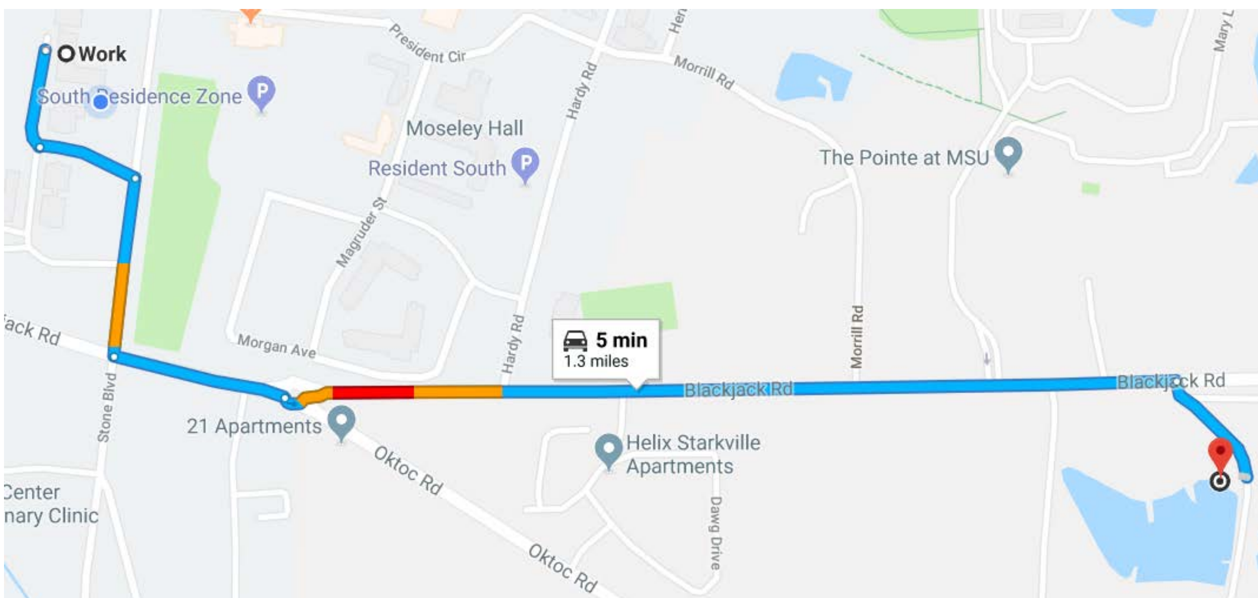
WF4313/6413-Fisheries Management

Class 16

Announcements

Don't forget that Dr. Neal is hosting a fishing day out at the Blackjack Ponds **THIS FRIDAY** (Nov. 2nd). We will have open fishing, a chance to teach others to fish, a fillet station, and we will be frying fish (so bring an appetite!). **If possible, please bring a few extra fishing rods that would be suitable for a novice fisherman, that you wouldn't mind sharing, to help out in case we don't have enough rods.**



AFS Meeting

- Our next meeting is scheduled for ***Wednesday, Nov. 7th!***

Percina crypta

Common Name: HALLOWEEN DARTER

Scientific Name: *Percina* crypta Freeman, Freeman, and Burkhead

https://georgiawildlife.com/sites/default/files/wrd/pdf/fact-sheets/halloween_darter-2008.pdf

Revised Schedule**

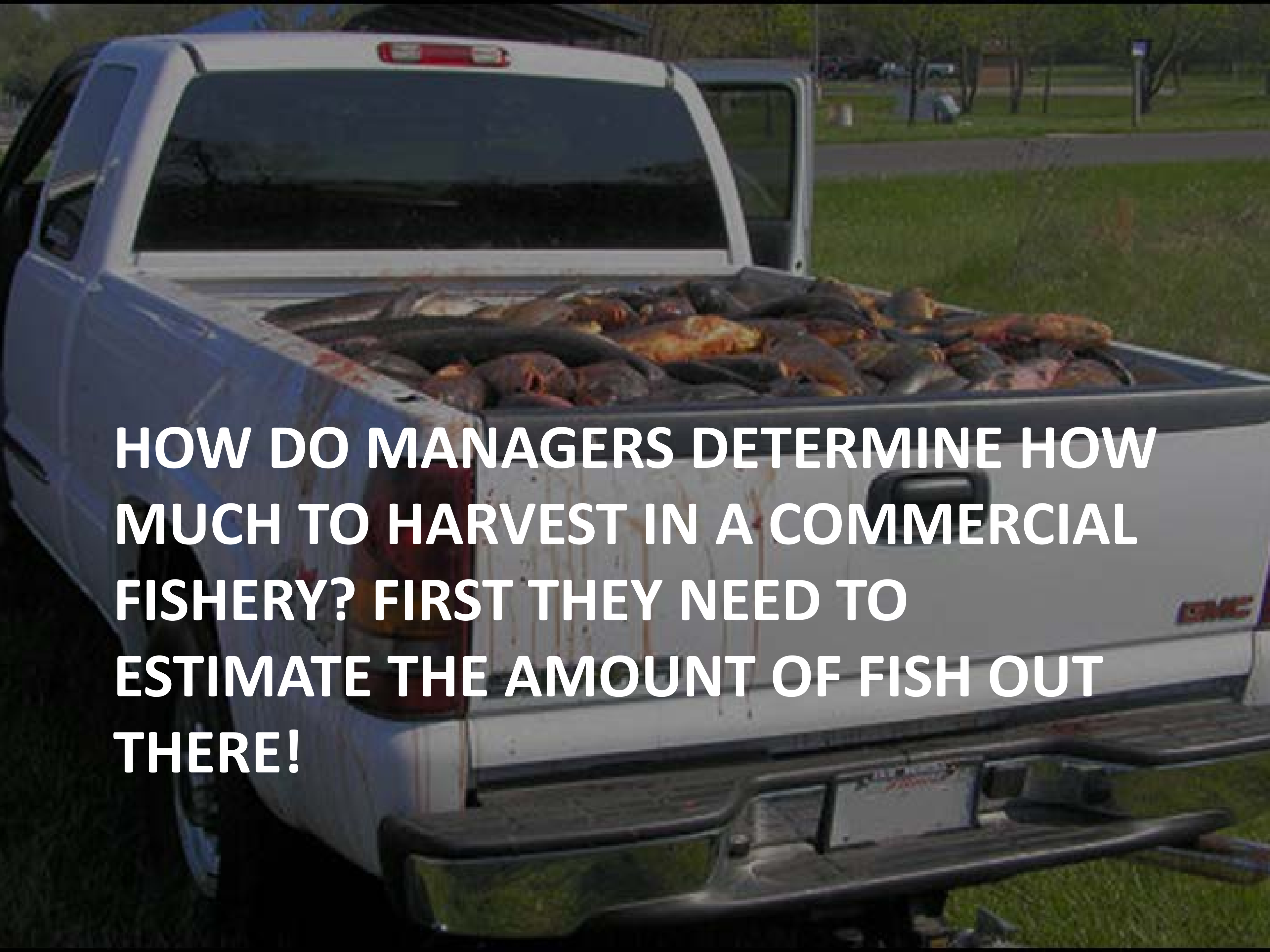
- ~~October 30 = Group 1 @ Panther Creek~~
- November 6th = Group 2 we'll do something
- November 13th = NO LAB… ☹
- Exam II = November 14th
- November 20th = Group 1 will do what group 2 did
- November 27th & December 4th ???

** Contingent on van availability

Lab 11/6

Interested in chasing more lamprey? Opportunities to assist on an undergraduate research project.

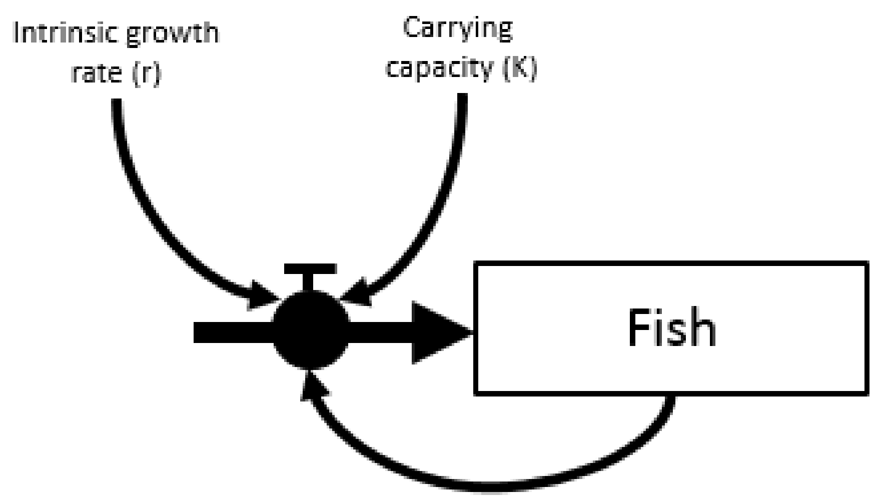
WHERE WE LEFT OFF


HOW DO MANAGERS DETERMINE HOW MUCH TO HARVEST IN A COMMERCIAL FISHERY? FIRST THEY NEED TO ESTIMATE THE AMOUNT OF FISH OUT THERE!

What do we need to figure out ho much to harvest?

What is in the biomass dynamics models?

1. States: Fish abundance & biomass
2. Parameters:
   1. Intrinsic growth rate
   2. Carrying capacity



Example of Lincoln Peterson Estimator

- Suppose you caught and tagged 948 crappie
- Then you caught 421 the next day of which 167 were tagged.

$$N = 2390 = \frac{421 \cdot 948}{167}$$

Biased

$$N = 2383 = \frac{(421+1)\cdot(948+1)}{167+1} - 1$$

Unbiased

>2 Occasions Schnabel Estimator

- For each sample t, the following is determined:
  - Ct = Total number of individuals caught in sample t
  - Rt = Number of individuals already marked (Recaptures) when caught in sample t
  - Mt = Number of marked animals in the population just before the sample is taken.
- Schnabel treated the multiple samples as a series of Lincoln-Peterson (L-P) samples and obtained a population estimate as a weighted average of the L-P estimates to estimate N:

$$N = SUM\ (Mt*Ct)\ /\ ((SUM\ Rt) + 1)$$

Capture-Recapture in practice more than 2 occasions

Suppose you go out 4 times to catch fish and your capture probability is 0.3. If there are 10,000 fish in the population the fish can be:

Captured ($p=0.3$) or not ($p=0.7$) on occasion 1

Captured ($p=0.3$) or not ($p=0.7$) on occasion 2

Captured ($p=0.3$) or not ($p=0.7$) on occasion 3

Captured ($p=0.3$) or not ($p=0.7$) on occasion 4

Capture histories of individuals

Capture History	Count
0000	24241
0001	10396
0010	10164
0011	4324
0100	10170
0101	4316
0110	4375
0111	1898
1000	10458
1001	4395
1010	4381
1011	1924
1100	4437
1101	1881
1110	1876
1111	764

Never captured → 0000

Capture history (1 is captured and 0 is not) → 0110

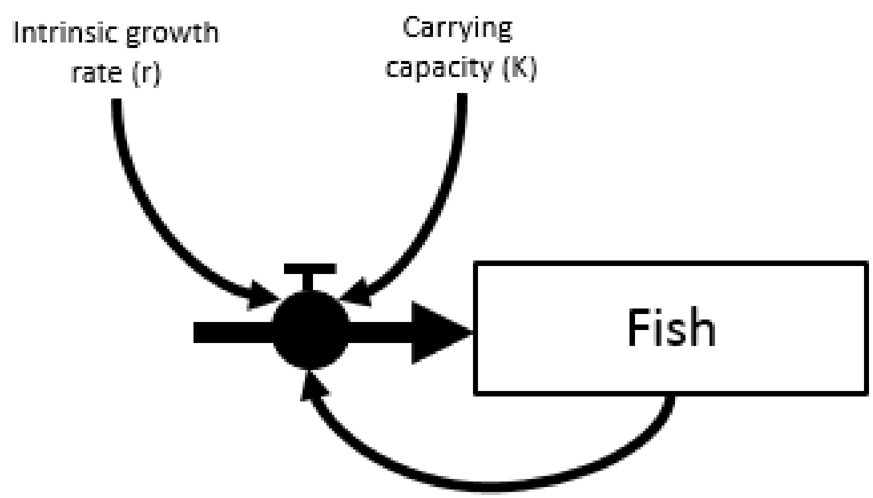
Captured every time → 1111

Adds up to 10,000

What do we need to figure out ho much to harvest?

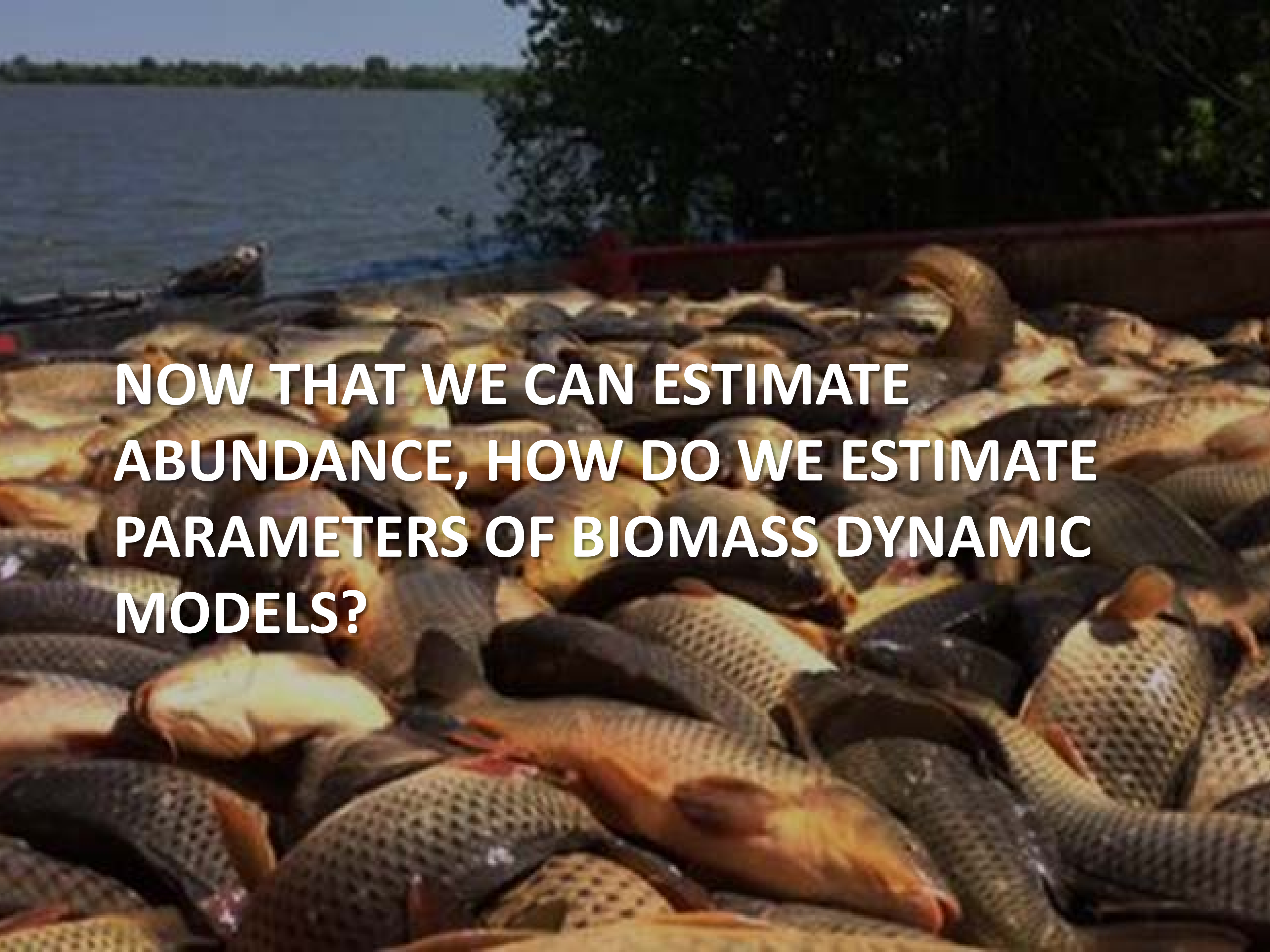
What is in the biomass dynamics models?

1. States: Fish abundance & biomass
2. Parameters:
   1. Intrinsic growth rate
   2. Carrying capacity



How do we estimate parameters?

We need time series of catch data to fit a model to!



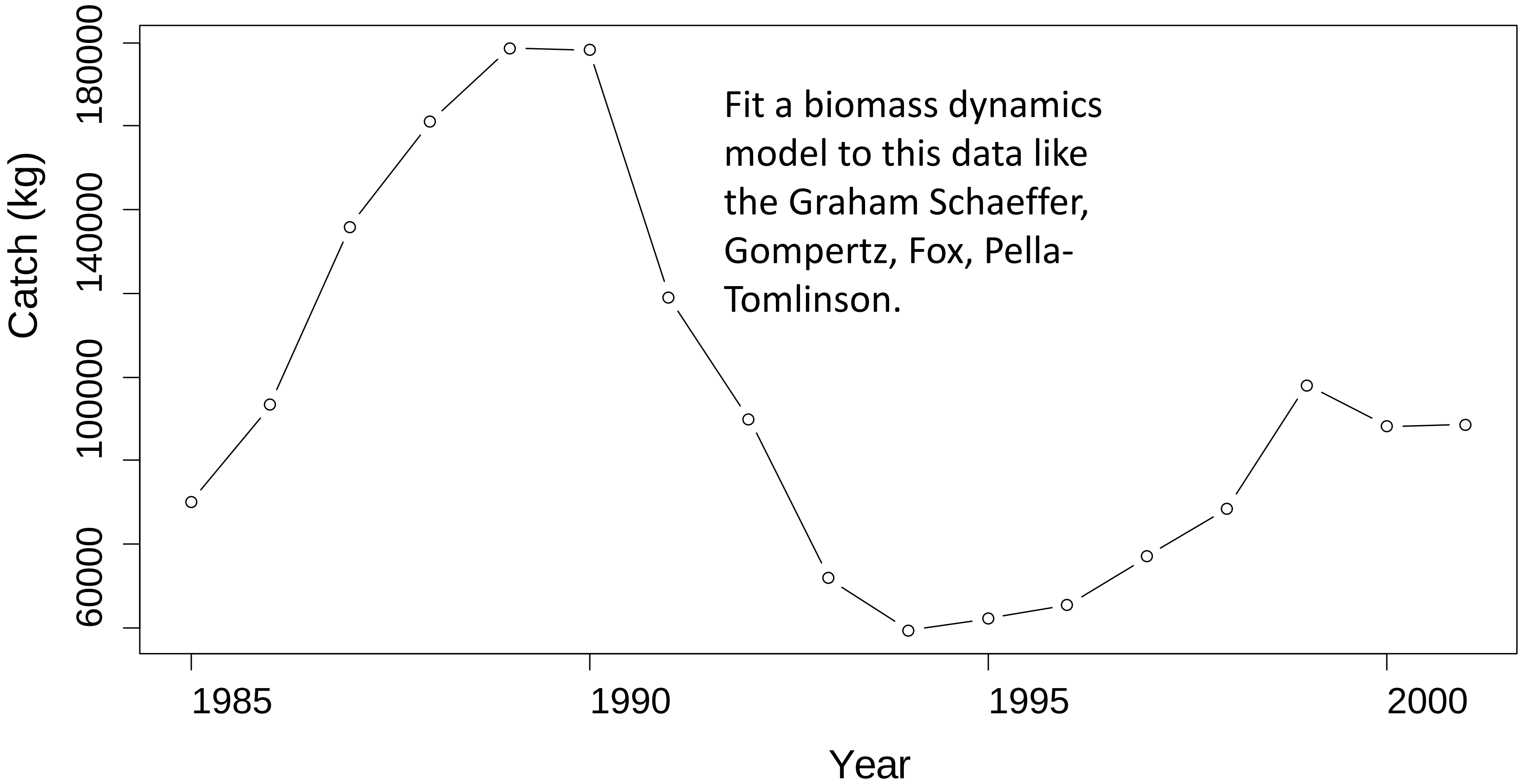
NOW THAT WE CAN ESTIMATE ABUNDANCE, HOW DO WE ESTIMATE PARAMETERS OF BIOMASS DYNAMIC MODELS?

Suppose we have data over time

year	effort	catch	cpe
1985	825	90000	109.09091
1986	1008	113300	112.40079
1987	1411	155860	110.46067
1988	1828	181128	99.08534
1989	2351	198584	84.46789
1990	2074	198395	95.65815
1991	1877	139040	74.07565
1992	1566	109969	70.22286
1993	1139	71896	63.12204
1994	893	59314	66.42105
1995	1029	62300	60.54422
1996	727	65343	89.88033
1997	658	76990	117.00608
1998	953	88606	92.97587
1999	1012	118016	116.61660
2000	1203	108250	89.98337
2001	1034	108674	105.10058

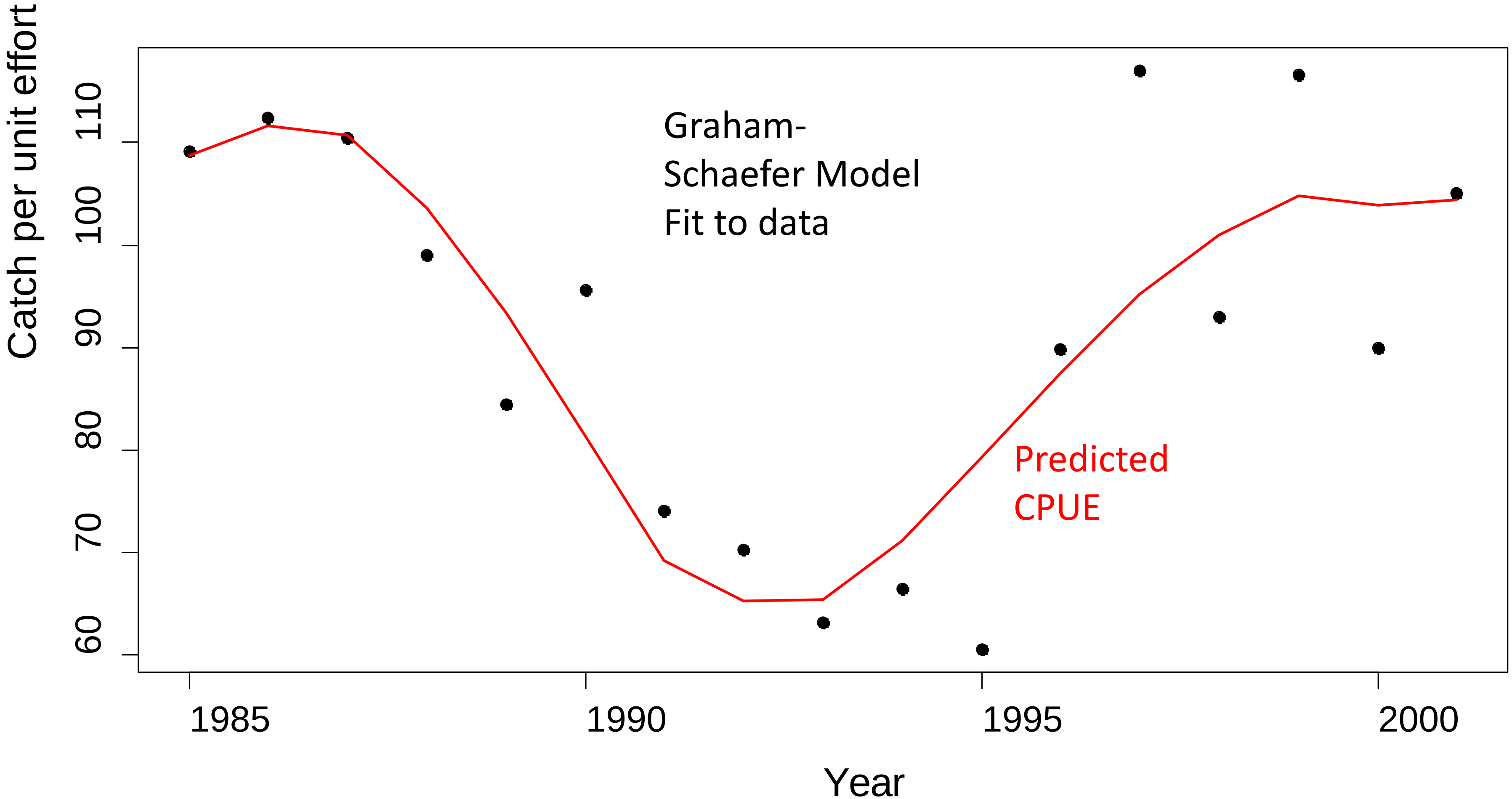
Catch/Effort (annotation pointing to the cpe column)

Catch data over time

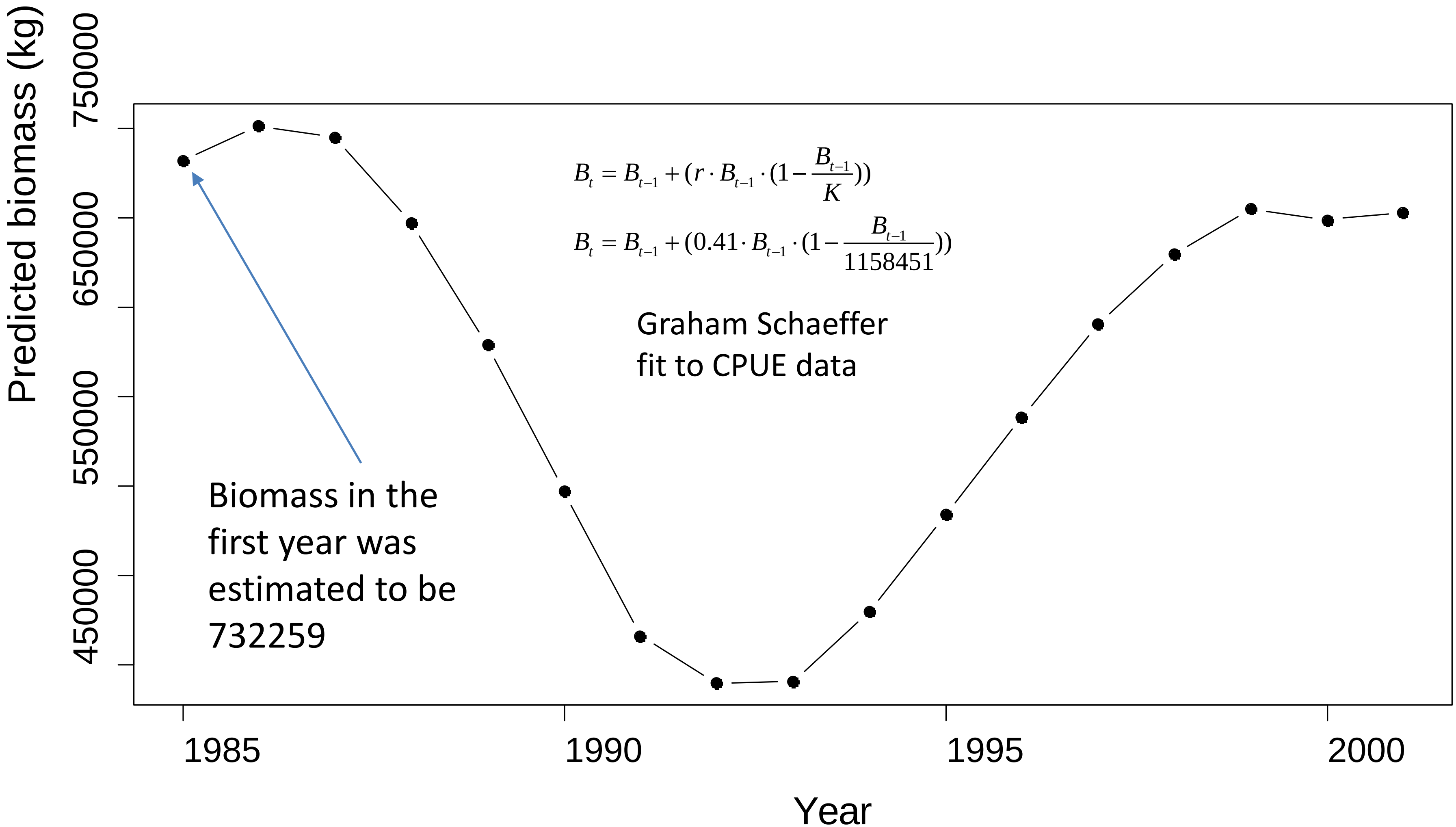


Fit a biomass dynamics model to this data like the Graham Schaeffer, Gompertz, Fox, Pella-Tomlinson.

CPUE and predicted CPUE



Predicted biomass dynamics

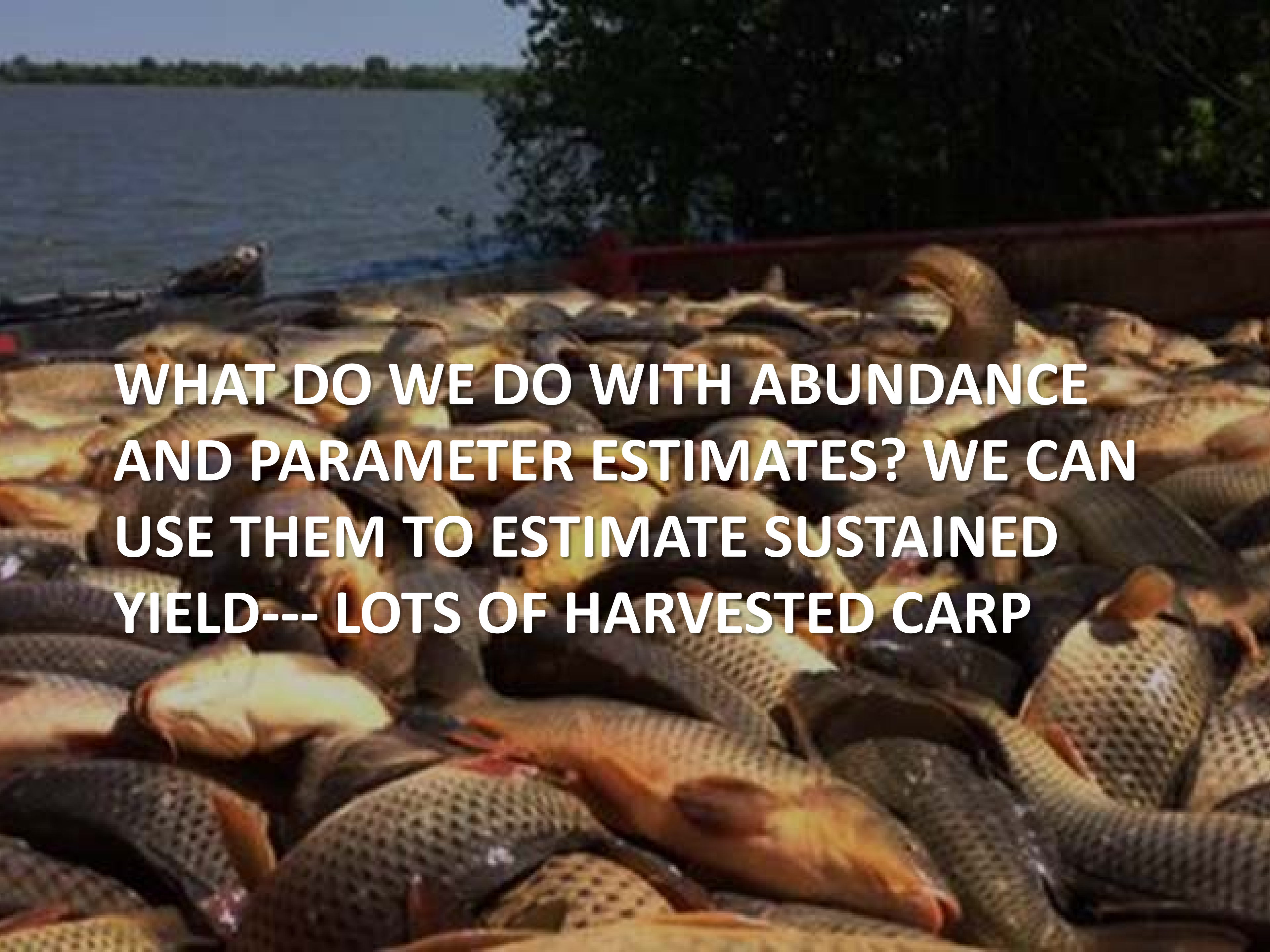


Using the fitted model we can predict the effect of varying fishing mortalities

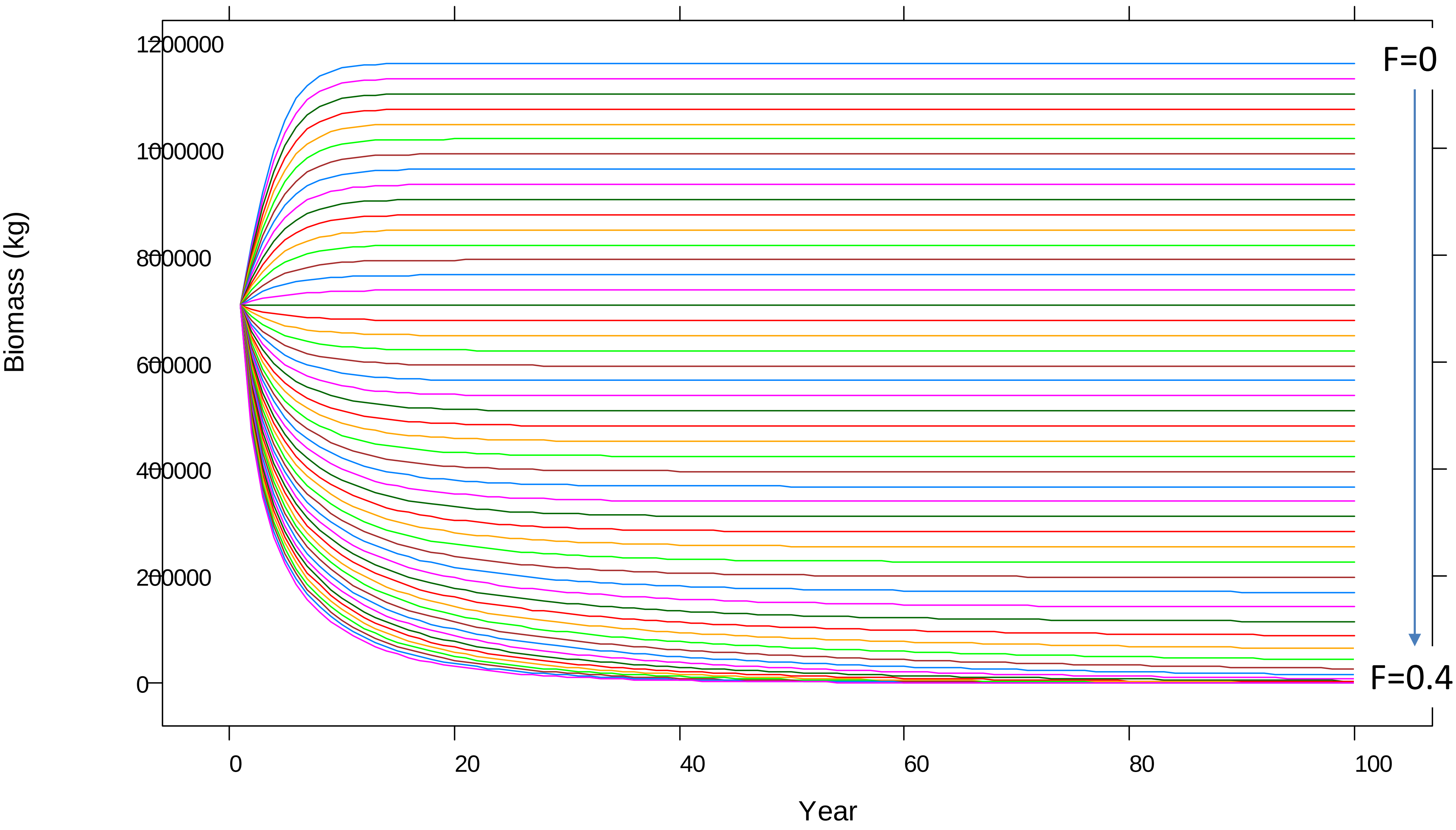
- Using the fitted model

$$B_t = B_{t-1} + (0.41 \cdot B_{t-1} \cdot (1 - \frac{B_{t-1}}{1158451})) - F \cdot B_{t-1}$$

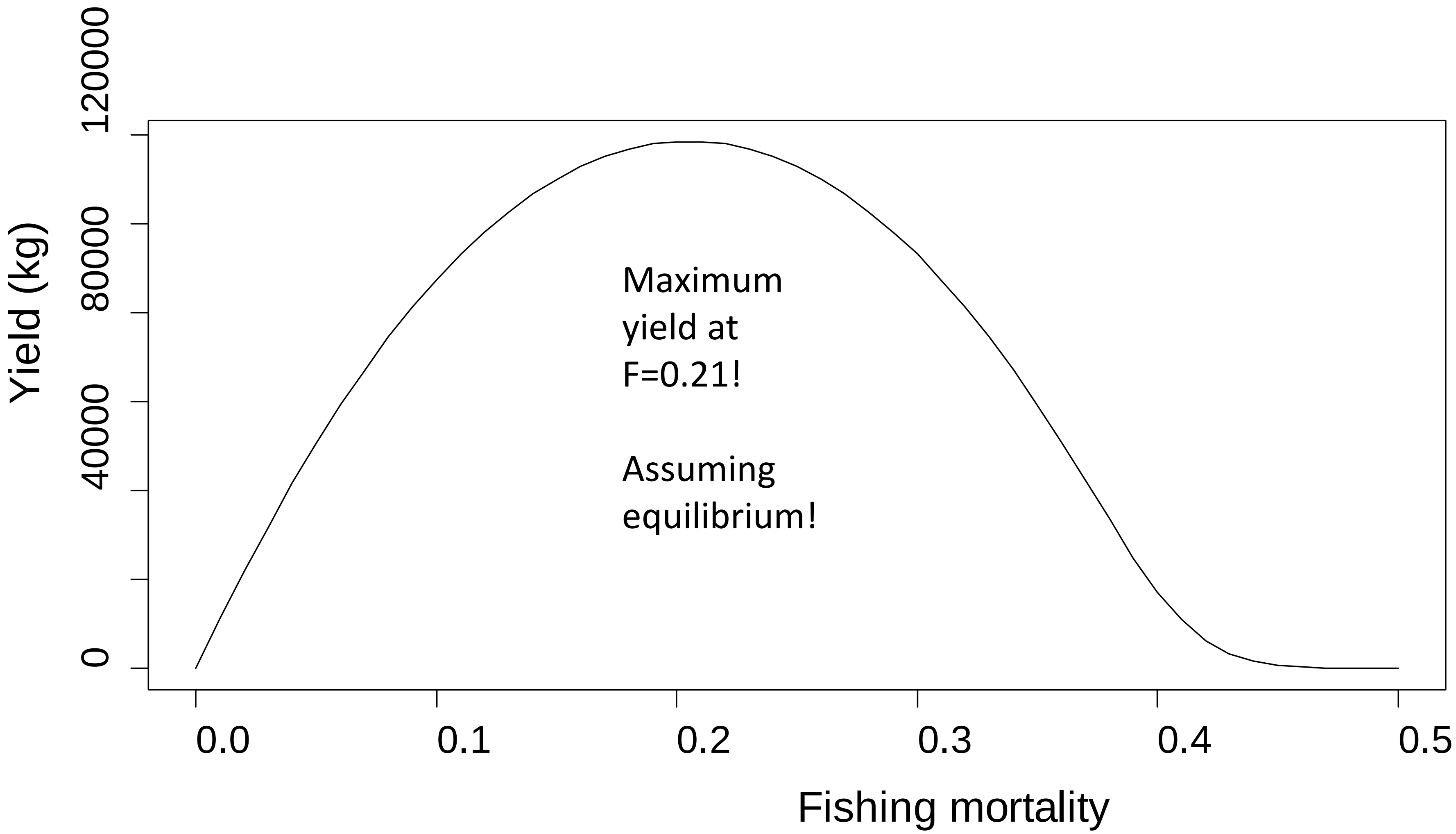
- And the estimated catchability 0.0001485687
- And CPUE in the previous year was 105
- The biomass is estimated as CPUE/q=B
- 105/0.0001485687=706743 kg of biomass


WHAT DO WE DO WITH ABUNDANCE AND PARAMETER ESTIMATES? WE CAN USE THEM TO ESTIMATE SUSTAINED YIELD--- LOTS OF HARVESTED CARP

Biomass dynamics given 706743 kg of biomass!



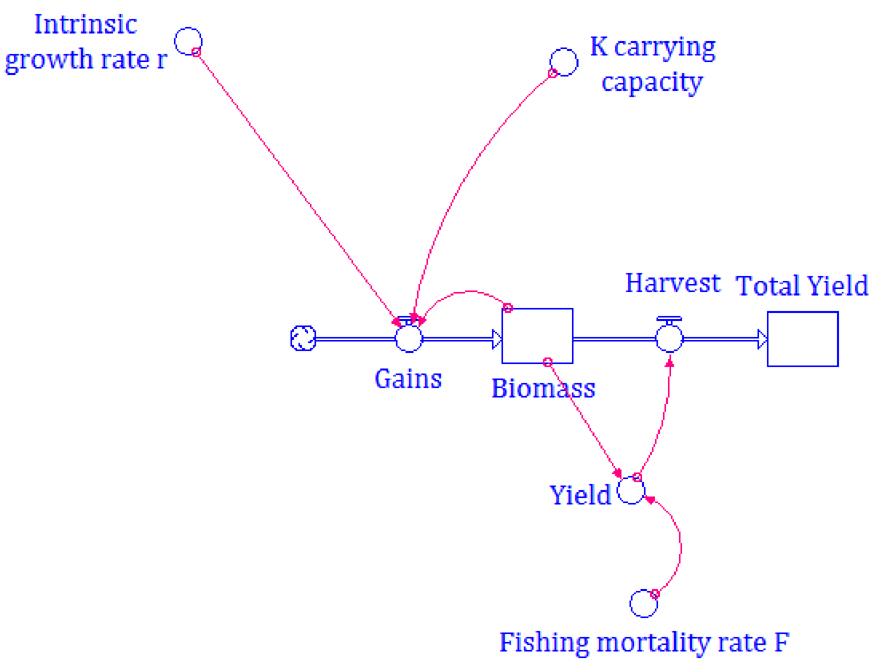
Equilibrium sustained yield

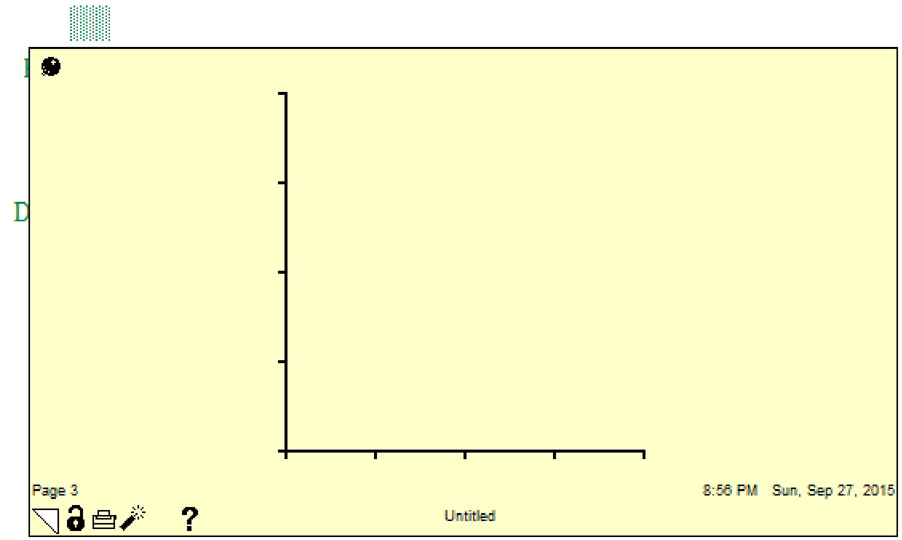


Why is this important?

- Most harvest model evaluate equilibrium yield!
- **We should harvest 706743*0.21=148416 kg**
- But it assumes equilibrium which can mess with dynamics if equilibrium is violated.
- Why? Lets explore this!

Biomass dynamics

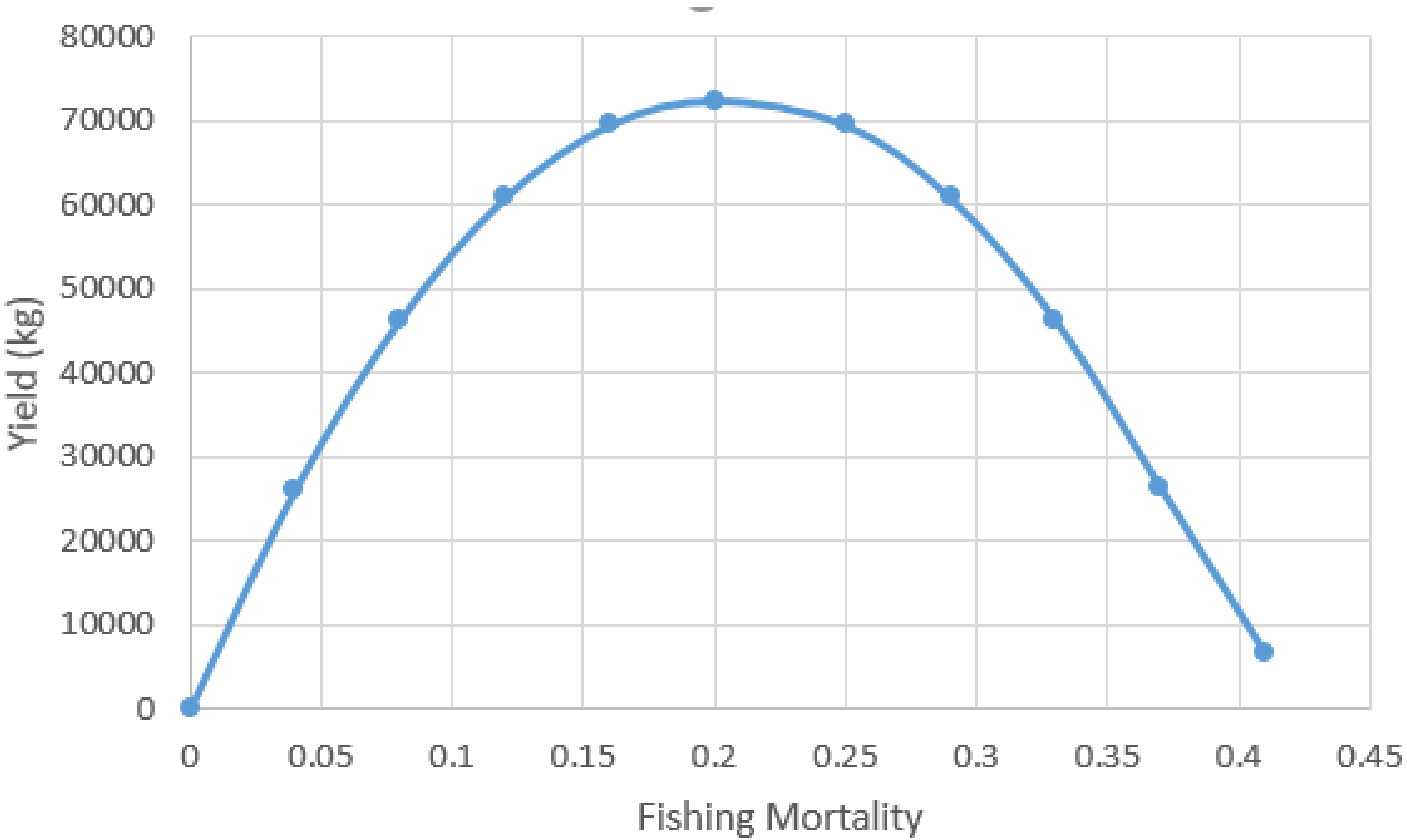




8:56 PM 9/27/2015 Data Table 1: p3 (Annual yield)

Years	1: Yield		

Equilibrium conditions

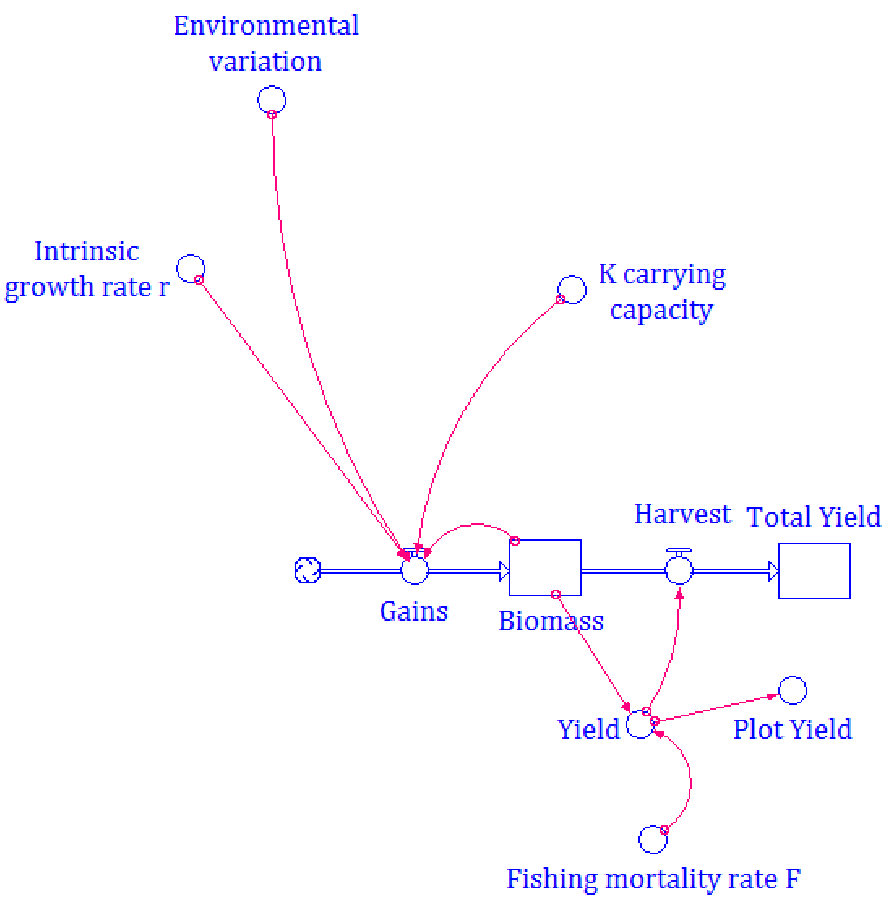


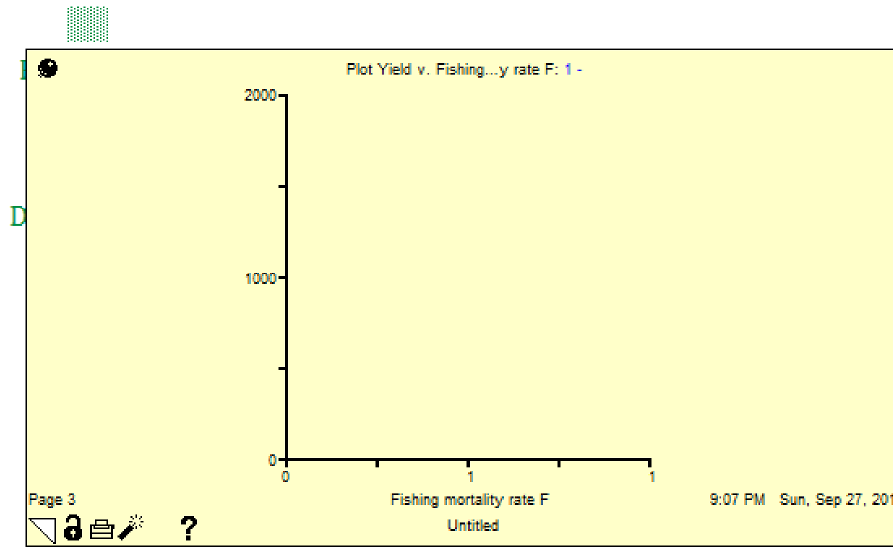
Biomass dynamics model assumptions

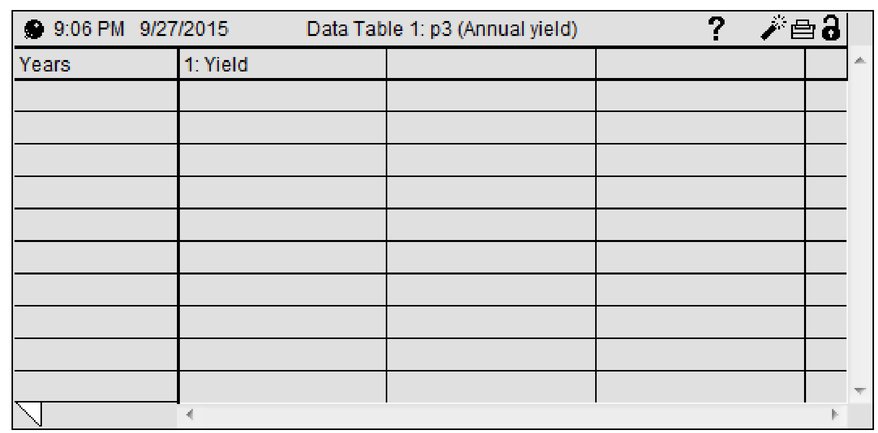
- Rates are constant
- Parameters are constant

Lets explore these

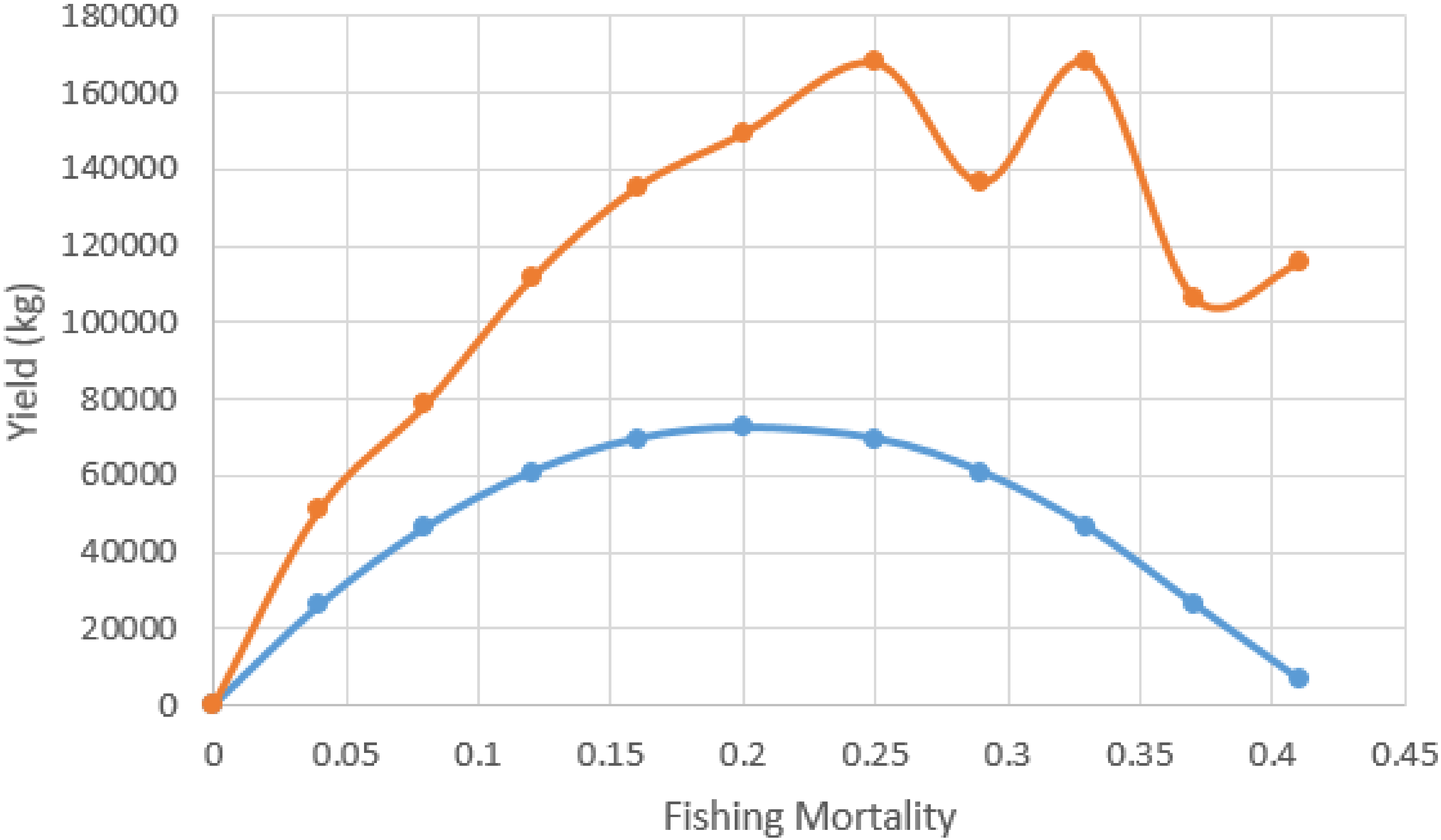
Varying carrying capacity



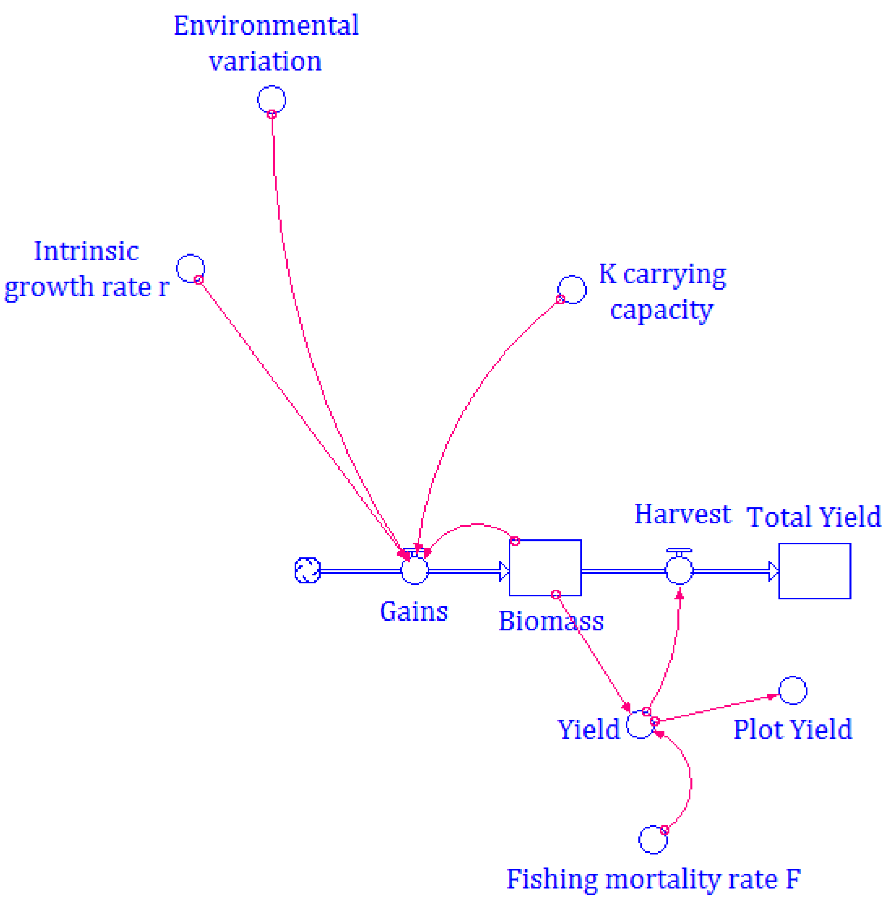


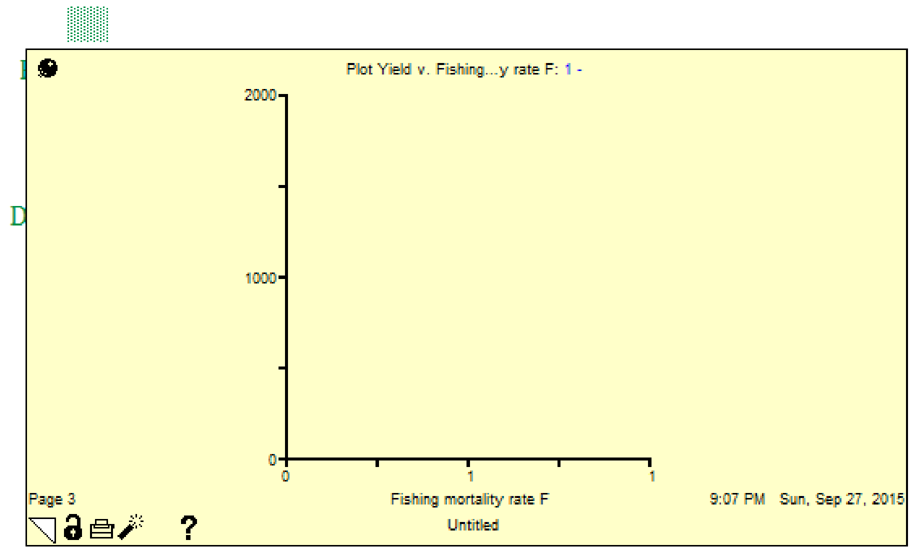


Variation in carrying capacity



Varying intrinsic growth rates

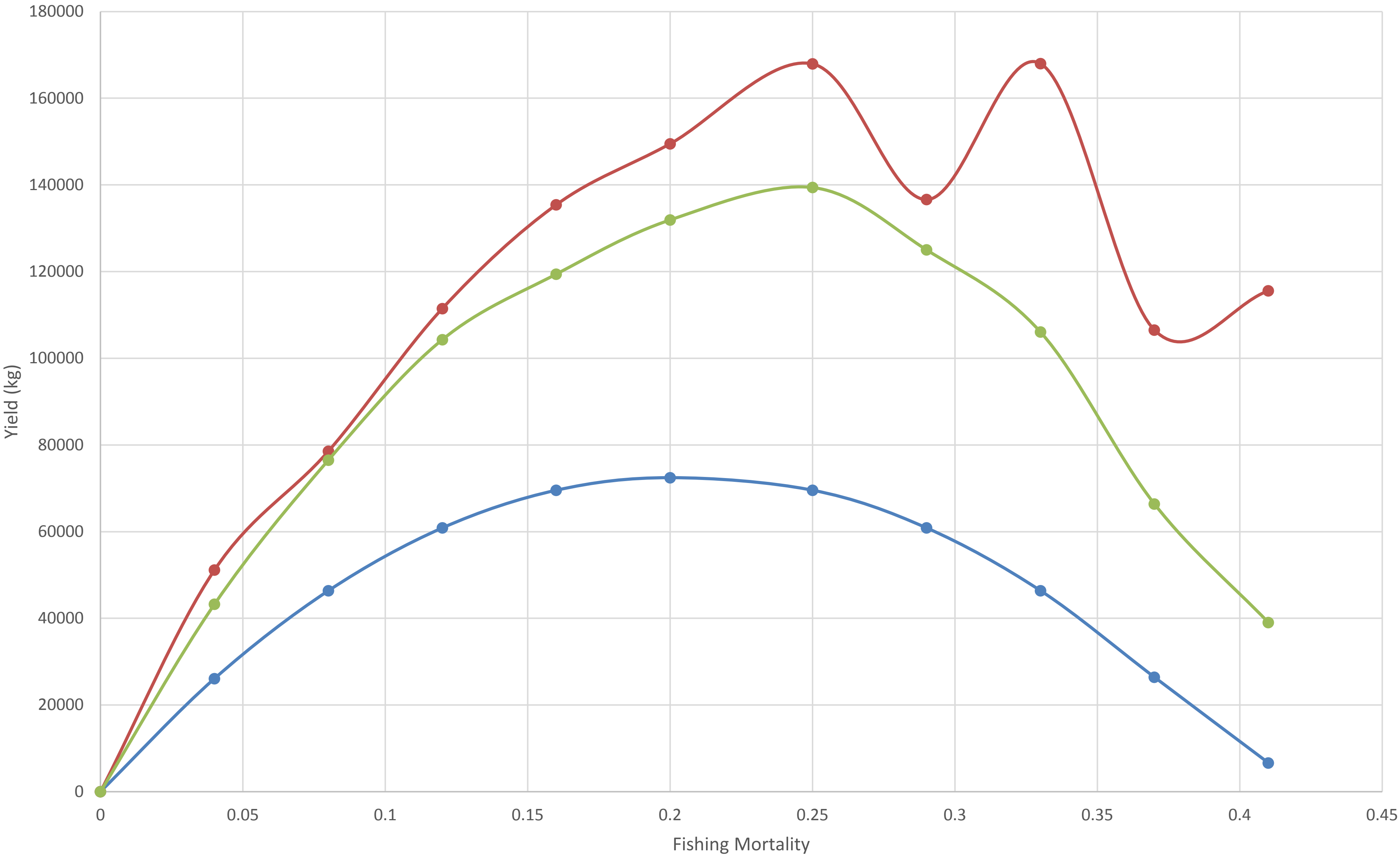




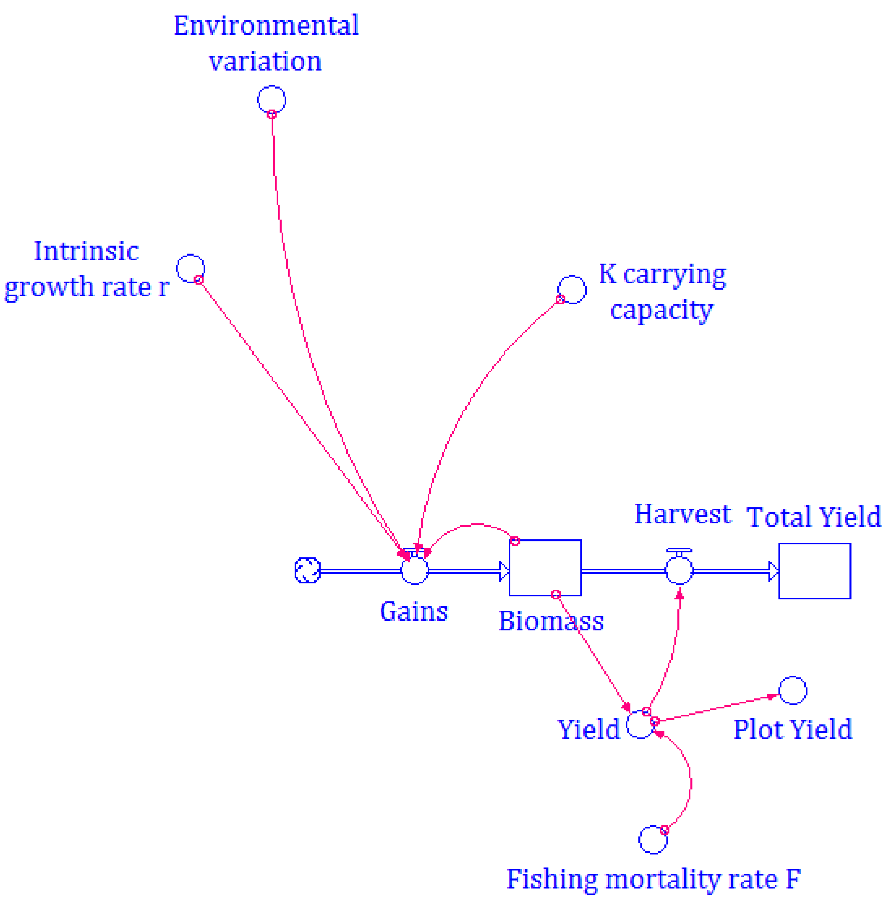
9:06 PM 9/27/2015 Data Table 1: p3 (Annual yield)

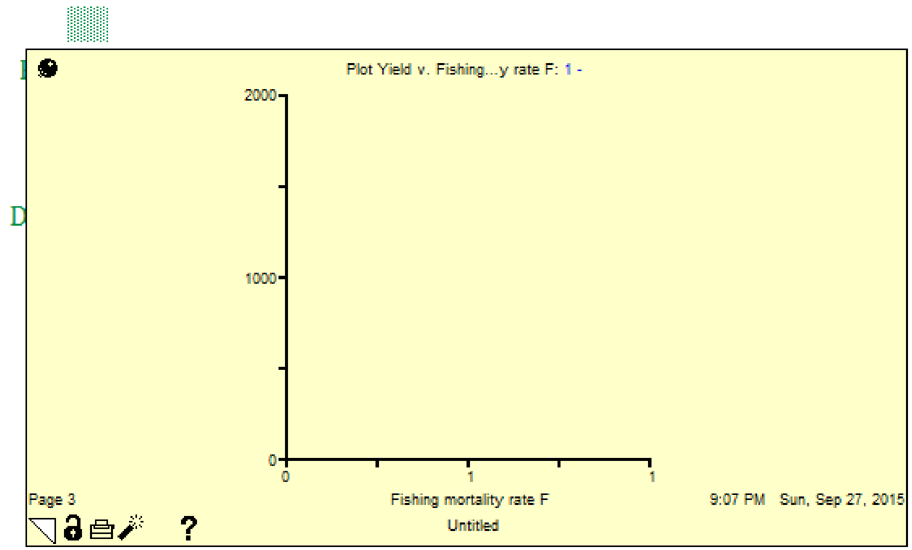
Years	1: Yield		

Variable r


180000
160000
140000
120000
100000
80000
60000
40000
20000
0
Yield (kg)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
Fishing Mortality

Variable K and r?

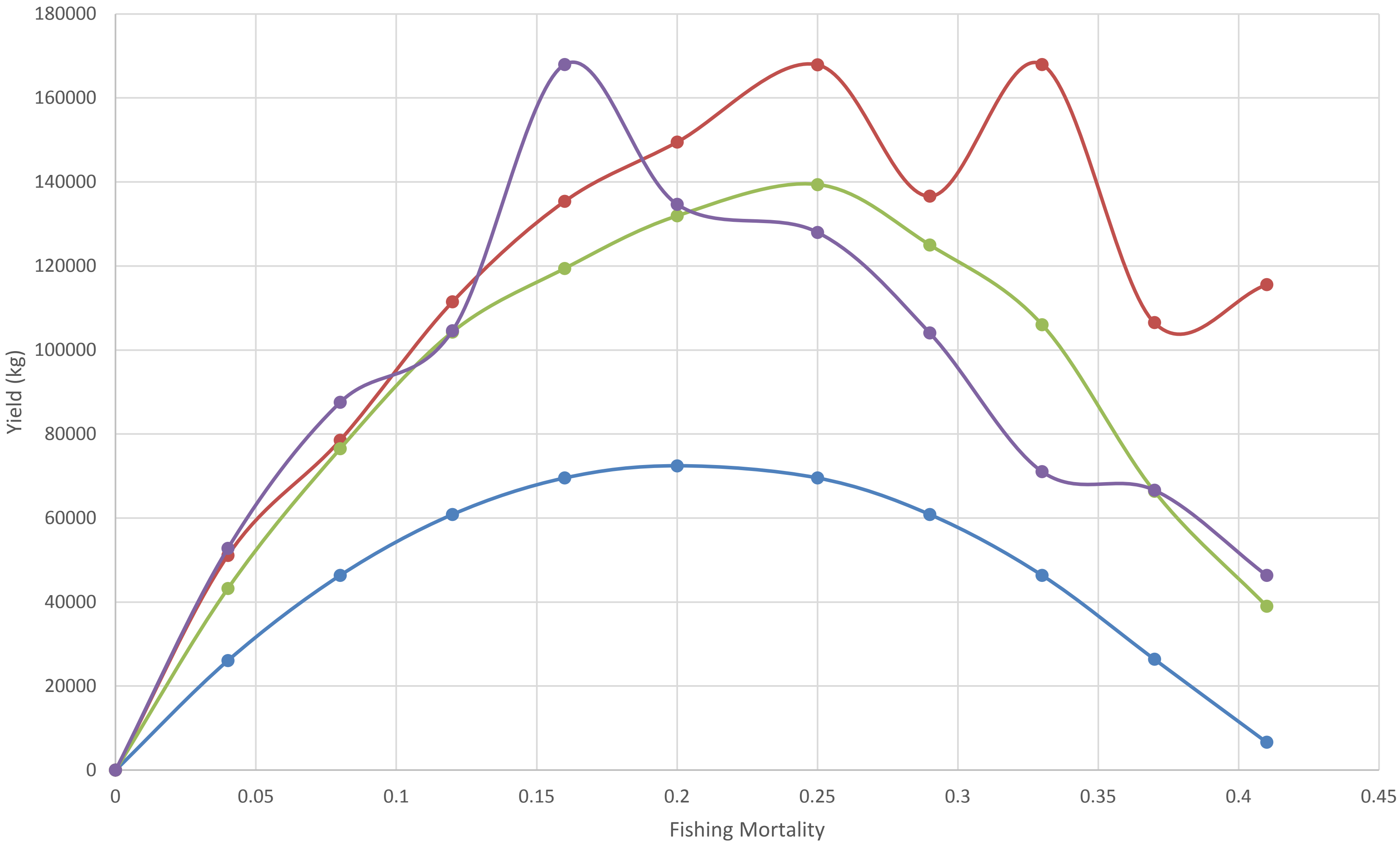




9:06 PM 9/27/2015 Data Table 1: p3 (Annual yield)

Years	1: Yield		

Variable r and K



Managing biomass yield of aquatic resources is not easy!

Dealing with these issues

- Precautionary approach
- Abandon MSY

Epitaph for MSY

TRANSACTIONS of the AMERICAN FISHERIES SOCIETY

January 1977

VOLUME 106

NUMBER 1

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

P. A. LARKIN

Institute of Animal Resource Ecology, University of British Columbia
Vancouver, British Columbia V6T 1W5

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

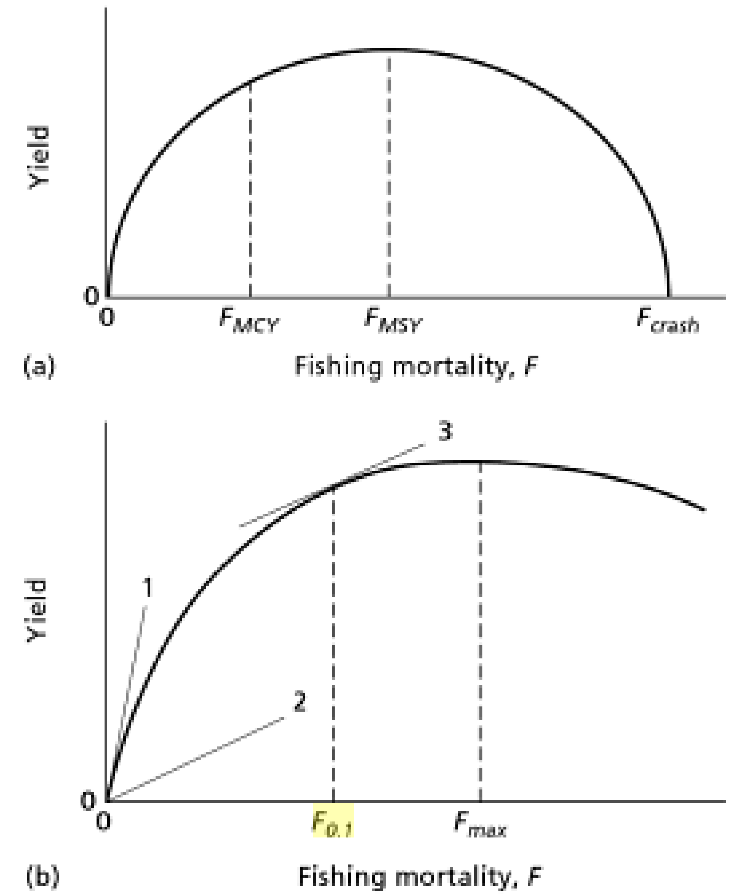
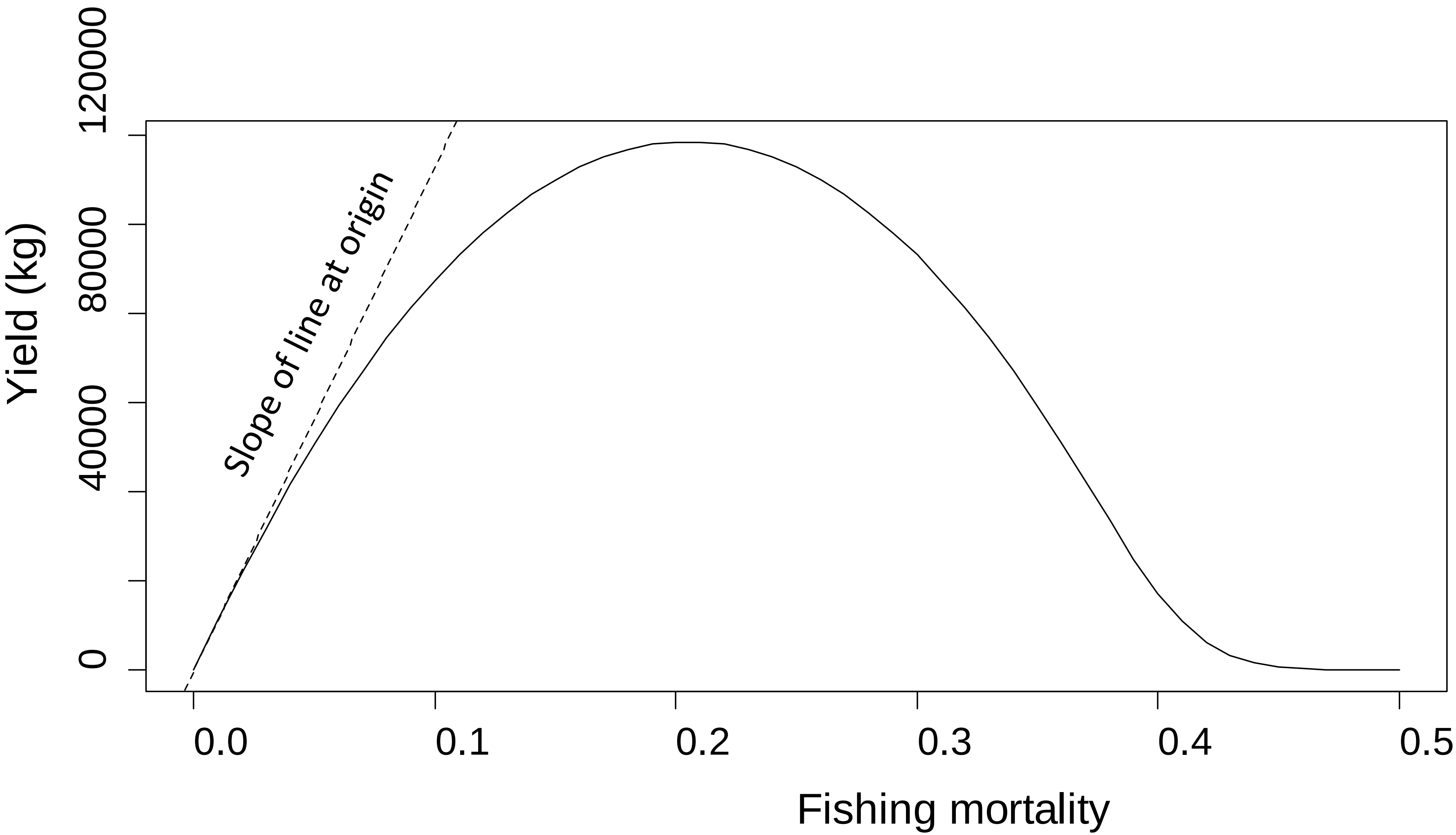
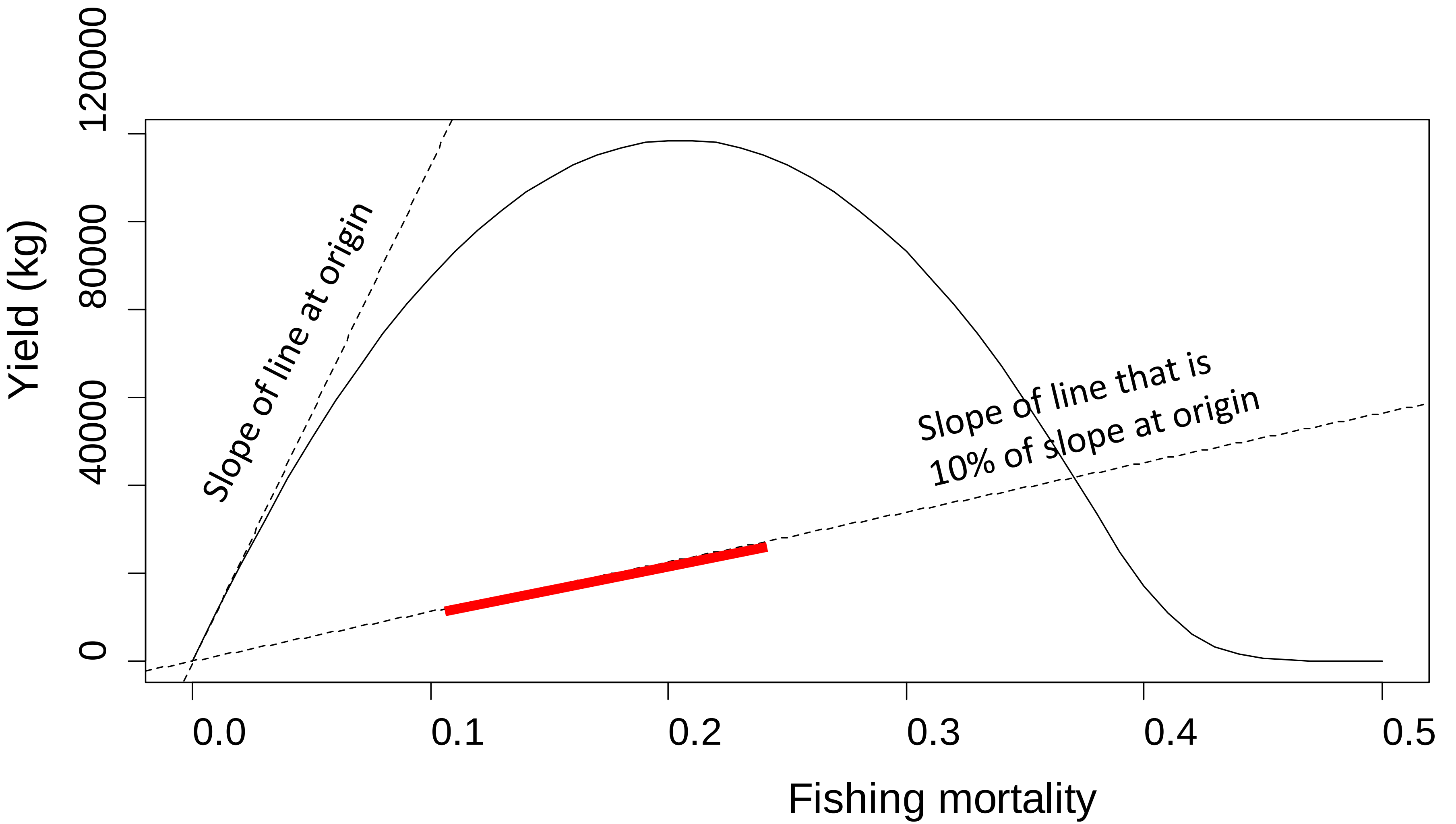


Fig. 7.20 Biological reference points. (a) Surplus production model; (b) yield-per-recruit model. $F_{0.1}$ is found by following the numbered steps indicated: (1) find slope at origin; (2) plot line with 10% of this slope; (3) find tangent to curve at this slope.

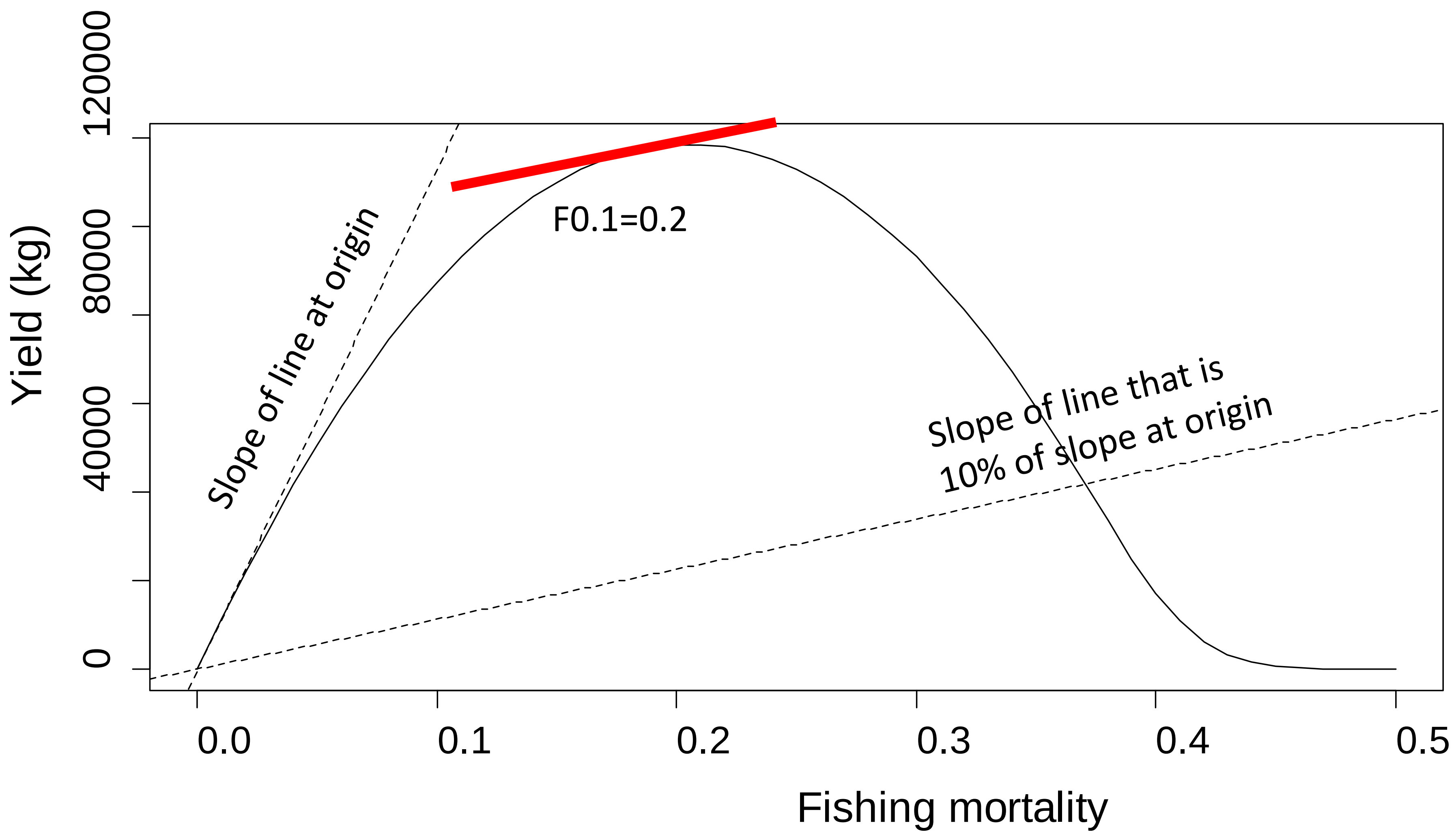
Slope at origin



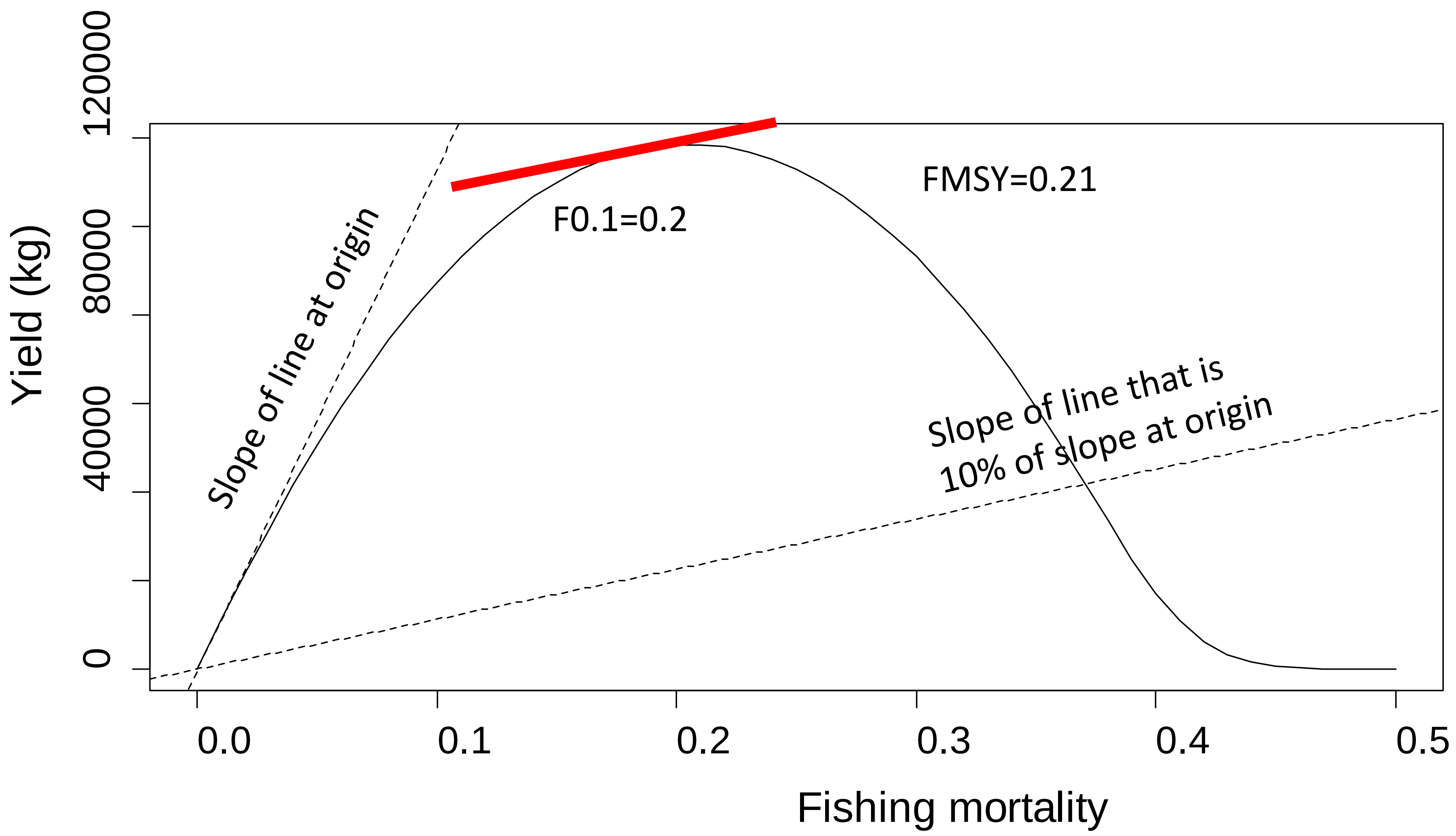
10% of slope at origin



10% of slope at origin



10% of slope at origin



F0.1 = 0.2

- Reduces harvest amount
- **FMSY: 706743*0.21=148416 kg**
- **F0.1: 706743*0.20=141348 kg (~5% reduction)**
- Why does F0.1 make sense?

Continuous harvest?

Finfish

Mississippi Red Snapper 2015

All vessels (private and for-hire) landing Red Snapper in Mississippi must use the Tails n' Scales electronic reporting system regardless of harvest area (federal waters, Mississippi state waters, adjacent states' waters, etc.) There are no exemptions. Mississippi Department of Marine Resources (MDMR) requires one report per trip per vessel.

The federal Red Snapper season begins on Monday, June 1st and ends on Wednesday, June 10th for recreational anglers. The Mississippi Red Snapper season begins on Thursday July 16th and ends on Saturday October 31st. The Commission on Marine Resources gave the MDMR Executive Director, Jamie Miller, the authority to establish supplemental state seasons.

During the 2015 season a trip authorization number must be obtained by a representative of each vessel prior to recreationally fishing for Red Snapper. Trip authorization numbers are only valid for 24 hours and must be closed out each time before a new trip number will be issued.

Registering, obtaining trip authorization numbers, and reporting harvest are easy and can be done using any of the methods listed below.

Free Downloadable App: **Tails n' Scales**

Continuous harvest?

Semidiscrete biomass dynamic modeling: an improved approach for assessing fish stock responses to pulsed harvest events

Michael E. Colvin, Clay L. Pierce, and Timothy W. Stewart

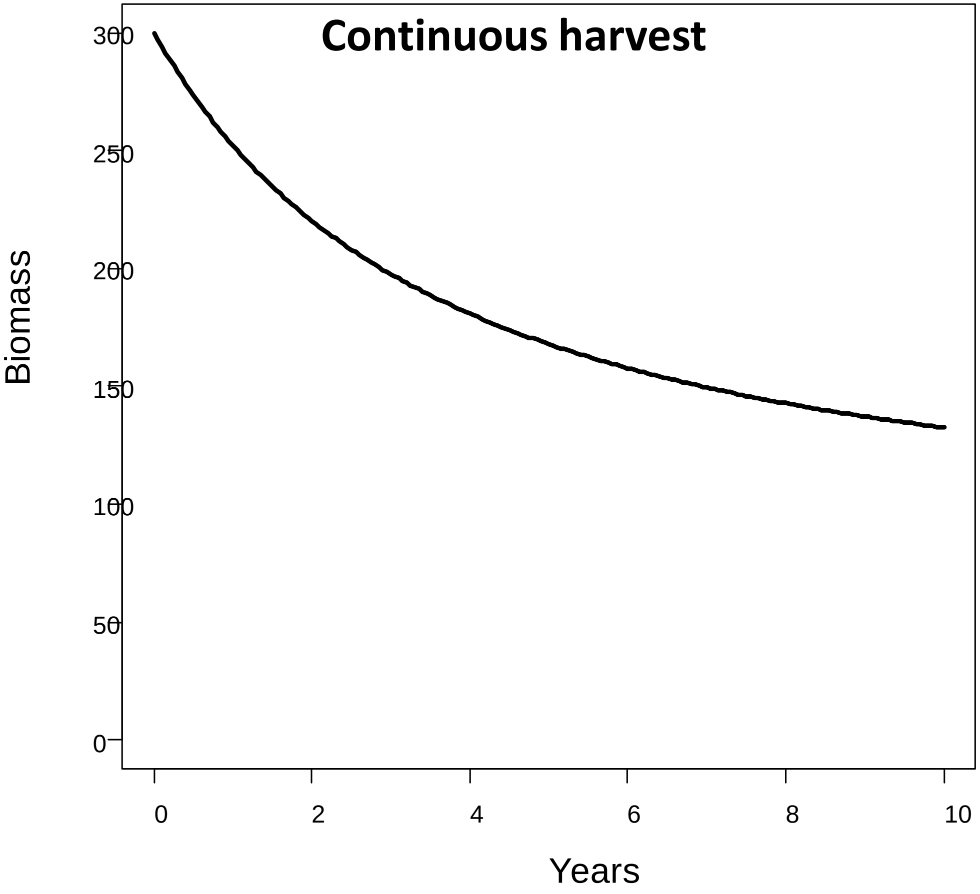
Abstract: Continuous harvest over an annual period is a common assumption of continuous biomass dynamics models (CBDMs); however, fish are frequently harvested in a discrete manner. We developed semidiscrete biomass dynamics models (SDBDMs) that allow discrete harvest events and evaluated differences between CBDMs and SDBDMs using an equilibrium yield analysis with varying levels of fishing mortality (F). Equilibrium fishery yields for CBDMs and SDBDMS were similar at low fishing mortalities and diverged as F approached and exceeded maximum sustained yield (F_{MSY}). Discrete harvest resulted in lower equilibrium yields at high levels of F relative to continuous harvest. The effect of applying

Colvin, M.E., Pierce, C.L., Stewart, T.W., 2012. Semidiscrete biomass dynamic modeling: an improved approach for assessing fish stock responses to pulsed harvest events. Canadian Journal of Fisheries and Aquatic Sciences 69, 1710-1721.

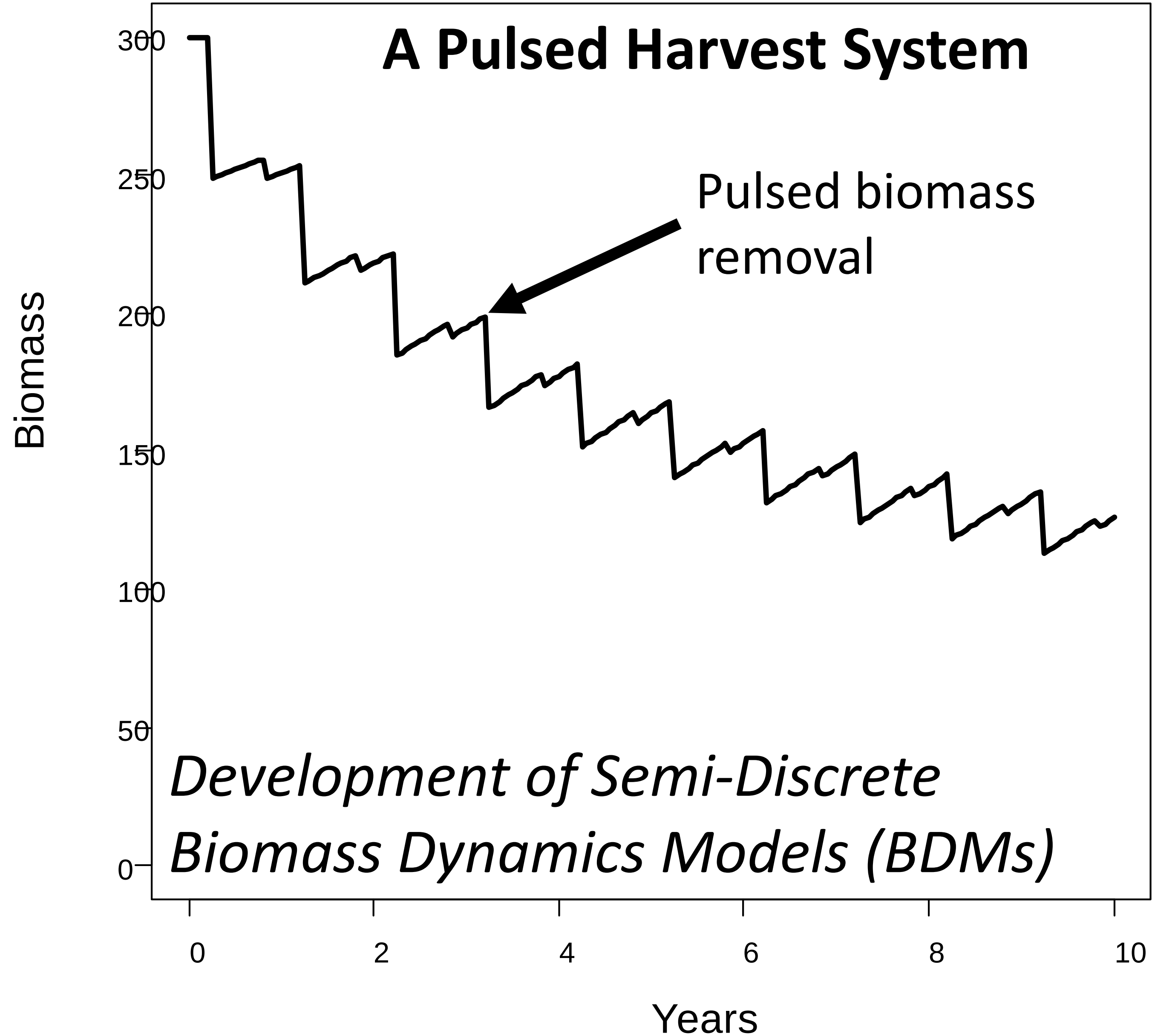
Traditional biomass models

- Assumes harvest occurs continuously
- Biomass models guide stock management
- Pulsed harvest?

Does assuming continuous harvest make a difference?

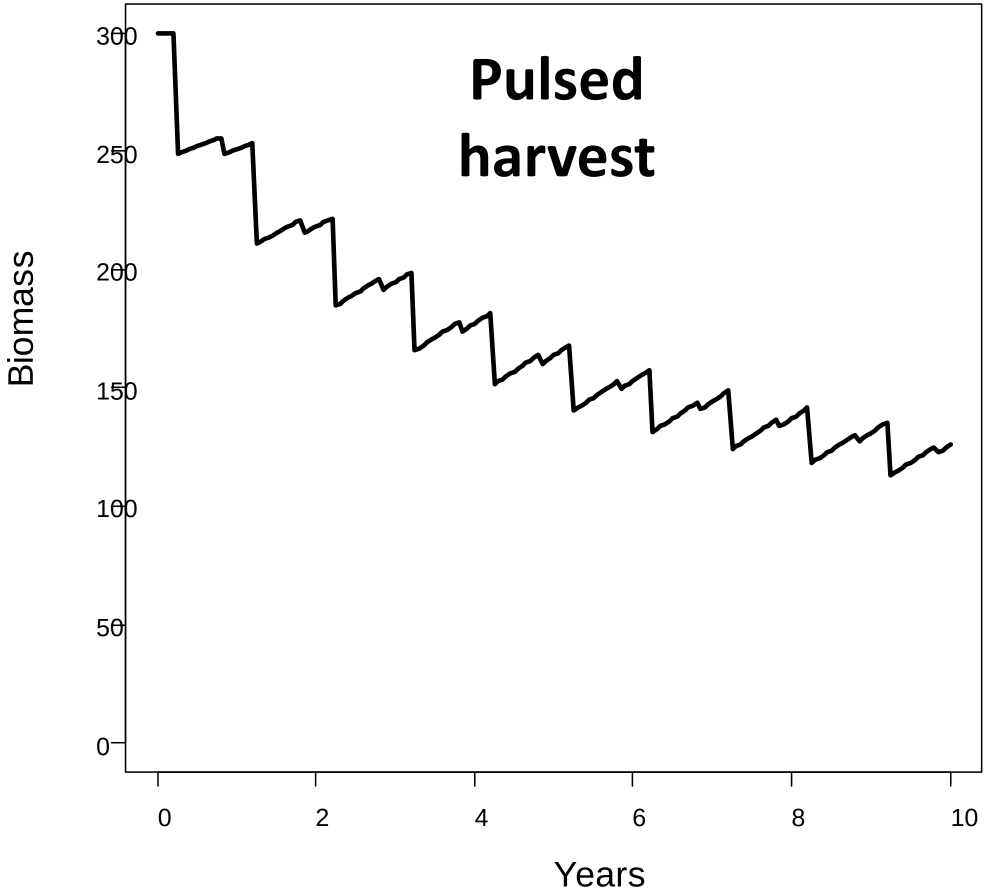


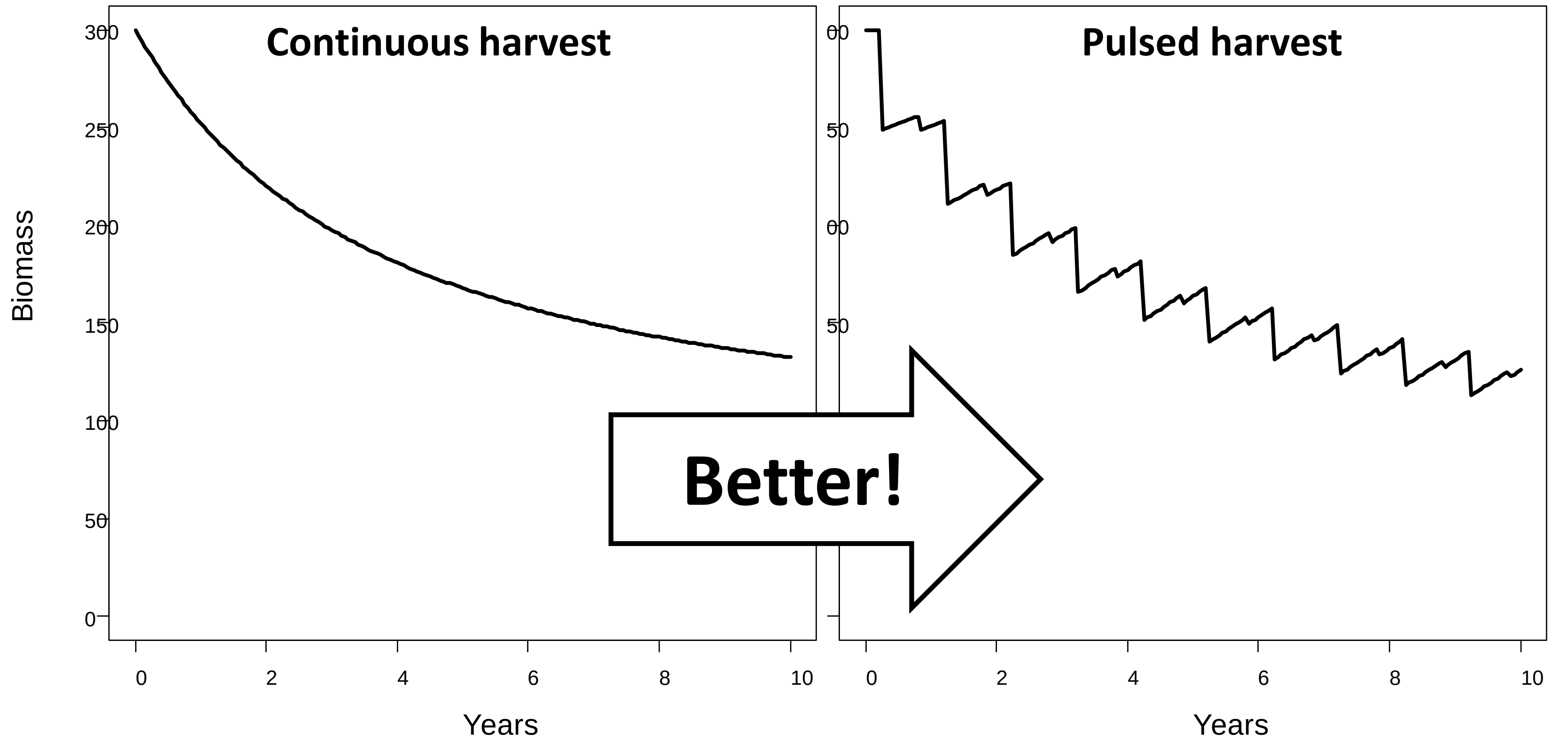
Pulsed harvest & biomass dynamics



Semi-discrete models

- Hybrid class of models that allow pulsed events in continuous time
- Continuous processes
  - intrinsic growth rate
- Pulsed harvest





Can biomass dynamics models be improved by accounting for pulsed harvests? YES

Equilibrium sustained yields

Assuming continuous harvest over estimates MSY!