

WF4113-Fisheries Science

Class 17-Overfishing

Housekeeping



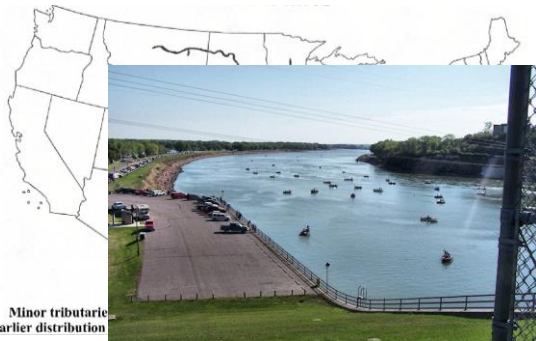
- Be working on your final project!
- Exam II-Next Monday 4/3 Anything up to 3/29 is fair game...



Current *Polyodon* Distribution in the United States



Recreational Fisheries



Minor tributaries
earlier distribution

Commercial Fisheries



Paddlefish life history

- Up to 7' long
- Up to 200 pounds!
- Species ~ 300 myo
- Vulnerable - IUCN

Spawning

- Males: Sexually mature at 4-9 yo
- Females: Sexually mature at 6-12 yo
- Spawn periodically 4-7 years
- Spawn over rocks gravel

Really big...

State-record paddlefish



Foraging

- Feed on zooplankton



PADDLEFISH ROE HARVEST

Co-authors:

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G.D. Scholten - Iowa Department of Natural Resources

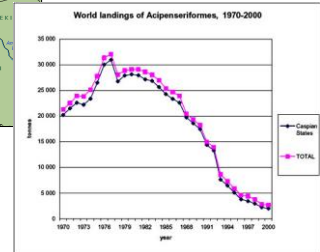


Caviar sources

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



Eurasian caviar stocks decline



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

NA Acipenseriformes harvest

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

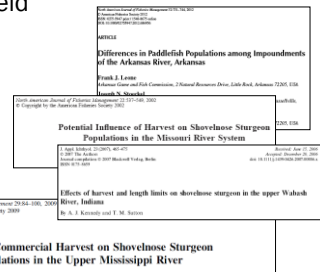


220 \$/kg roe; 500-650\$ per fish



Yield-per-recruit (YPR) models

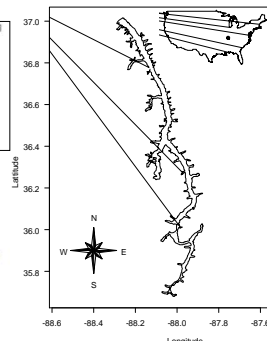
- Predicts fishery yield
- Age structured
- Evaluate varying:
 - Fishing mortality
 - Length limits
 - Natural mortality



Paddlefish harvest

Population Characteristics and Assessment of Overfishing for an Exploited Paddlefish Population in the Lower Tennessee River
 GEORGE D. SCHWENKE
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 205 Ponderbush Hall, Cookeville, Tennessee 38503, USA
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 U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit,
 Tennessee Technological University,
 205 Ponderbush Hall, Cookeville, Tennessee 38503, 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
But, commercial fishery targets ovarian tissue not biomass!

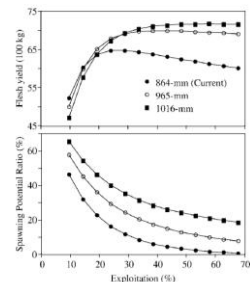
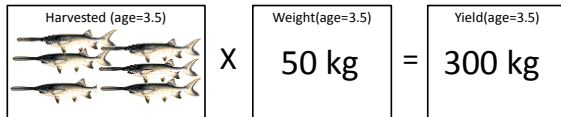


FIGURE 6.—Predicted paddlefish fish yield (per 1,000 recruits; top) and spawning potential ratio (bottom) versus exploitation for three different minimum length limits in Kentucky Lake in 2003–2004.

A yield predicting primer

$$\text{Yield}(\text{age}) = \text{Harvested}(\text{age}) \cdot \text{Weight}(\text{age})$$

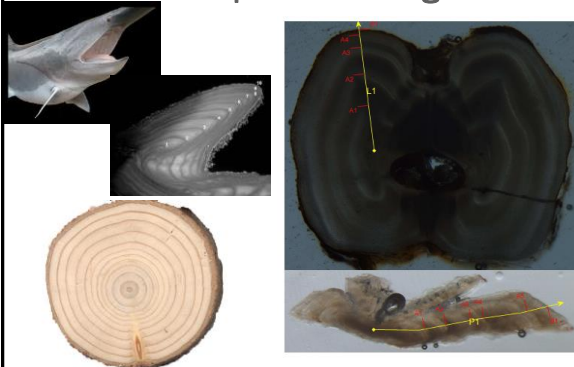


Paddlefish can live up to 21 years (λ_{max})...So how is total cohort yield calculated?

How is total cohort yield calculated?

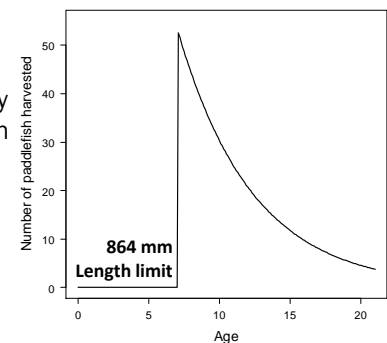
1. Maximum age
2. Catch-at-age
 1. Instantaneous natural mortality (M)
 2. Fishing mortality (F, u)
 3. Recruits (population, fishery)
3. Length-at-age
4. Weight-at-length

How are paddlefish aged?



Catch-at-age

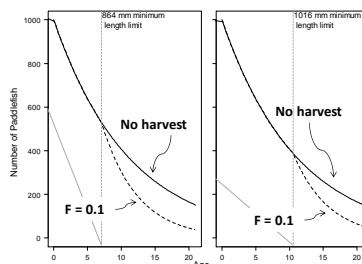
Convert length limit to years
- Von Bertalanffy growth function



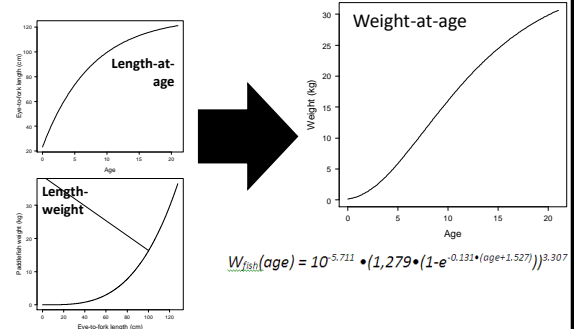
A yield predicting primer

Need 2 parts for simulated population

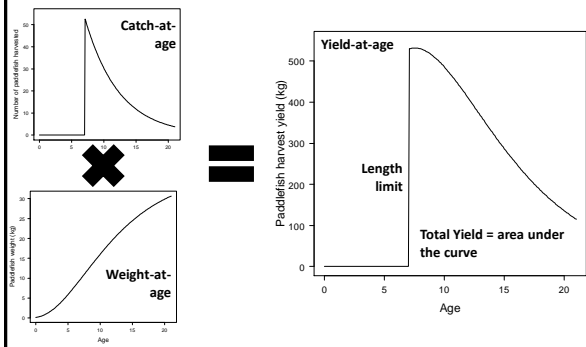
1. Catch-at-age
2. Weight-at-age



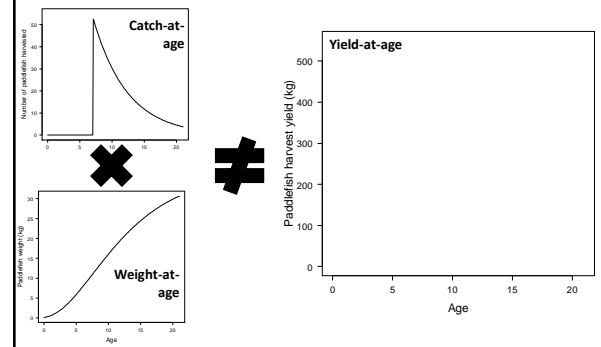
Weight-at-age



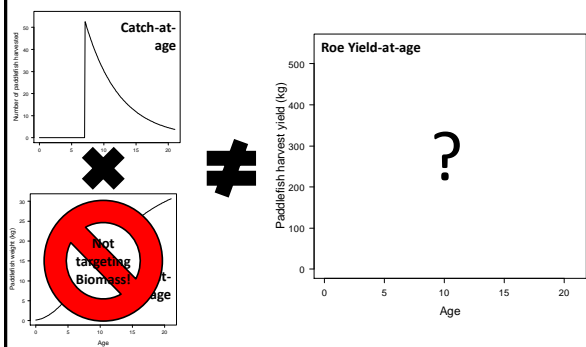
Putting it all together



Roe yield?



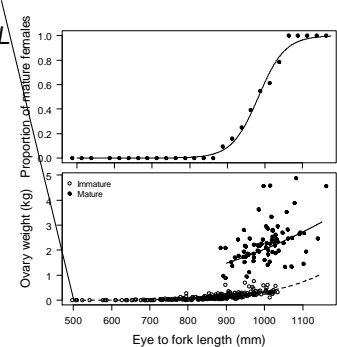
Putting it all together



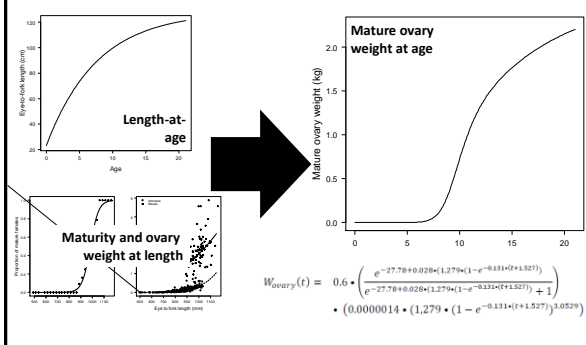
Simulating roe yield

Ovary weight-at-EFL
Account for:

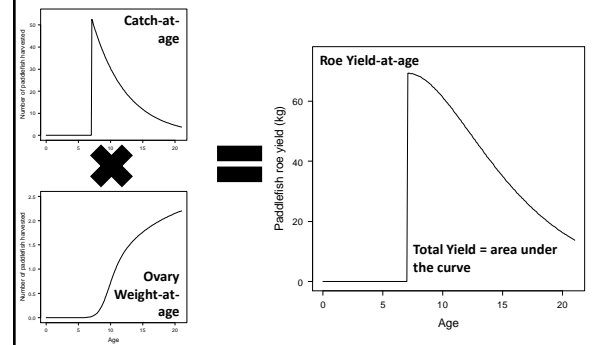
- Maturity
- Ovary weight



Simulating roe yield



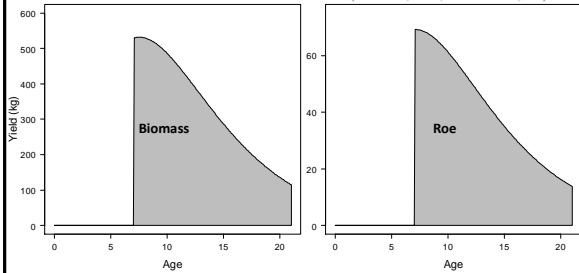
Finally...roe yield!



Finally...yield!

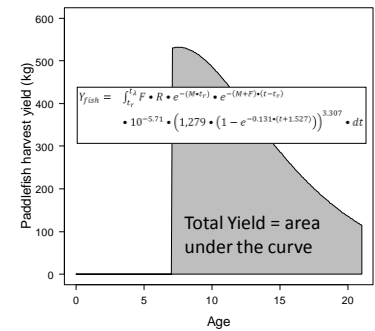
$$Y_{fish} = \int_{t_0}^{t_d} F \cdot R \cdot e^{-(M+F)(t-t_0)} \cdot e^{-(M+F)(t-t_d)} \cdot 0.6 \cdot 10^{-5.71} \cdot (1.279 \cdot (1 - e^{-0.131(t+1.527)}))^{3.307} \cdot dt$$

$$Y_{roe} = \int_{t_0}^{t_d} F \cdot R \cdot e^{-(M+F)(t-t_0)} \cdot e^{-(M+F)(t-t_d)} \cdot 0.6 \cdot \left(\frac{e^{-27.78+0.0284(1.279(1-e^{-0.131(t+1.527)}))}}{e^{-27.78+0.0284(1.279(1-e^{-0.131(t+1.527)}))} + 1} \right) \cdot (0.0000014 \cdot (1.279 \cdot (1 - e^{-0.131(t+1.527)}))^{3.307}) \cdot dt$$



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

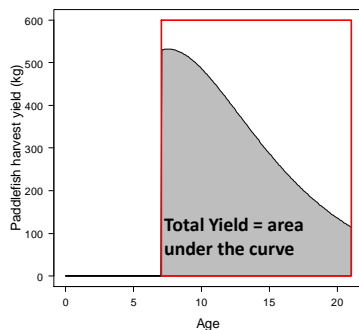
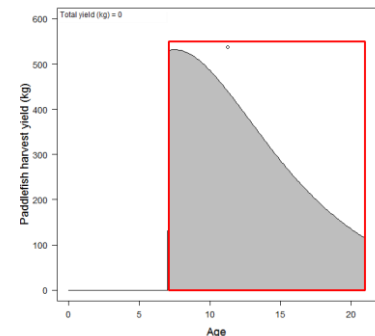


Illustration of numerical integration

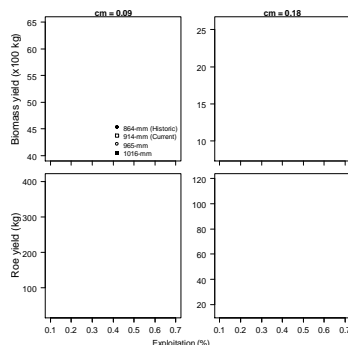
Monte Carlo
numerical
integration
- Do for many
random draws
within box
- Very Flexible



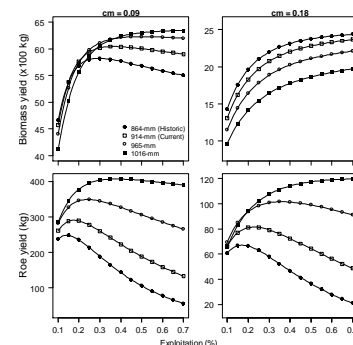
Predicted biomass and roe yields

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



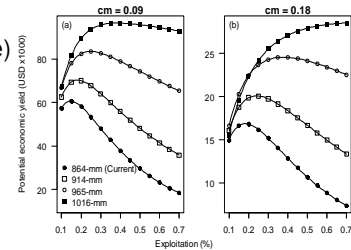
Multiple tissue harvest?



Multiple tissue harvest

Economic yield

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



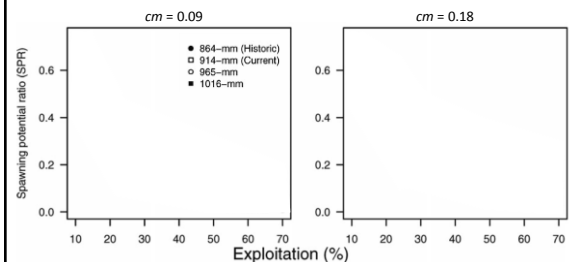
Assessing recruit overfishing

- Spawning potential ratio

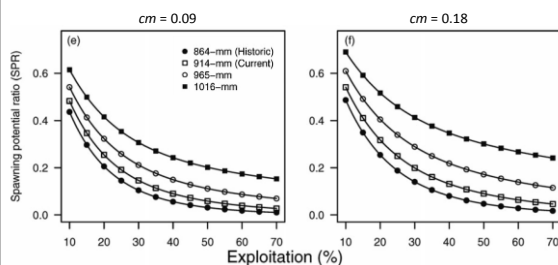
$$SPR = \frac{SSP_{fished}}{SSP_{unfished}}$$

the amount of mature ovary biomass left after harvest (i.e., potential spawning biomass) was used to calculate the SPR

Spawning potential ratio



Spawning potential ratio



Further realism

Commercial fishers can check paddlefish for roe with a large (10 or 12-gauge) syringe

- Viewed as a conservation measure
- Bycatch mortality unknown

Effect of this biological reality into roe-yield-per recruit model?

- Current results should be conservative



