WF4133-Fisheries Science

Class 25– Review

Housekeeping

- Total Points
  - Final Exam 250
  - Report 150

Housekeeping

- Final Exam Wednesday May 3rd 8-11 am

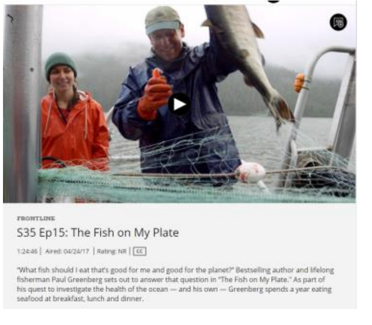
MWF, MW, M, W, F CLASSES

If Class Meets		Exam Will Be			
8:00 am	MWF	Thu	May 4	8:00 am to 11:00 am	
9:00 am	MWF	Wed	May 3	8:00 am to 11:00 am	
10:00 am	MWF	Tue	May 2	8:00 am to 11:00 am	
11:00 am	MWF	Thu	May 4	12:00 pm to 3:00 pm	
12:00 pm	MWF	Fri	Apr 28	12:00 pm to 3:00 pm	
12:30 pm	MW	Fri	Apr 28	12:00 pm to 3:00 pm	
1:00 pm	MWF	Mon	May 1	12:00 pm to 3:00 pm	
2:00 pm	F	Thu	May 4	3:00 pm to 6:00 pm	
2:00 pm	W	Thu	May 4	3:00 pm to 6:00 pm	

http://www.registrar.msstate.edu/students/schedules/exam-schedule/s/?year[value][year]=2017&semester=spring

The Fish on My Plate

- http://www.pbs.org/video/3000267728/



SIZE STRUCTURE

Adding length categories

Gabelhouse (1984): need to move beyond a two-cell model of length categorization and further refine PSD by using:

- stock (S)
- quality (Q)
- preferred (P)
- memorable (M)
- trophy (T)

Calculation of length categories

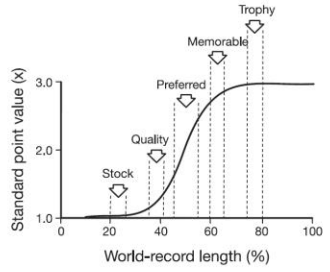


Figure 14.3 Gabelhouse's adoption of Weithman's (1978) fish quality index to identify length ranges from which (or near to which) minimum stock, quality, preferred, memorable, and trophy lengths were selected (from Gabelhouse 1984a).

Length categories

Category	Largemouth bass (mm)	Bluegill (mm)
Stock	200	80
Quality	300	150
Preferred	380	200
Memorable	510	250
Trophy	630	300

Traditional PSD

$$PSD - X = \frac{\text{Number of fish} \geq \text{ specified length}}{\text{Number of fish } \geq \text{ stock length}} \cdot 100$$

Category	N	Value
PSD-S	400	100
PSD-Q	100	40
PSD-P	75	25
PSD-M	80	14
PSD-T	10	2

Incremental PSD

$$PSD - X = \frac{\text{Number of fish in bin}}{\text{Number of fish } \geq \text{ stock length}} \cdot 100$$

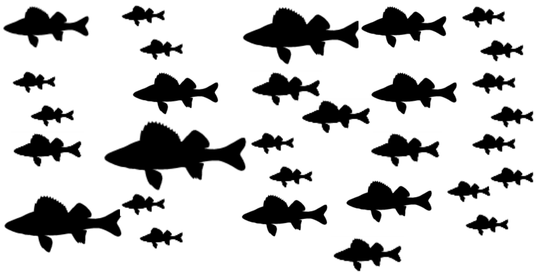
Category	N	Value
PSD-S-Q	400	60
PSD-Q-P	100	15
PSD-P-M	75	11
PSD-M-T	80	12
PSD-T	10	2

Should sum to 100

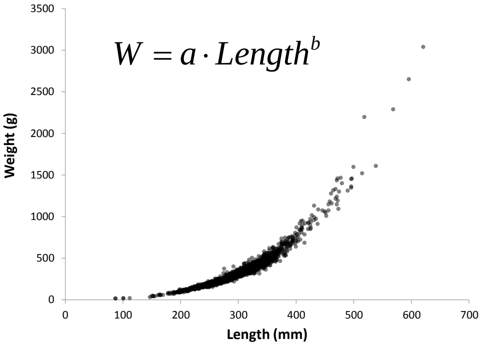
LENGTH-WEIGHT

Population characteristics

Quantities and indices of a population



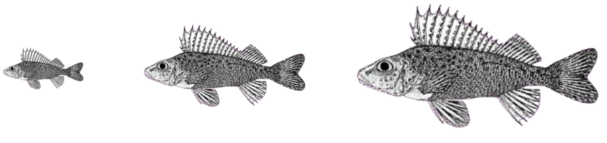
Length-weight relationship



Isometric scaling

If b=3 then fish growth is isometric

- all dimensions change similarly over time
- shape of fish does not change over time

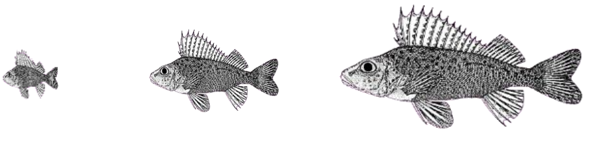


$$W = a \cdot L^{b=3}$$

Allometric scaling

- if b<3 then fish gets more fusiform with time

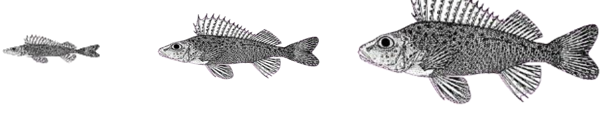
$$W = a \cdot L^{b<3}$$



Allometric scaling

- if b>3 then fish gets more plump with time

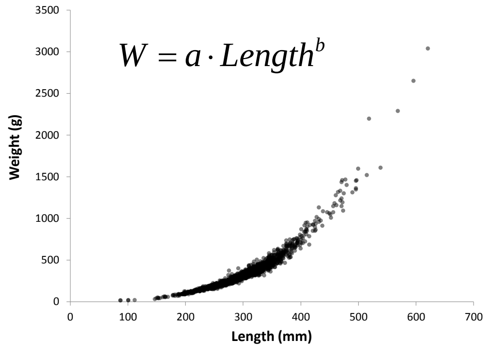
$$W = a \cdot L^{b>3}$$



Using length-weight relationships

- Estimate weight from length
- Measure variation from the **expected** weight for length of individual fish or relevant group of individuals as indications of fatness, general 'well-being,' gonad development, etc.
  - Does a fish weigh more than another even though they are the same length?

Estimating weight from length



Straightening the curve

Law of logarithms

$$W = a \cdot L^b$$

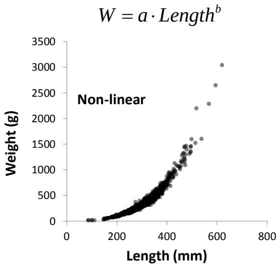
$$\log_{10}(W) = \log_{10}(a \cdot L^b)$$

$$\log_{10}(W) = \log_{10}(a) + b \cdot \log_{10}(L)$$

$$\log_{10}(W) = a' + b \cdot \log_{10}(L)$$

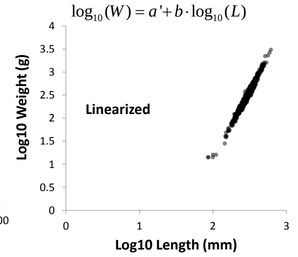
Estimating weight from length

$$W = a \cdot Length^b$$



$$\log_{10}(W) = \log_{10}(a) + b \cdot \log_{10}(L)$$

$$\log_{10}(W) = a' + b \cdot \log_{10}(L)$$

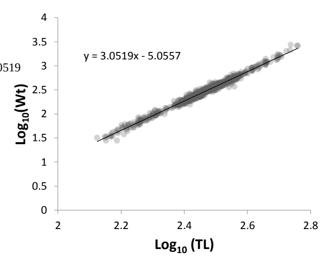


Can estimate weight from length!

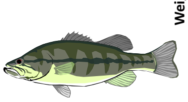
$$Weight = 10^{-5.0557} \cdot Length^{3.0519}$$

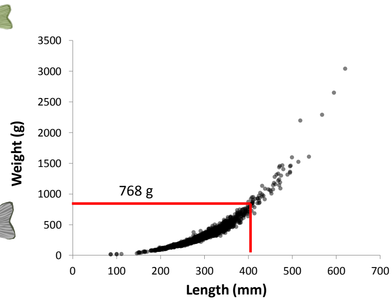
$$Weight = 10^{-5.0557} \cdot 400^{3.0519}$$

$$Weight = 768\,g$$

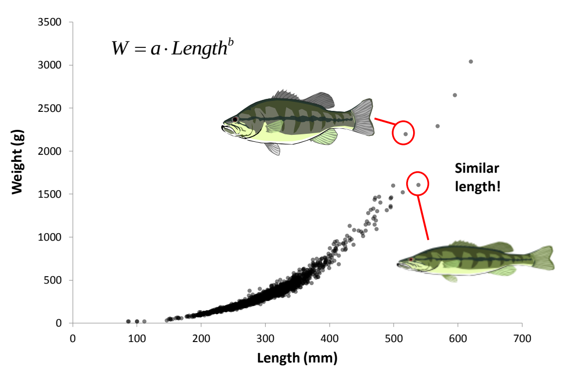


Length-weight data



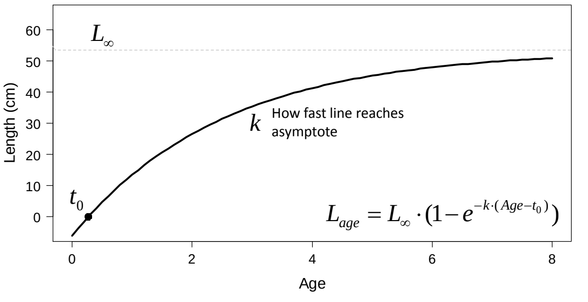


Condition

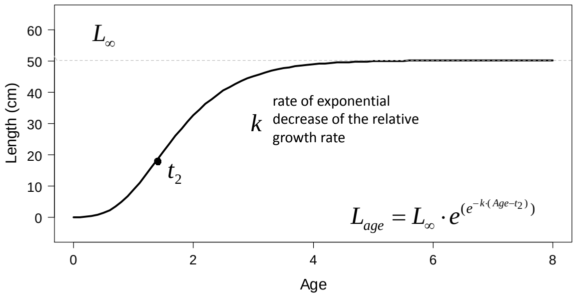


AGE-LENGTH

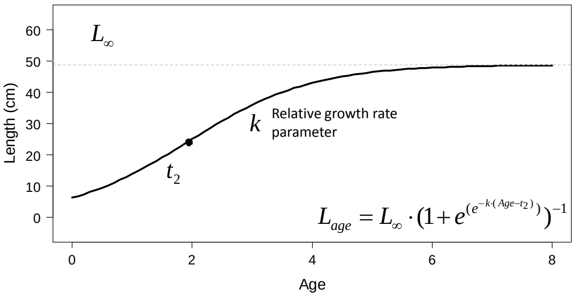
von Bertalanffy Growth Function



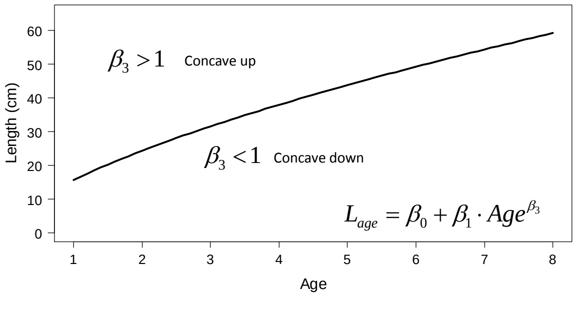
Gompertz



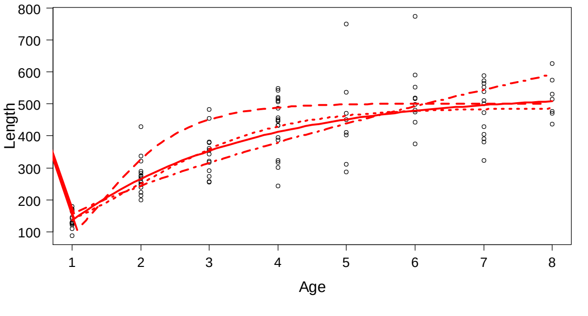
Logistic



Power



Length at age?



Example

Proposed minimum length limit

1. 8 inches (203 mm)
2. 12 inches (304 mm)
3. 14 inches (356 mm)
4. 15 inches (381 mm)

$$Length_{\infty} = 400$$
$$K = 0.3$$
$$t_0 = 0.1$$

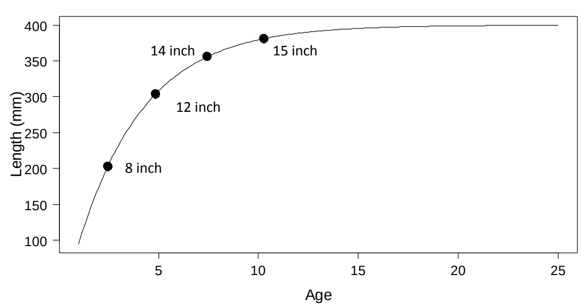
8 inch limit

$$t_0 + \frac{\log\left(1 - \frac{Length_{age}}{Length_{\infty}}\right)}{-K} = age$$
$$0.1 + \frac{\log\left(1 - \frac{203}{400}\right)}{-0.3} = age$$
$$0.1 + \frac{-3.05}{-0.3} = age$$
$$0.1 + 10.16 = age$$
$$2.46 = age$$

12 inch limit

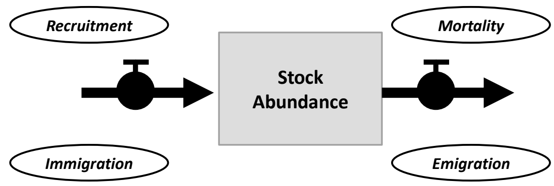
$$t_0 + \frac{\log\left(1 - \frac{Length_{age}}{Length_{\infty}}\right)}{-K} = age$$
$$0.1 + \frac{\log\left(1 - \frac{304}{400}\right)}{-0.3} = age$$
$$0.1 + \frac{-1.427}{-0.3} = age$$
$$0.1 + 4.757 = age$$
$$4.857 = age$$

Length limit & growth



RECRUITMENT

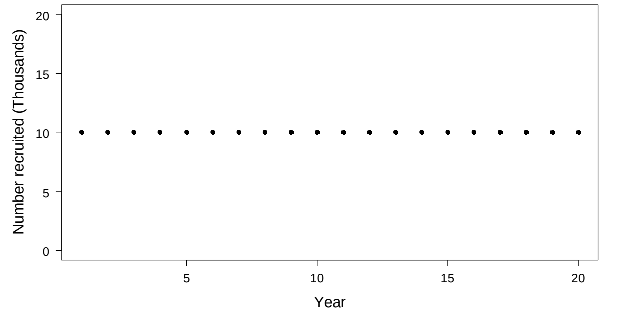
Fish dynamics



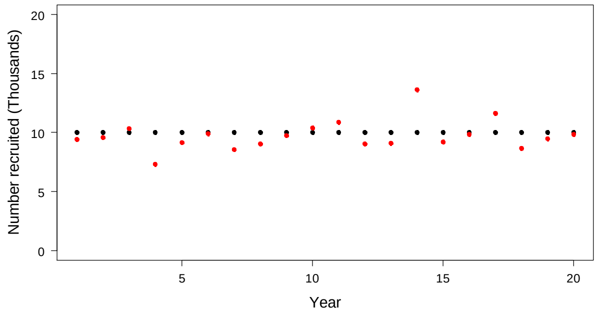
What is *recruitment*?

The addition of new fish into the catchable, harvestable, or adult populations.

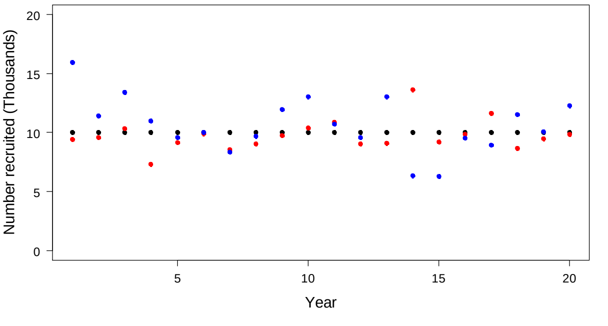
Constant recruitment



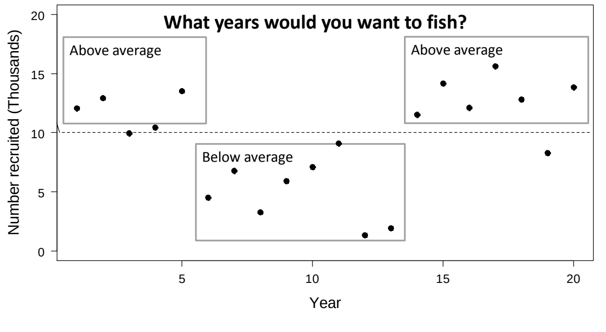
CV = 10%



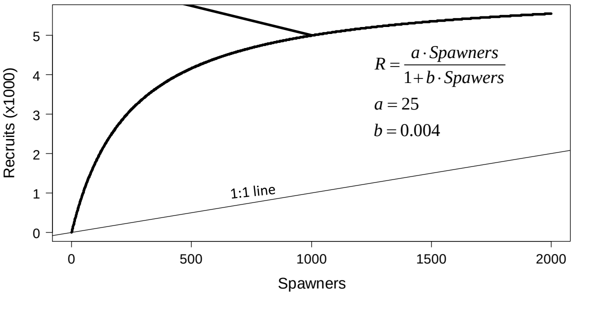
CV = 20%



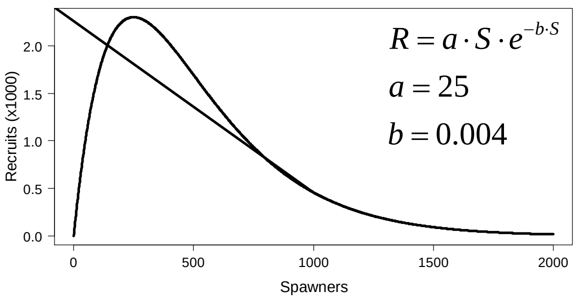
The magnitude of recruitment variation is important to because…



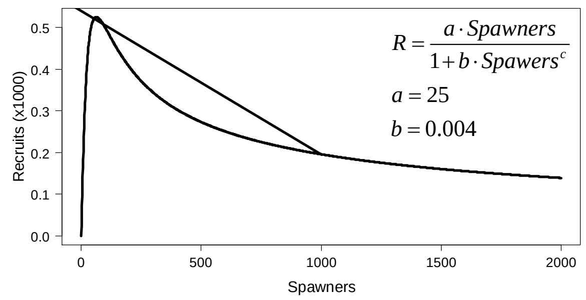
Beverton-Holt



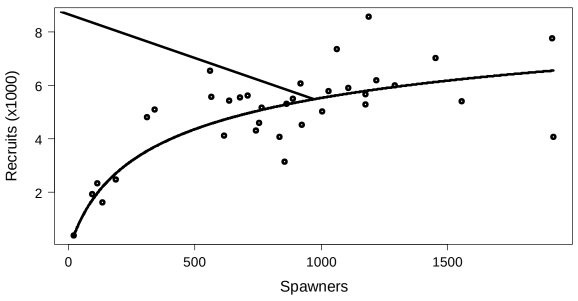
Ricker



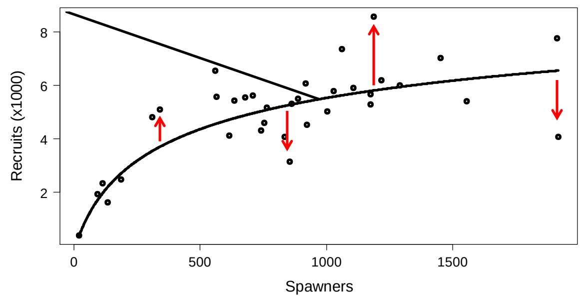
Sheperd curve



Beverton Holt



Recruitment variability



Recruitment variability

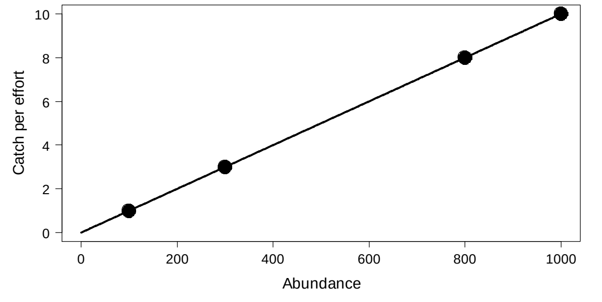
- Match-mismatch: food resources don’t match emergence timing
- Micropredation: smaller fish eating eggs
- Allee effect: spawners have a tough time finding each other
- Depensation?
- Depensation-offspring reduced at low spawning levels

Recruitment variability

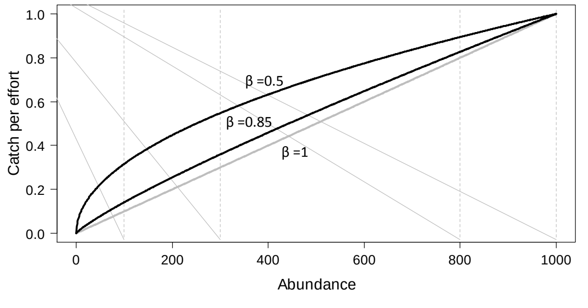
- Temperature-incubation time
- Water quality-turbidity,
- Spawning Habitat-gravel, aerated substrates
- Macrophytes-needed to spawn for some fish
  Water levels-access to spawning areas

HYPERSTABILITY & HYPERDEPLETION

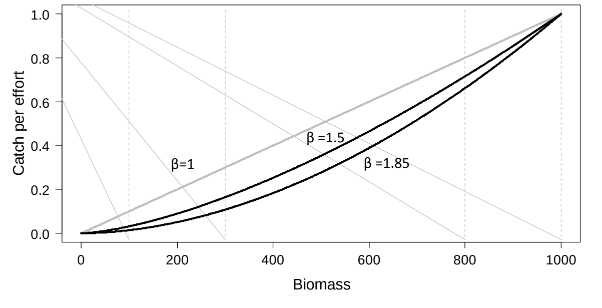
CPE, catchability, & biomass



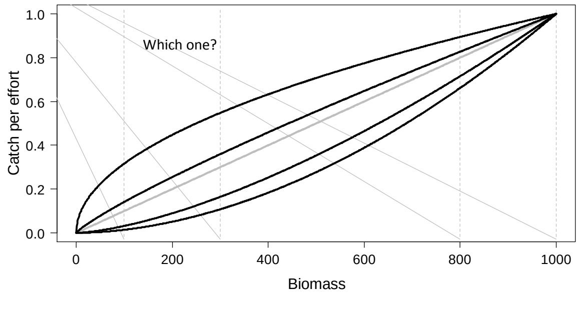
Hyperstability



Hyperdepletion

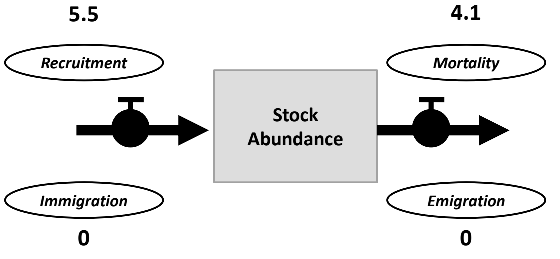


The whole picture

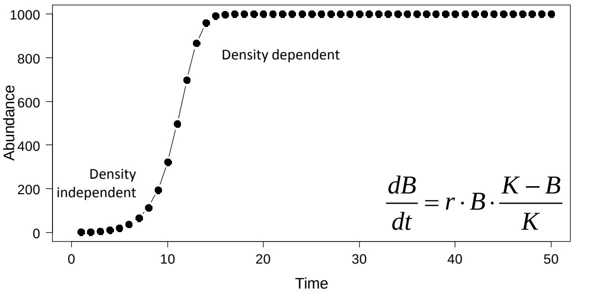


OVERFISHING, MSY, MEY & OSY

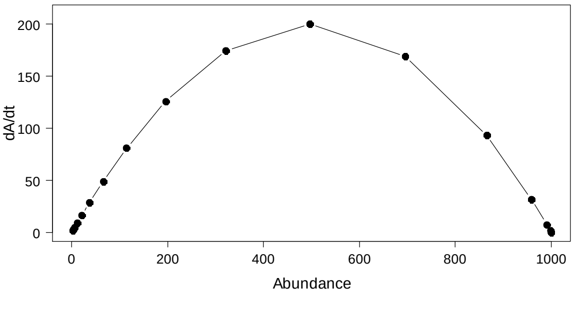
Fish dynamics



Graham-Schaefer model



dA/dt versus Abundance



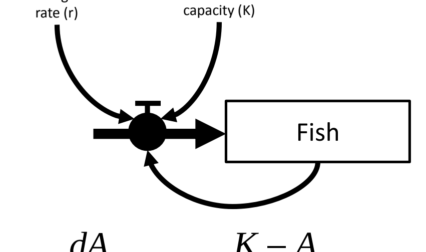
Sustainability

1. Ability to persist in the long-term. Often used as "short hand" for sustainable development;

2. Characteristic of resources that are managed so that the natural capital stock is non-declining through time, while production opportunities are maintained for the future.

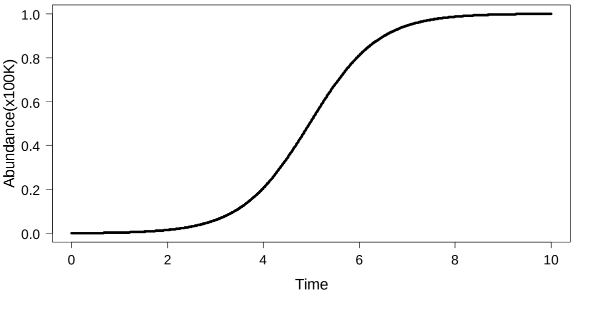
https://www.st.nmfs.noaa.gov/st4/documents/FishGlossary.pdf

Graham-Schaefer model

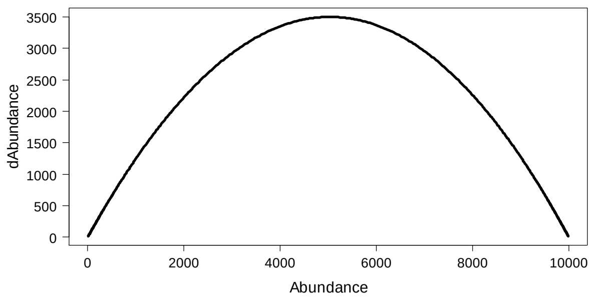


$$\frac{dA}{dt} = r \cdot A_t \cdot \frac{K - A_t}{K}$$

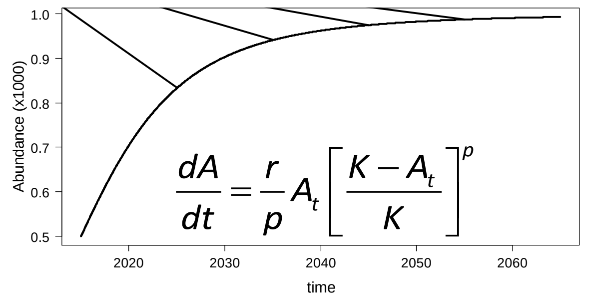
Graham-Schaefer model



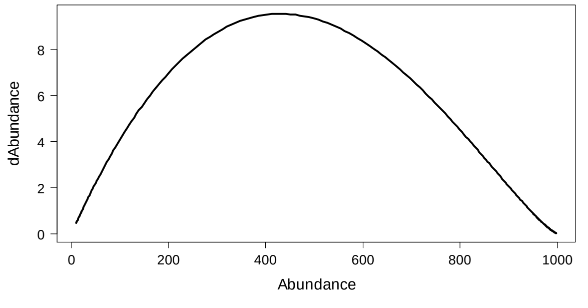
dA versus A



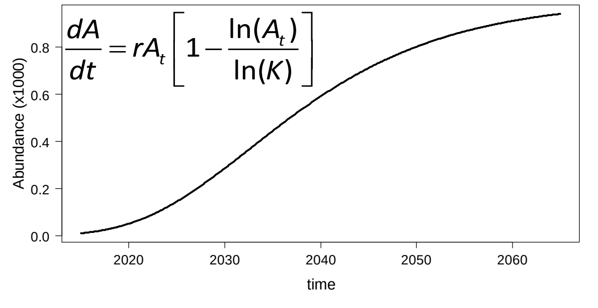
Pella-Tomlinson



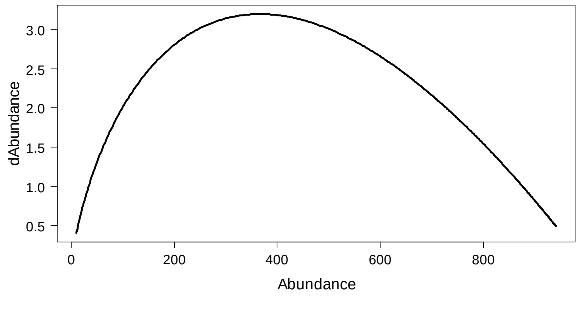
dA versus A



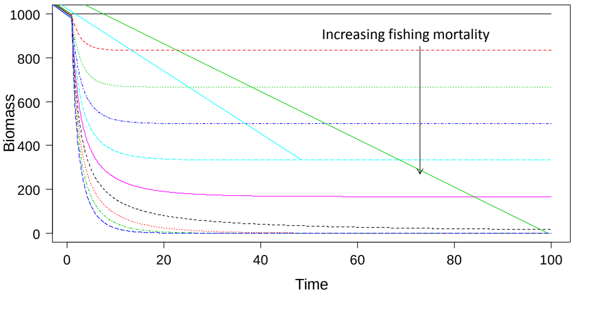
Fox model



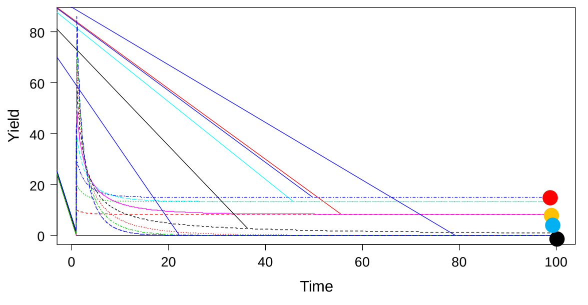
dN/dt versus N



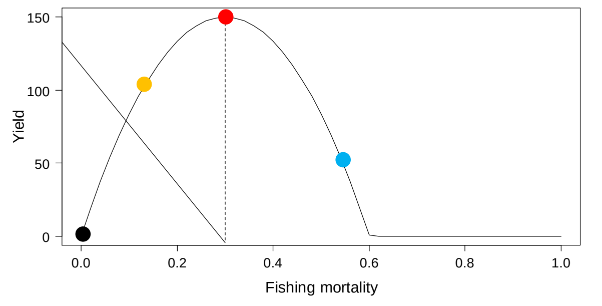
Biomass dynamics



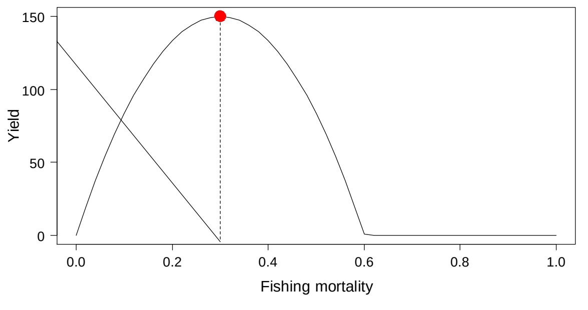
Yield



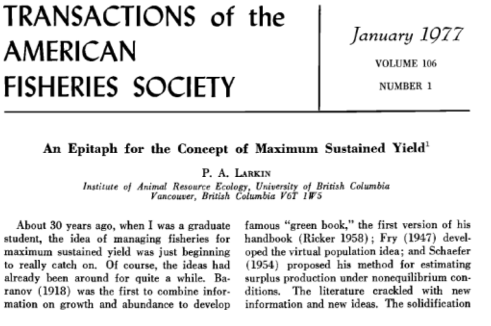
Maximum sustained yield (MSY)



Maximum sustained yield (MSY)



Epitaph for MSY



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NUMBER 1

An Epitaph for the Concept of Maximum Sustained Yield[1]

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About 30 years ago, when I was a graduate student, the idea of managing fisheries for maximum sustained yield was just beginning to really catch on. Of course, the ideas had already been around for quite a while. Baranov (1918) was the first to combine information on growth and abundance to develop famous "green book," the first version of his handbook (Ricker 1958); Fry (1947) developed the virtual population idea; and Schaefer (1954) proposed his method for estimating surplus production under nonequilibrium conditions. The literature crackled with new information and new ideas. The solidification

$F_{0.1}$

The use of $F_{0.1}$ has emerged as a useful "rule of thumb" for managing fisheries, but according to Hilborn and Walters (1992) this is an arbitrary, ad hoc strategy with no theoretical basis.

How do we figure out $F_{0.1}$

1. Find slope at origin
2. Plot line with 10% of this slope
3. Find tangent of curve at this slope

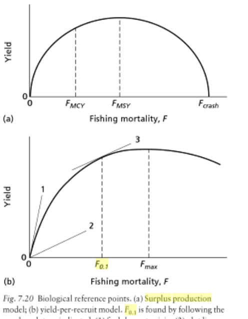
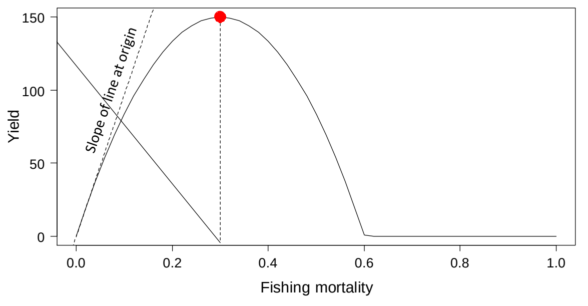
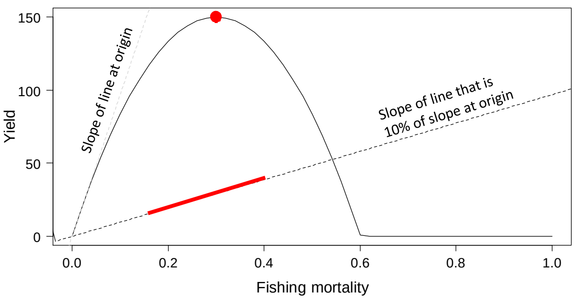


Fig. 7.20 Biological reference points. (a) Surplus production model; (b) yield-per-recruit model. $F_{0.1}$ is found by following the numbered steps indicated: (1) find slope at origin; (2) plot line with 10% of this slope; (3) find tangent to curve at this slope.

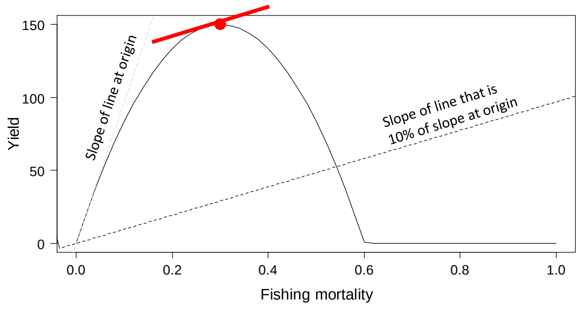
Slope at origin



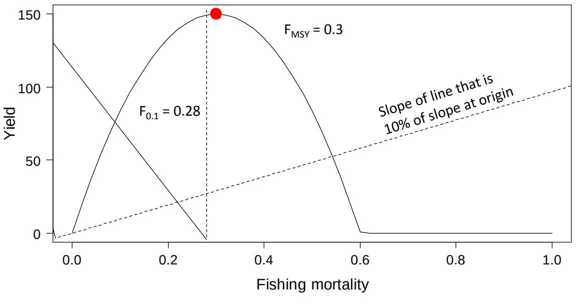
10% of slope at origin



10% of slope at origin

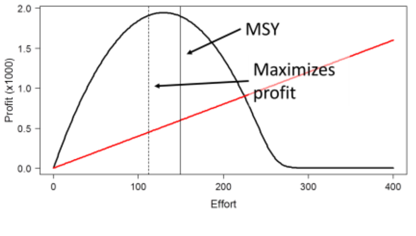


$F_{0.1}$

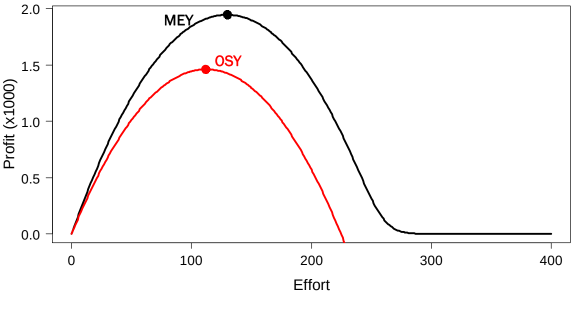


Optimal sustained yield (OSY)

Maximize difference between maximum economic yield and cost



MEY & OSY



Predicted biomass and roe yields