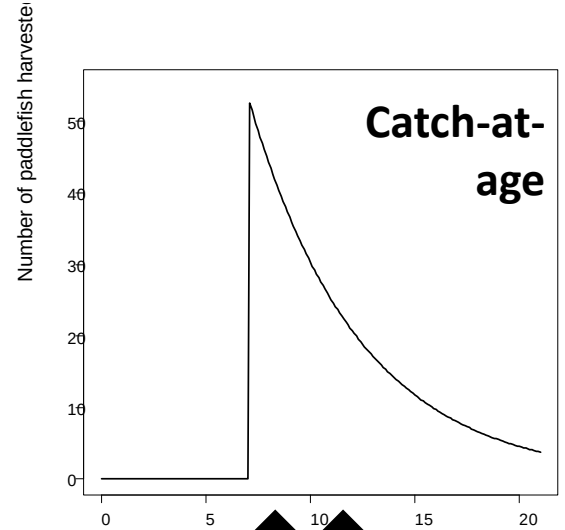


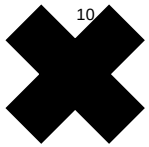


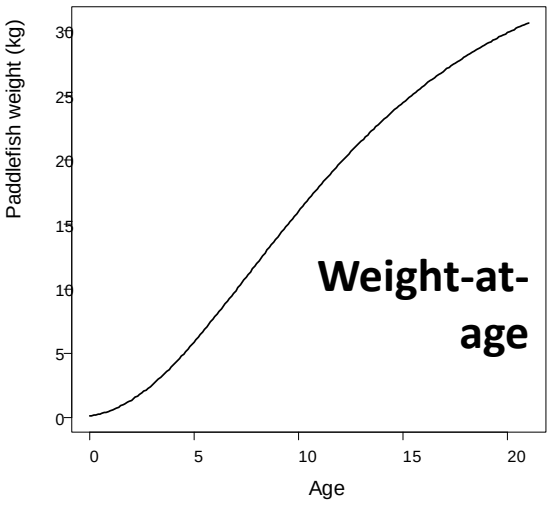


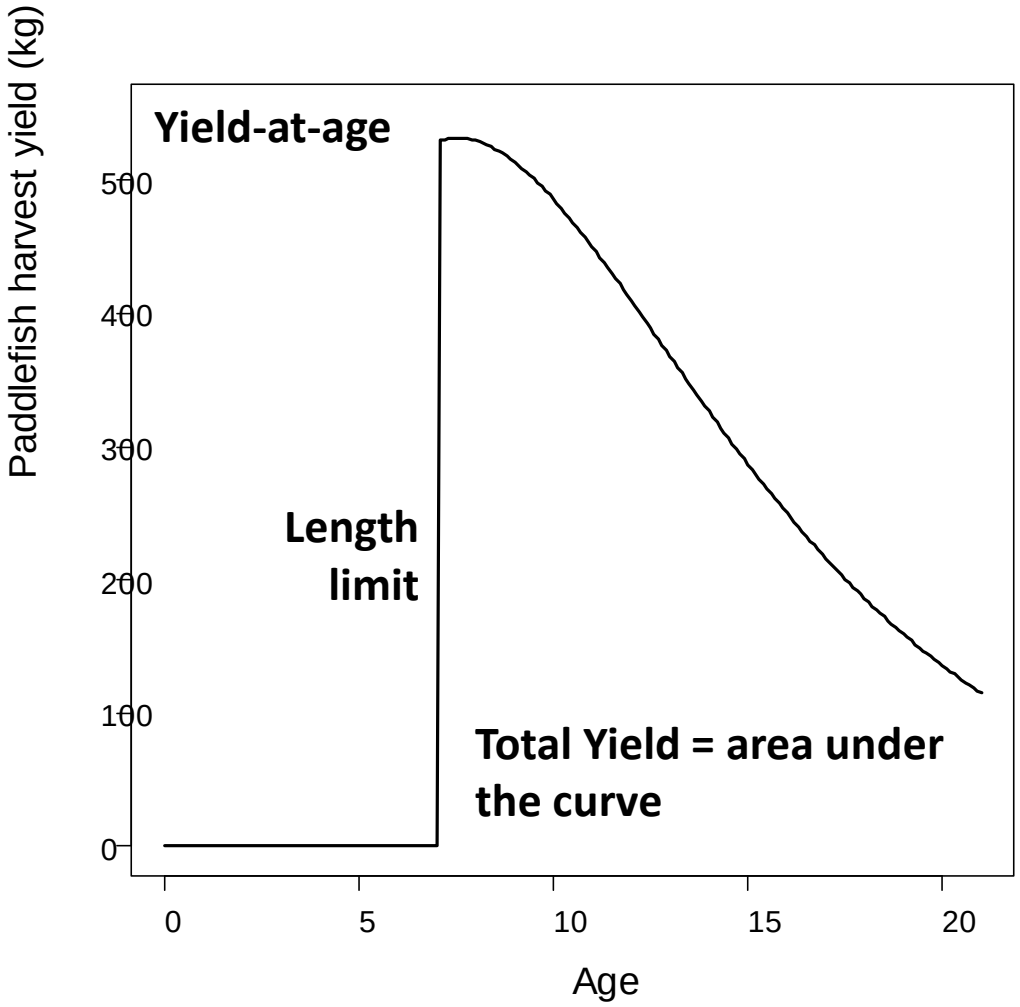


Putting it all together

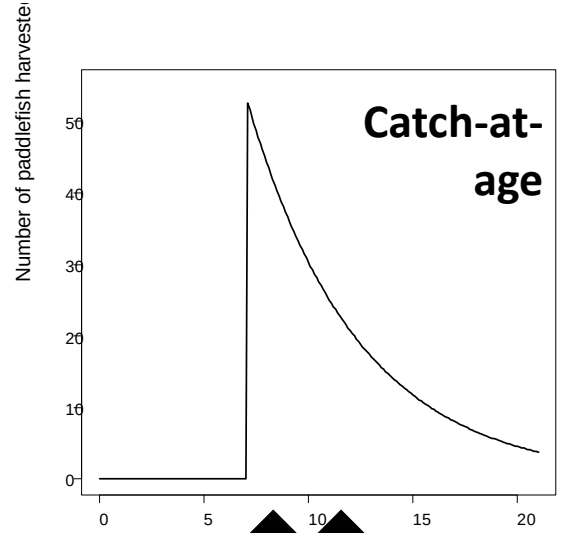


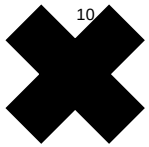


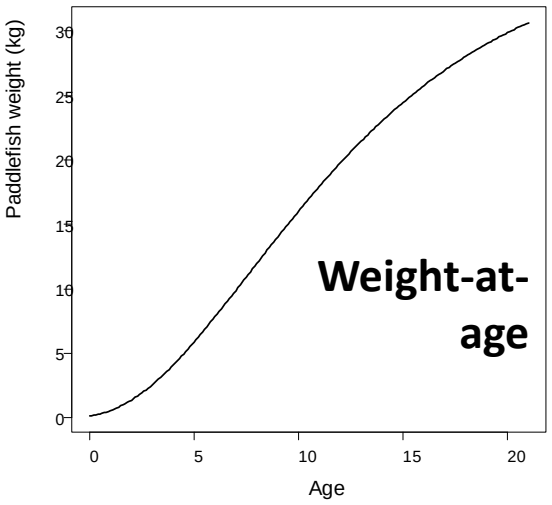


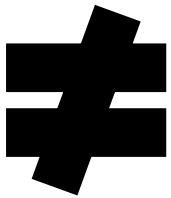


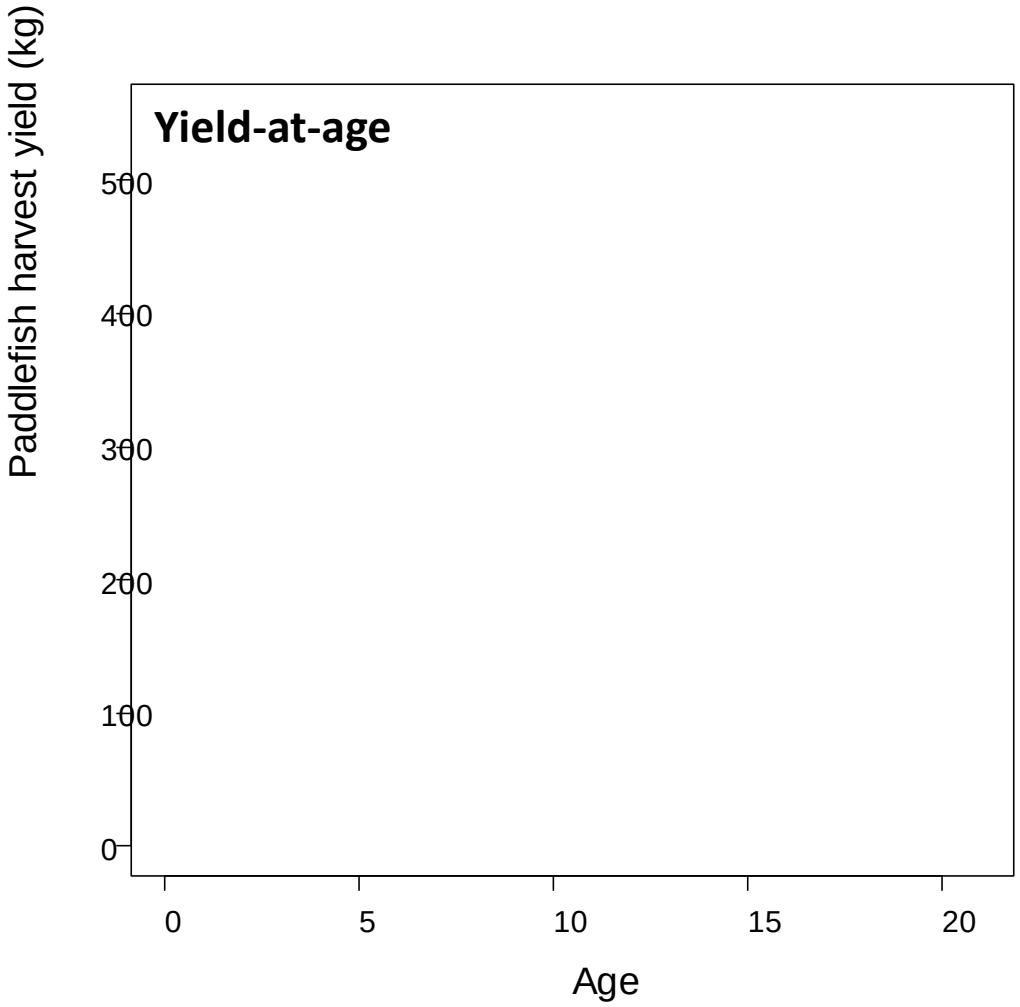
Roe yield?


Number of paddlefish harveste
Catch-at-age
0
10
20
30
40
50
0
5
10
15
20

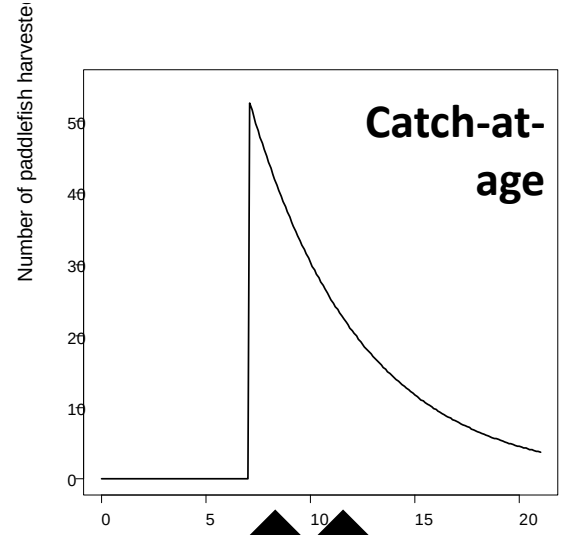


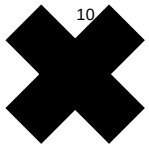

Paddlefish weight (kg)
Weight-at-age
0
5
10
15
20
25
30
0
5
10
15
20
Age

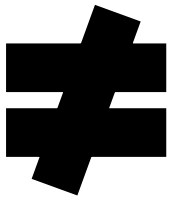


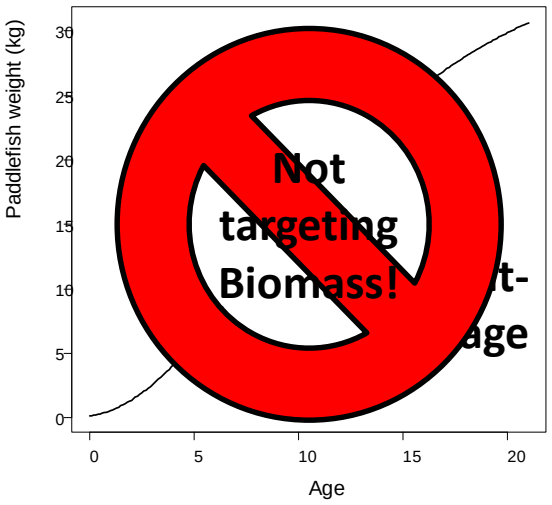

Paddlefish harvest yield (kg)
Yield-at-age
0
100
200
300
400
500
0
5
10
15
20
Age

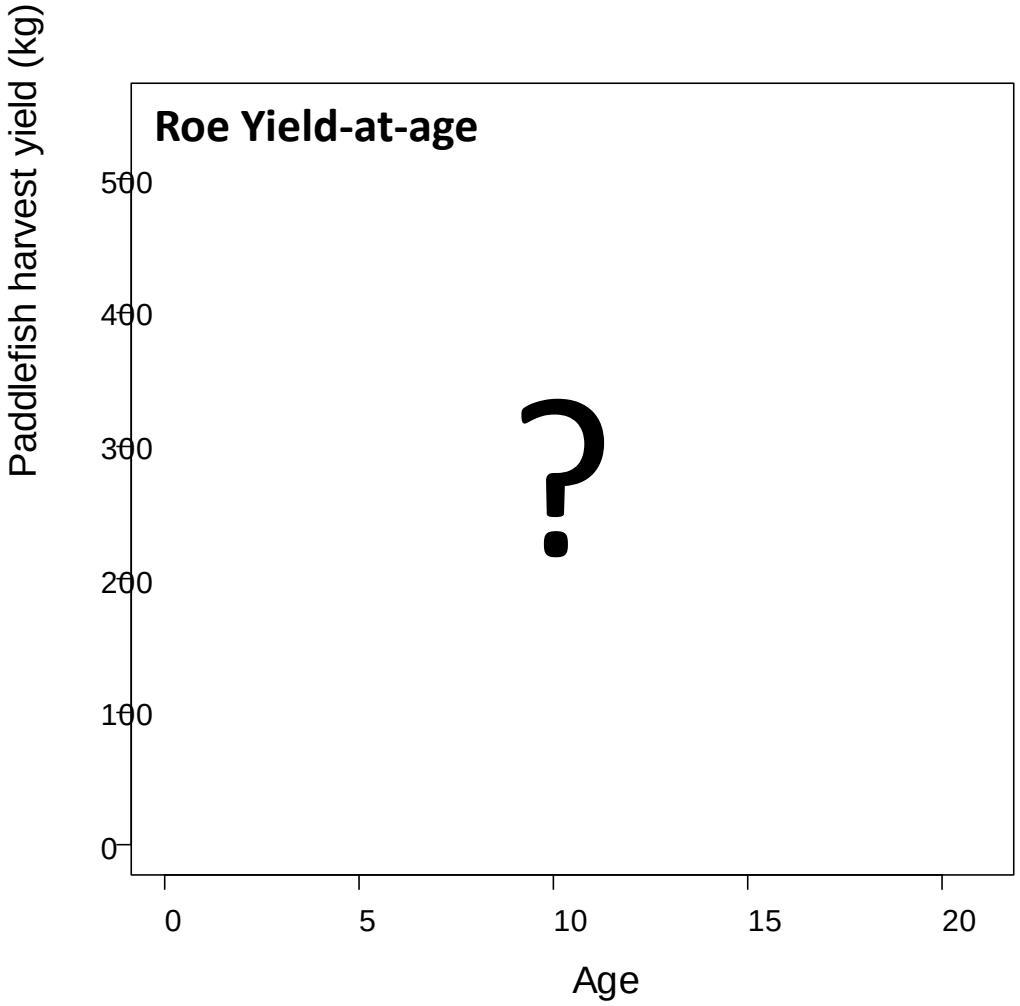
Putting it all together









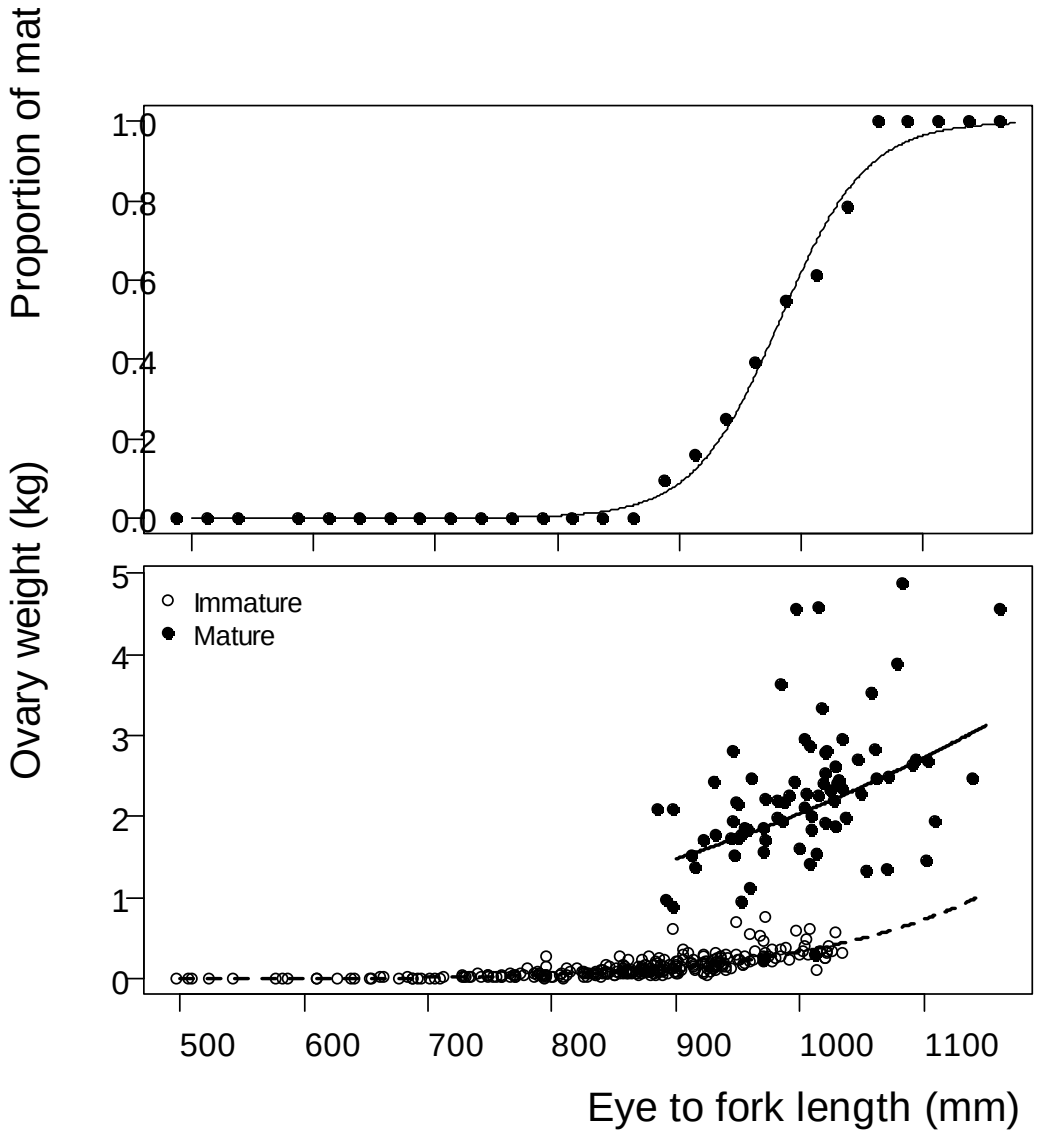


Simulating roe yield

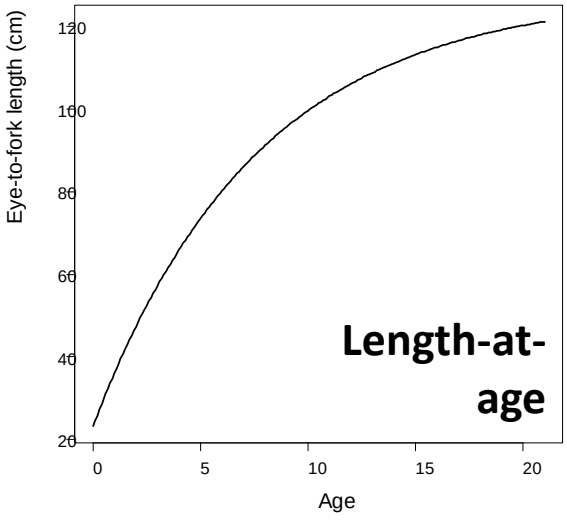
Ovary weight-at-EFL

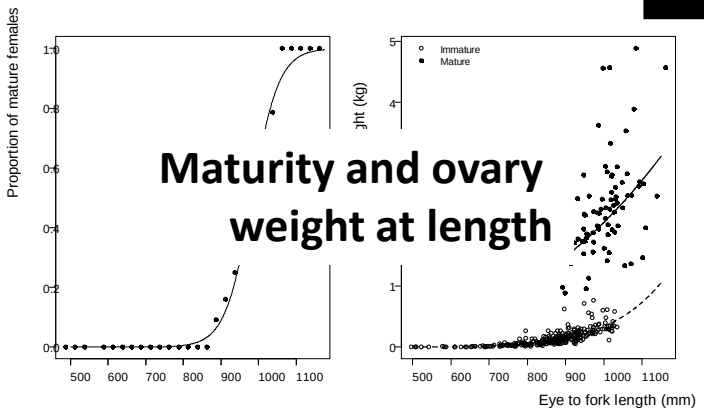
Account for:

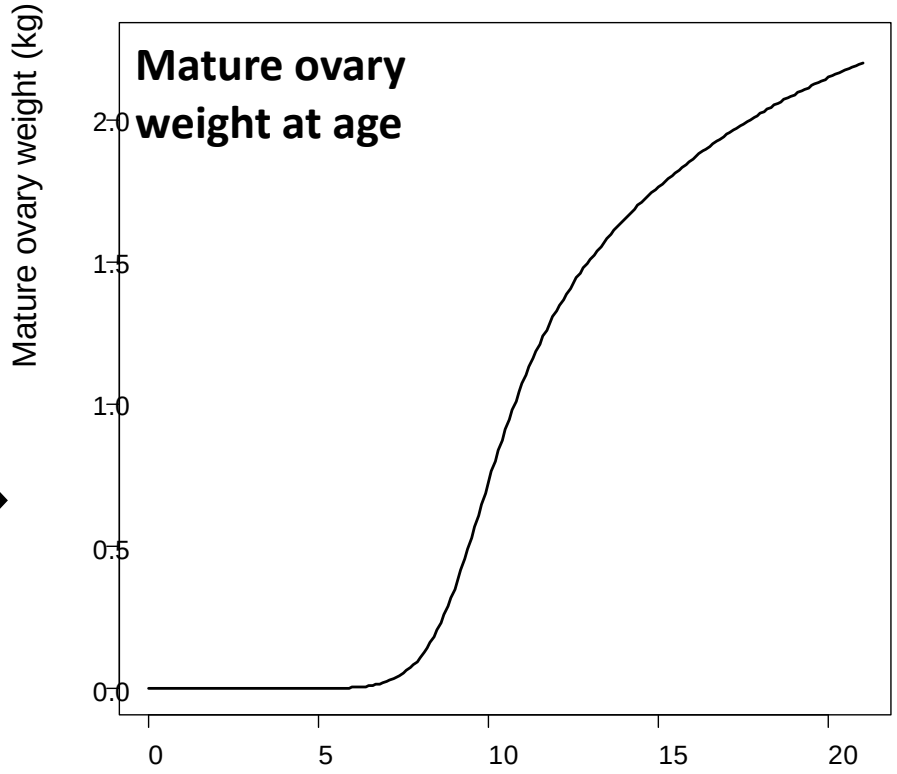
- Maturity
- Ovary weight



Simulating roe yield

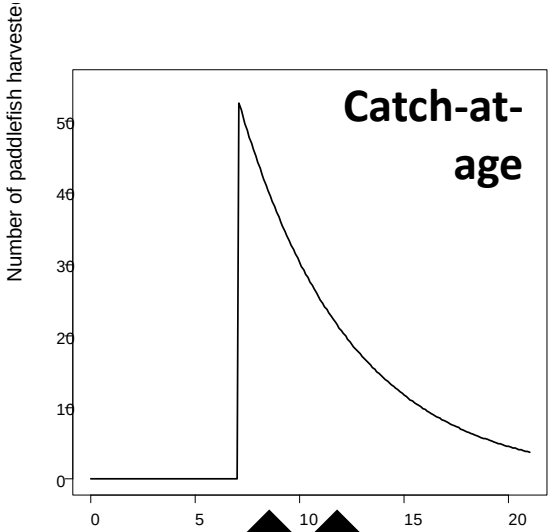


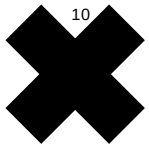


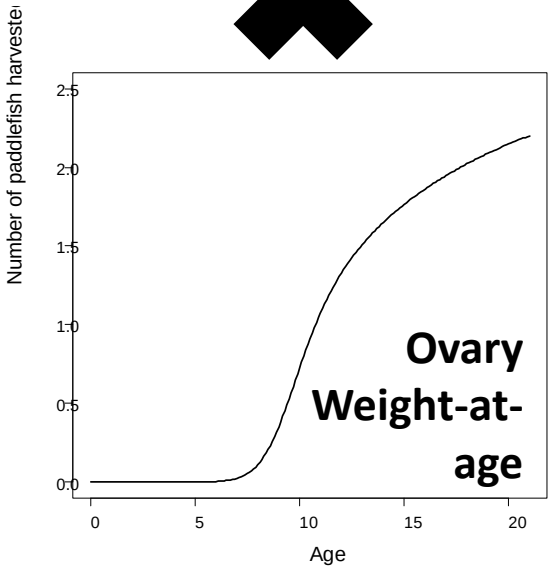


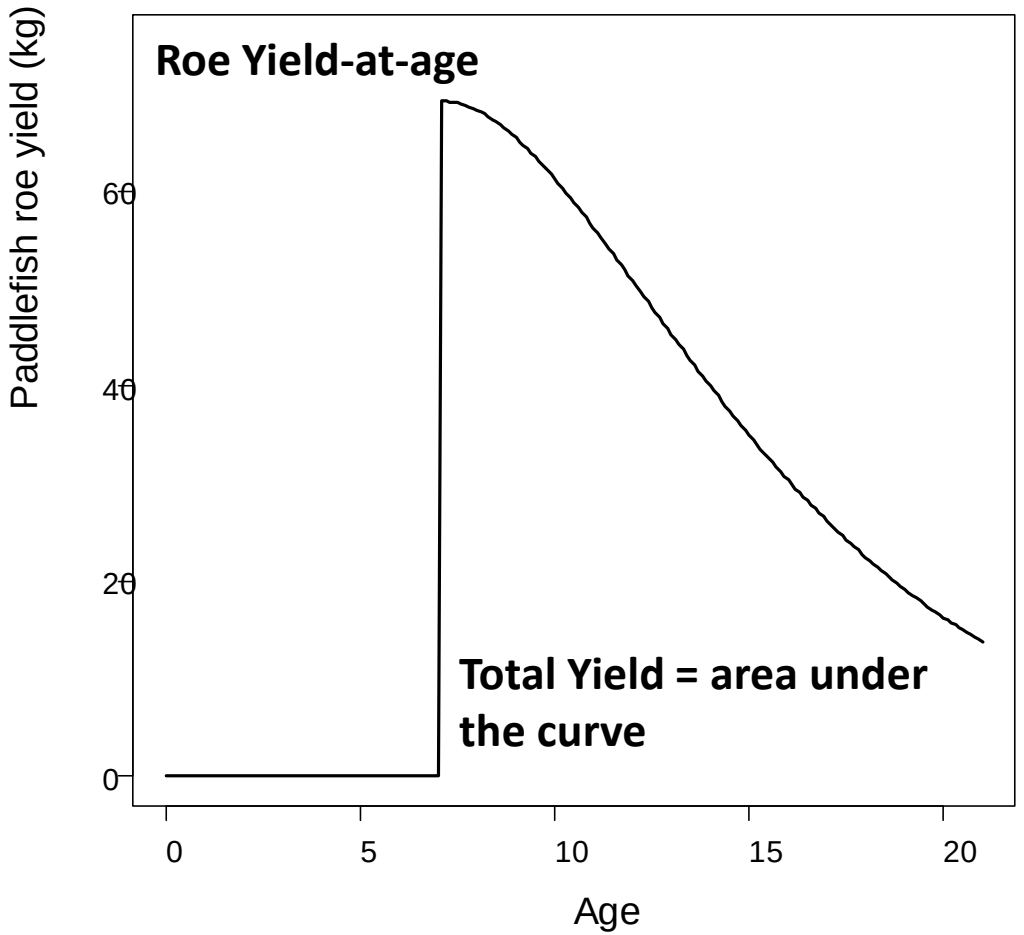
$$W_{ovary}(t) = 0.6 \bullet \left(\frac{e^{-27.78+0.028\bullet(1{,}279\bullet(1-e^{-0.131\bullet(t+1.527)})}}{e^{-27.78+0.028\bullet(1{,}279\bullet(1-e^{-0.131\bullet(t+1.527)})} + 1} \right) \bullet \left(0.0000014 \bullet (1{,}279 \bullet (1 - e^{-0.131\bullet(t+1.527)})^{3.0529}\right)$$

Finally…roe yield!





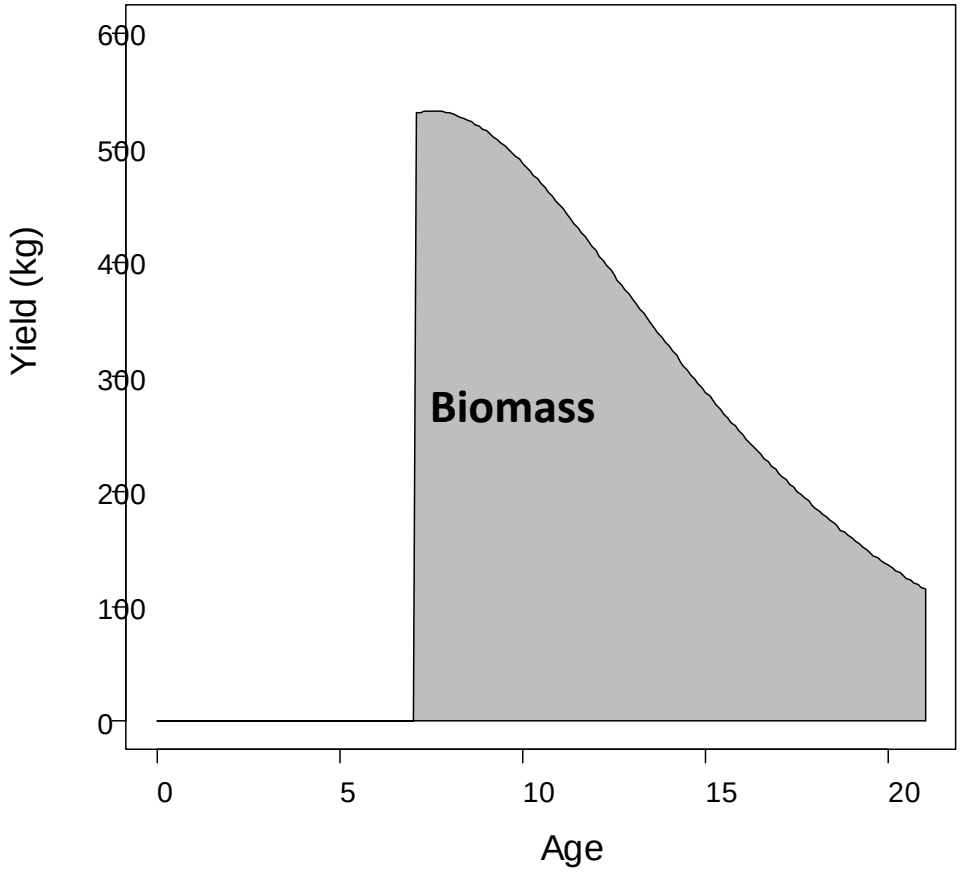


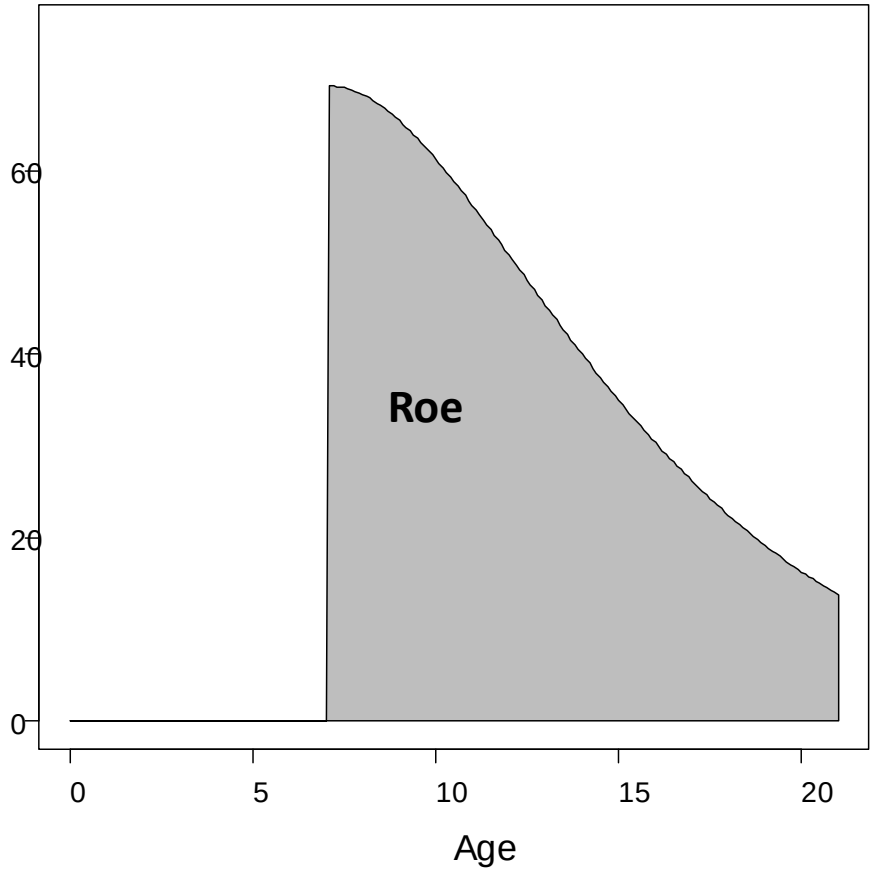


Finally…yield!

$$Y_{fish} = \int_{t_r}^{t_\lambda} F \bullet R \bullet e^{-(M \bullet t_r)} \bullet e^{-(M+F) \bullet (t-t_r)} \bullet 10^{-5.71} \bullet \left(1{,}279 \bullet \left(1 - e^{-0.131 \bullet (t+1.527)}\right)\right)^{3.307} \bullet dt$$

$$Y_{roe} = \int_{t_r}^{t_\lambda} F \bullet R \bullet e^{-(M \bullet t_r)} \bullet e^{-(M+F) \bullet (t-t_r)} \bullet 0.6 \bullet \left(\frac{e^{-27.78+0.028 \bullet (1{,}279 \bullet (1-e^{-0.131 \bullet (t+1.527)}))}}{e^{-27.78+0.028 \bullet (1{,}279 \bullet (1-e^{-0.131 \bullet (t+1.527)}))} + 1}\right) \bullet \left(0.0000014 \bullet (1{,}279 \bullet (1 - e^{-0.131 \bullet (t+1.527)})^{3.0529}\right) \bullet dt$$





Predicting total yield

Analytical?

Approximate?

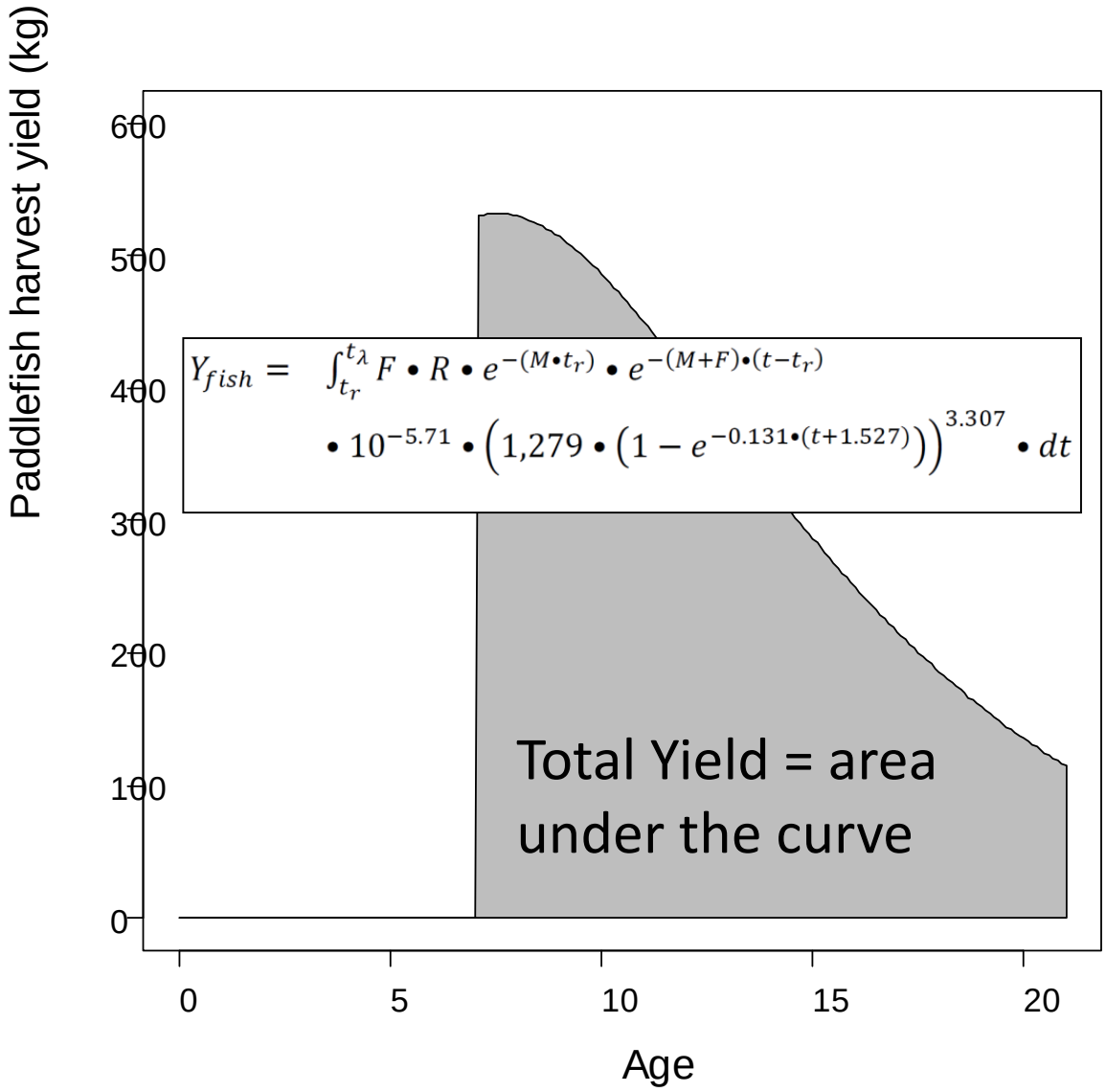
Jones (1957)

– Incomplete

β function

— FAST

— FAMS



Numerical approaches

Box the region

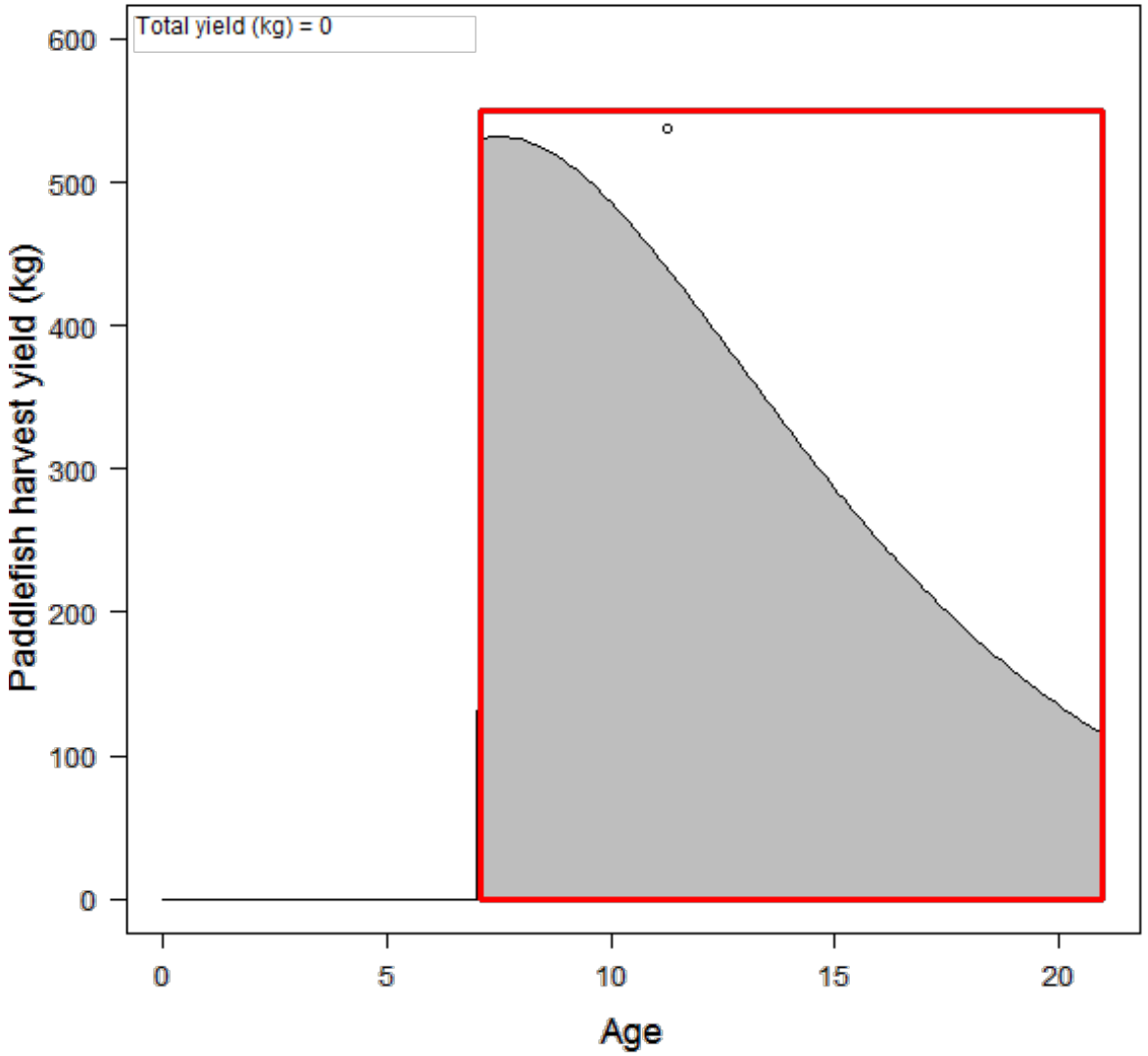
- Age recruited to fishery
- Maximum age
- Known area

Illustration of numerical integration

Monte Carlo numerical integration

- Do for many random draws within box

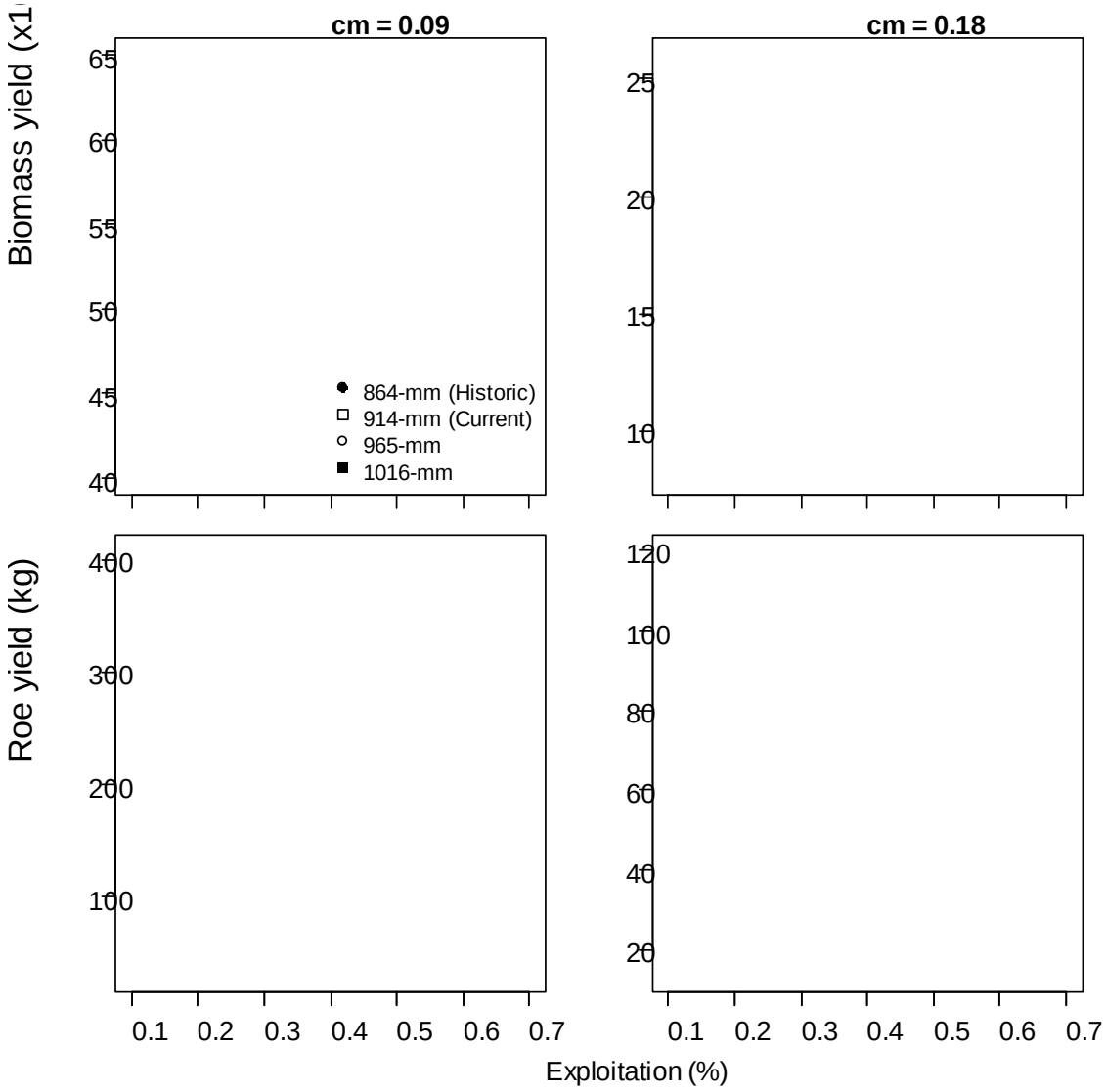
- Very Flexible



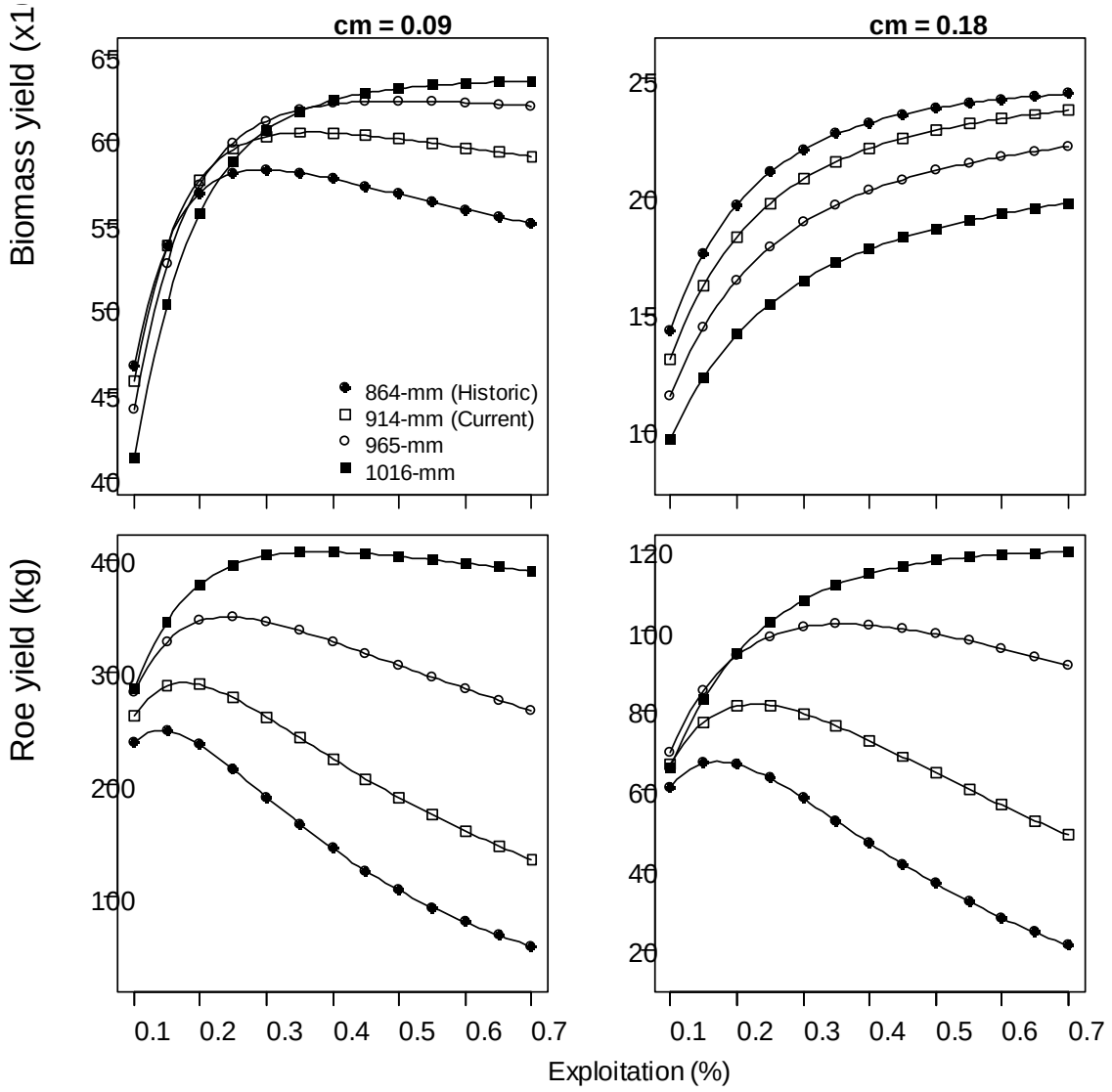
Predicted biomass and roe yields

Varying:

- Exploitation
- Natural Mortality
- Length limit



Predicted biomass and roe yields



Key points

- Growth overfishing (roe)
  - Occurs at **lower** exploitation rates
  - **More severe** in terms of roe
  - Suggests higher minimum length limits
- Less sensitive to uncertainty to natural mortality

Multiple tissue harvest?

Multiple tissue harvest

Economic yield

- Roe (200 $/ounce)
- Flesh (1 $/pound)
- Domestic culture?