WF4313/6413-Fisheries Management

Class 9

In the news & announcements

Refining Crappie (*Pomoxis spp.)* Aquaculture Techniques

Christian Shirley, M.S. candidate

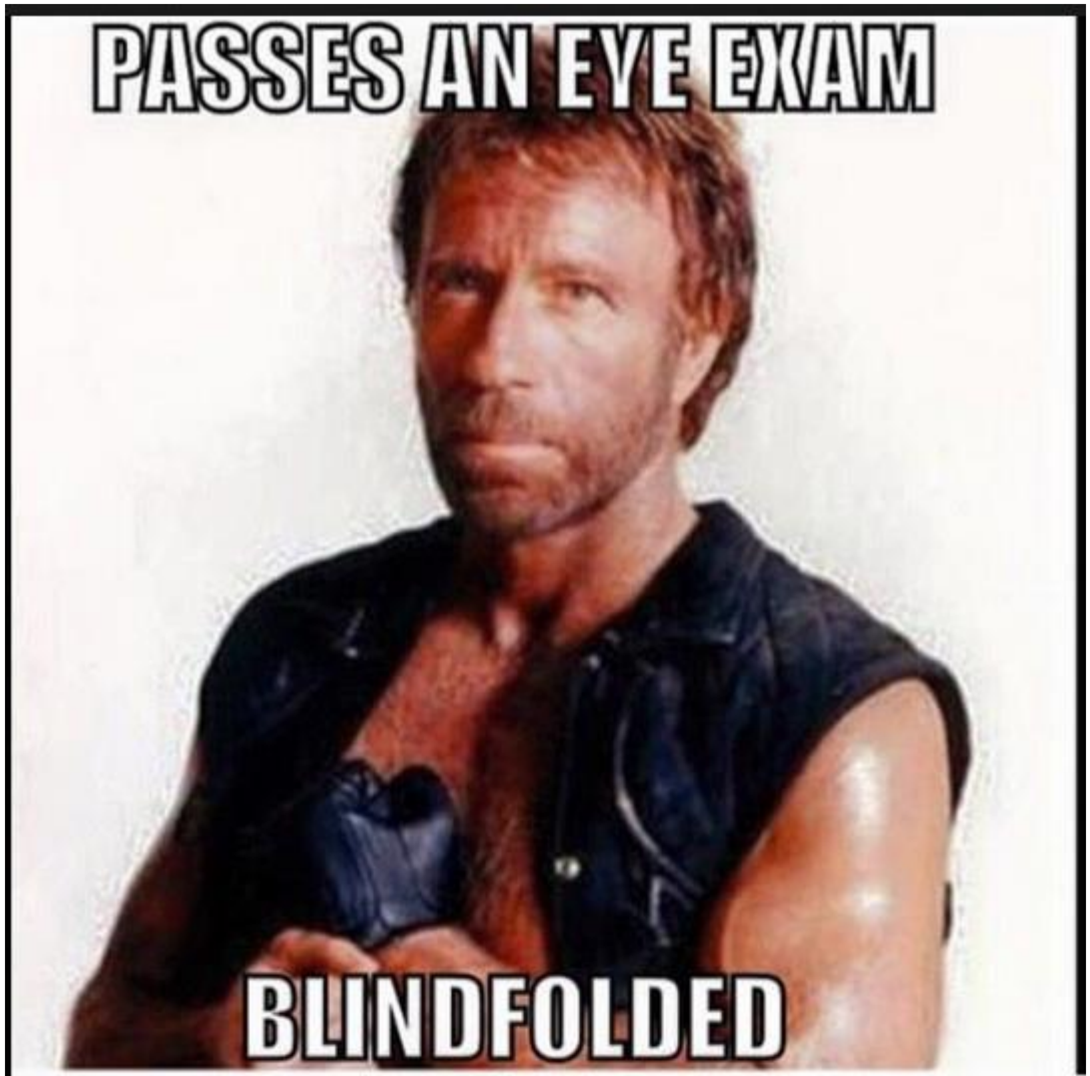
Thesis seminar

Department of Wildlife, Fisheries and Aquaculture

September 26, 2018 12:30 p.m.

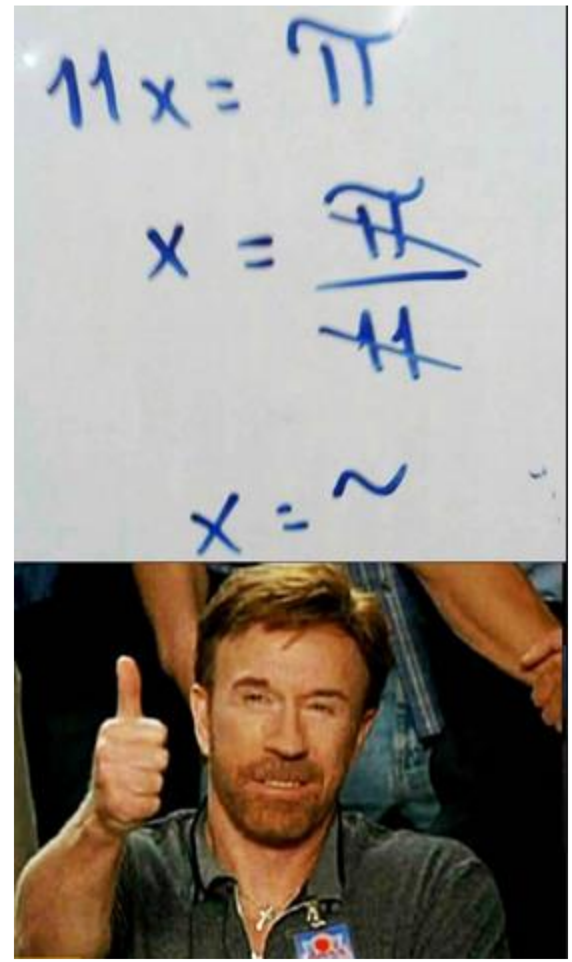
Tully Auditorium

Exam 1: Monday October 1st @ 8am



Some things to consider

- Do not memorize equations
- Know how to interpret a graph (e.g., length-weight, age-length).
- If you see things on slides in several places it is likely important!



FW4313 Fisheries Management Exam I September XXth, 20XX
Name: ____________________________

Print your name at the top of each page (1 point deduction of you do not). Answer each question clearly and concisely. If you need additional space, please use the back of the exam. Make sure that your answers are clearly marked. You have a maximum of 50 minutes to complete the exam. This exam is worth a total of 125 points.

Remember to abide by the Mississippi State University Honor Code at all times.

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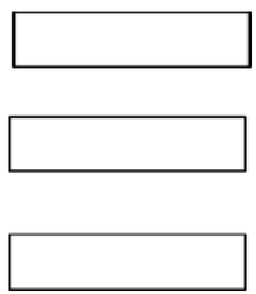
1) Circle the most correct answer below. What is part of the conceptual process of fisheries management? (2 point)
   a) Internet marketing
   b) Fishing license sales
   c) Decision making
   d) Fish sampling

2) Circle the most correct answer below. What is a necessary component of fisheries management? (2 point)
   a) Fishing
   b) Trophy fish
   c) Total angler satisfaction
   d) Allocation of resources

3) Is monitoring fish fishery management? (2 point)

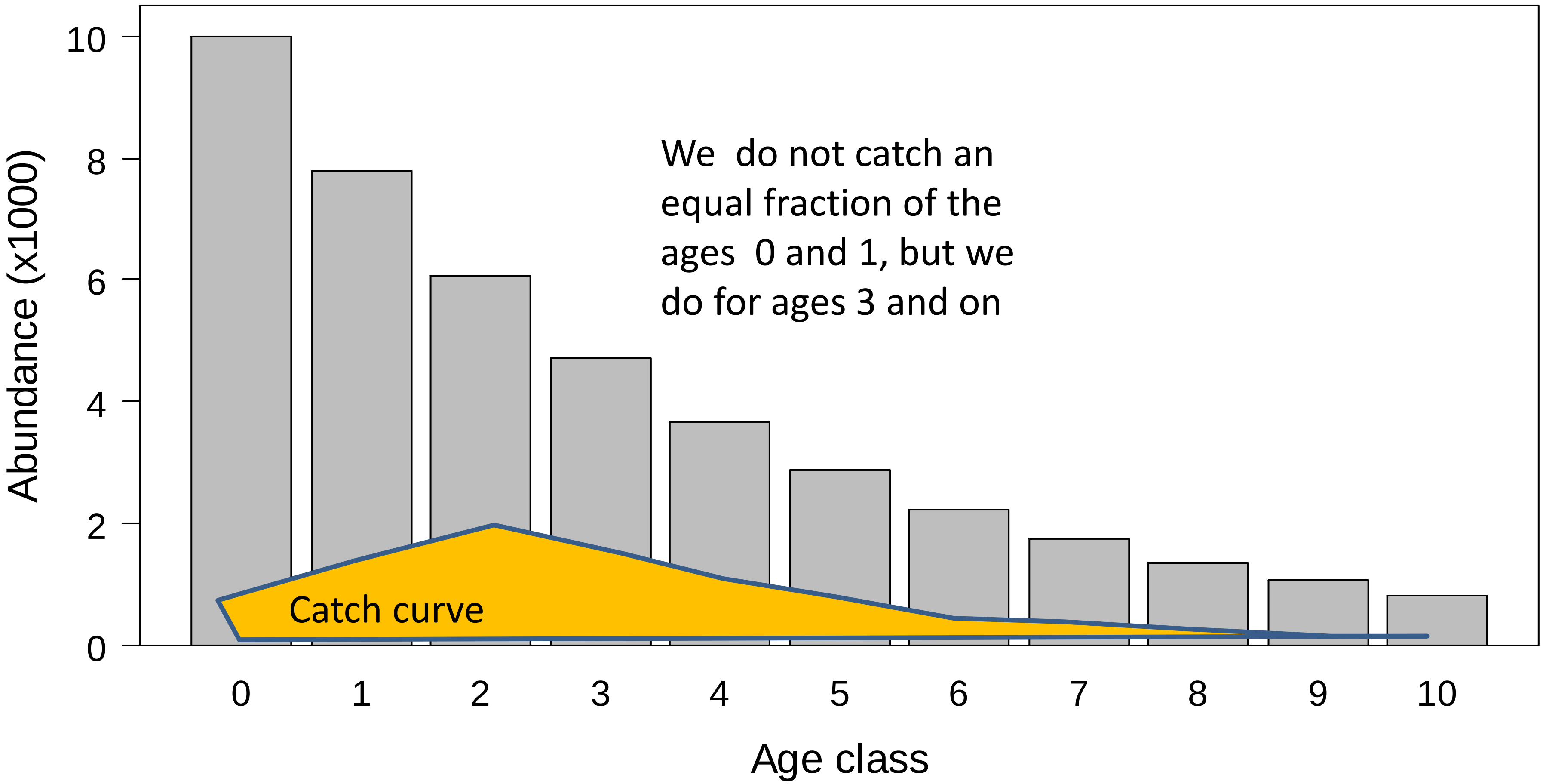
4) Fill in the boxes with names and arrows representing the conceptual model of fisheries. (4 points)



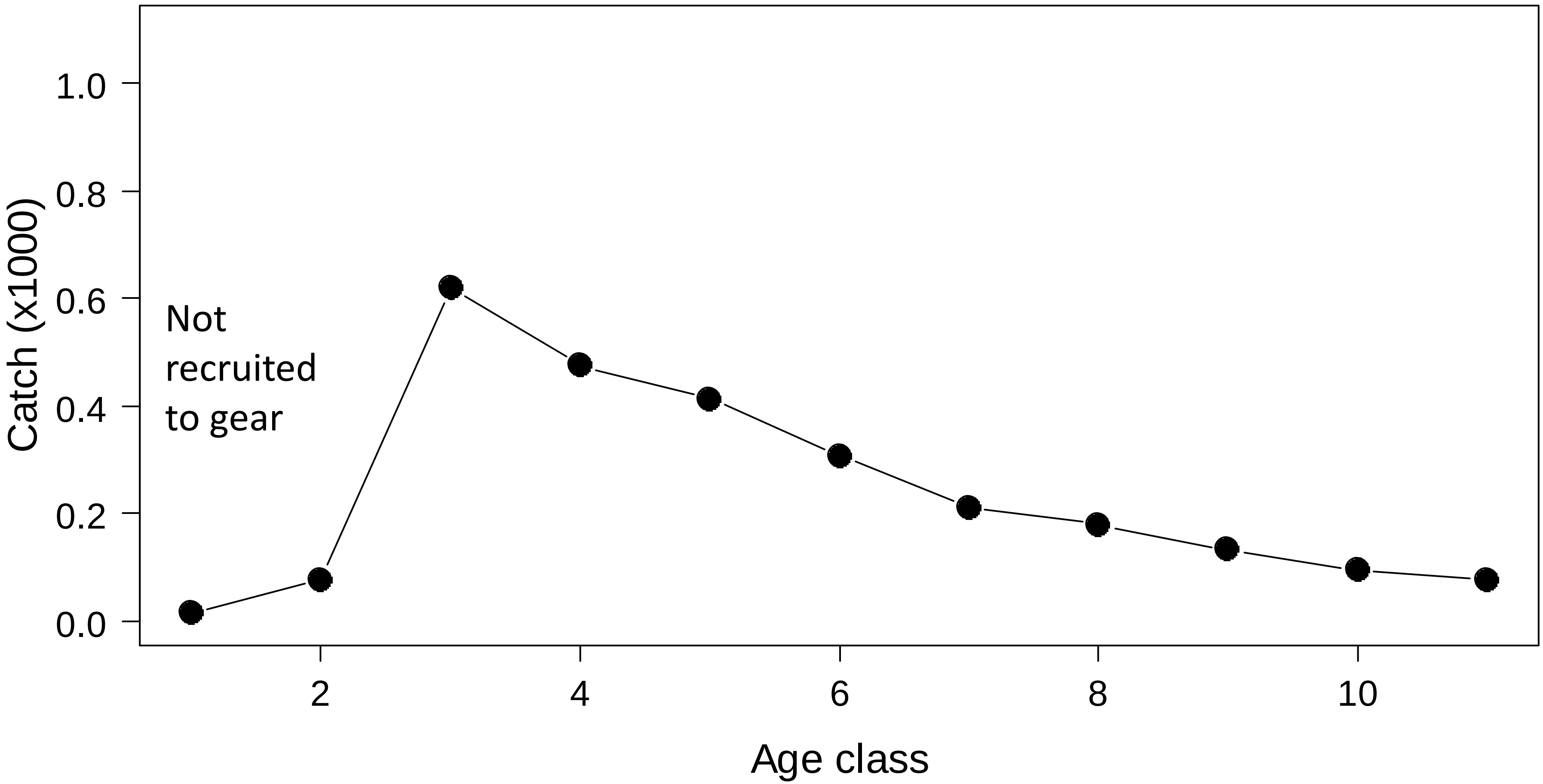
5) Circle the most correct answer below. How much is the seafood industry worth? (2 point)
   a) 37 dollars
   b) 37 thousand dollars
   c) 37 million dollars
   d) 37 billion dollars

ESTIMATING TOTAL MORTALITY (*Z*)

The practical realities



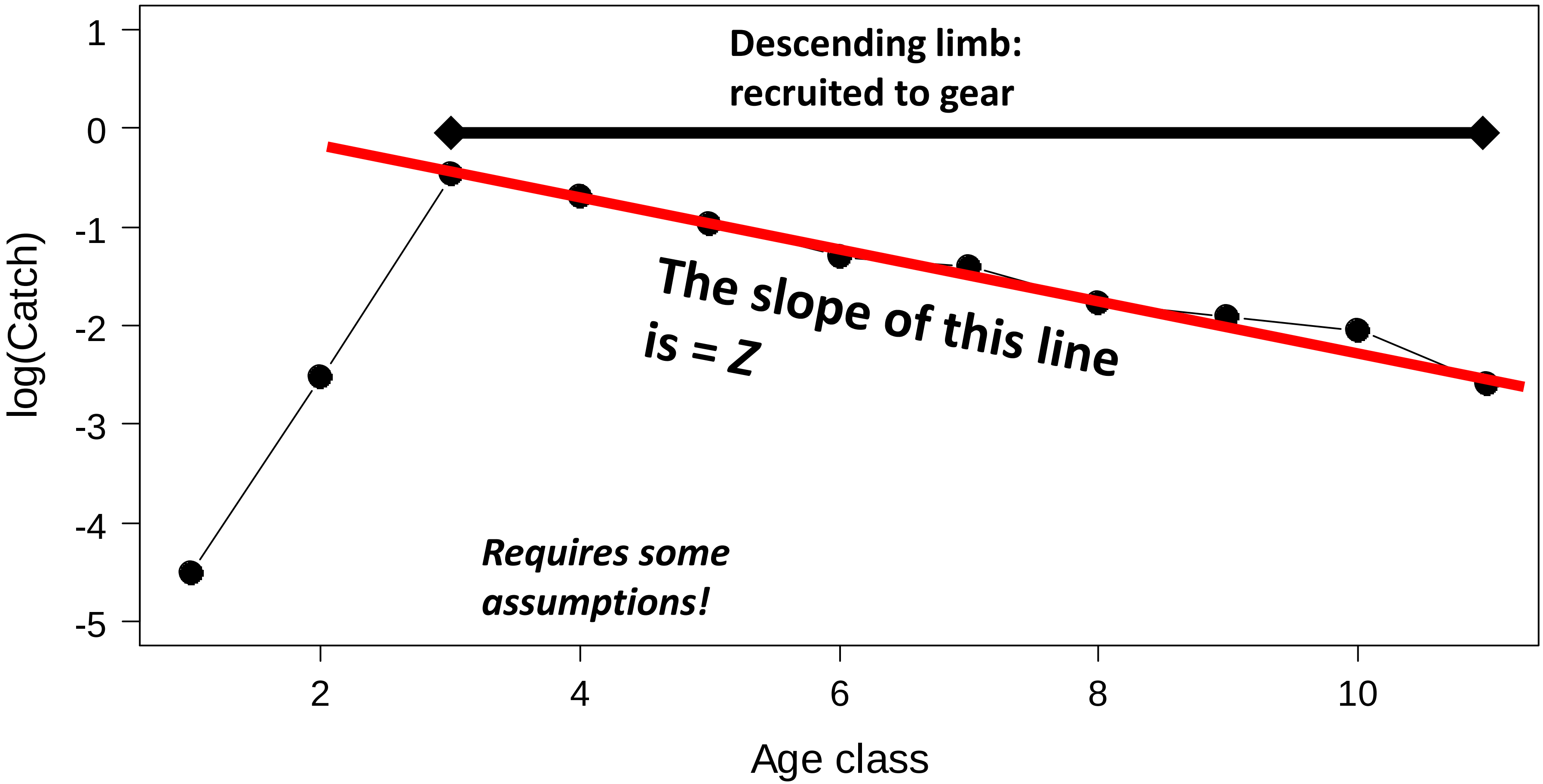
Practical realities: catch curve



Practical realities: catch curve

Practical realities: catch curve

Practical realities: catch curve



Catchability?

$$Z = F + M$$

$$F = Catchability \cdot Effort$$

Links effort and catch

Hard to estimate!

Lets talk about rates

- Instantaneous
- Finite

$$\frac{Abundance}{dt} = r \cdot Abundance - M \cdot Abundance$$

$$\frac{dN}{dt} = -Z \cdot N$$

Types of rates: Instantaneous

Instantaneous mortality rates are used in many fisheries models. They represent the rate of change over a time period. So, if you could chop up a year into very small increments the instantaneous rate would get applied to that very small time step. In essence the time step would be 0.

Types of rates: Finite

Finite mortality rates are the fraction of fish stock that dies in timeframe (e.g., a year).

Example: annual total mortality rate (*A*) of 0.2 means that 20% of the fish stock dies over one year. So if we have 100 fish 20 of those fish would die and 80 would survive.

10% off per day late!

- 10% off your assignment per day after due date
- What if you are 15 hours late?
- Should you get a full 10% off?
- If 24 hours (1 day) gets 10% off what should 15 hours get you?

If 24 hours (1 day) gets 10% off what should 15 hours get you?

- 10% finite rate (100*(1-0.1))=90 if you got all the points but was 1 day late
- 90*(1-0.1) = 81 if you got all the points but was 1 day late
- 15 hours?
- Convert 10% from finite to instantaneous… actually (1-0.1)

Finite→ Instantaneous

- Convert finite to instantaneous

$$S = -\log(0.9)$$

$$S = 0.10536$$

- We can divide *S* into time intervals

$$S = 0.10536 \cdot \frac{15}{24}$$

$$S = 0.0658$$

- The <u>instantaneous</u> survival rate for 15 hours is 0.0658

Instantaneous→ Finite

- Now we can convert the instantaneous rate to a finite rate

$$s = \exp(-1 \cdot 0.0658)$$

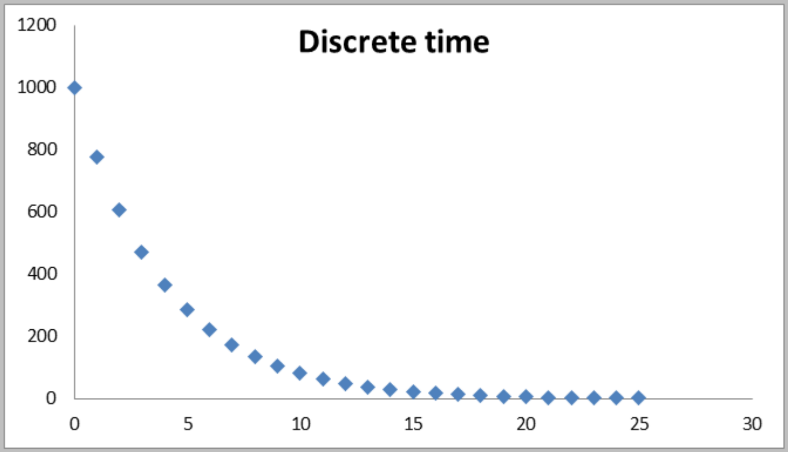
$$s = 0.936271$$

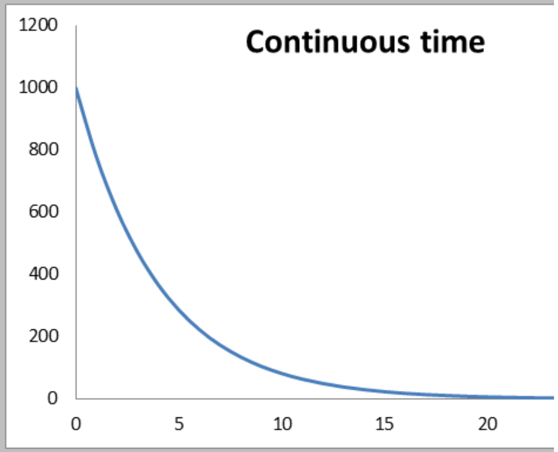
- So if you were 15 hours late on an assignment but you got all 100 points you would get a 93.6271
- That seems much better than getting a 90!

Types of rates

	Exponential	Discrete
Z	-0.25	0.778801
B_0	1000	1000

t	Exponential	Discrete
0	1000	1000
1	778.8007831	778.8008
2	606.5306597	606.5307
3	472.3665527	472.3666
4	367.8794412	367.8794
5	286.5047969	286.5048
6	223.1301601	223.1302
7	173.7739435	173.7739
8	135.3352832	135.3353
9	105.3992246	105.3992
10	82.08499862	82.085
11	63.92786121	63.92786
12	49.78706837	49.78707
13	38.77420783	38.77421
14	30.19738342	30.19738
15	23.51774586	23.51775
16	18.31563889	18.31564
17	14.26423391	14.26423
18	11.10899654	11.109
19	8.651695203	8.651695
20	6.737946999	6.737947
21	5.247518399	5.247518
22	4.086771438	4.086771
23	3.182780797	3.182781





Worked example

Suppose we had 1000 fish and 700 survive to the next year, the finite morality rate *A* is be 0.3 over the 12 month interval

Suppose we wanted to know what the morality rate was at 4 & 8 months.

To determine this the easy way we need to know instantaneous mortality

Worked example

First we convert our **finite morality rate *A*** to an instantaneous rate

$$Z = -\log_e(1-(N_t - N_{t+dt})/N_t)$$

$$Z = -\log_e(1-(1000-700)/1000)$$

$$Z = -\log_e(1-0.3)$$

$$Z = 0.356$$

$$Z = -\log_e(1-A)$$

$$A = 1-e^{-Z}$$

Worked example

One of the nice properties of instantaneous rates is that we can simply divide them by time to get varying interval rates. For example, 1 month

$$Z_{1months} = \frac{0.356}{12}$$

$$Z_{1months} = 0.0297$$

$$A_{1months} = 1 - e^{-0.238}$$

$$A_{1months} = 0.0292$$

Worked example

Similarly we can do the same thing for an 3 month interval

$$Z_{3months} = \frac{0.356}{4}$$

$$Z_{3months} = 0.119$$

$$A_{3months} = 1 - e^{-0.119}$$

$$A_{3months} = 0.112$$

There are 4 3 month periods in 12 months

A worked example

So at 1 months past June 1 we would expect the population abundance to be:

$$N_{1months} = 1000 - (1000 \cdot 0.0292)$$

$$N_{1months} = 971$$

And for 3 months

$$N_{3months} = 1000 - (1000 \cdot 0.112)$$

$$N_{3months} = 888$$

So there were 29 mortalities in the first month and 112 in the first 3 months

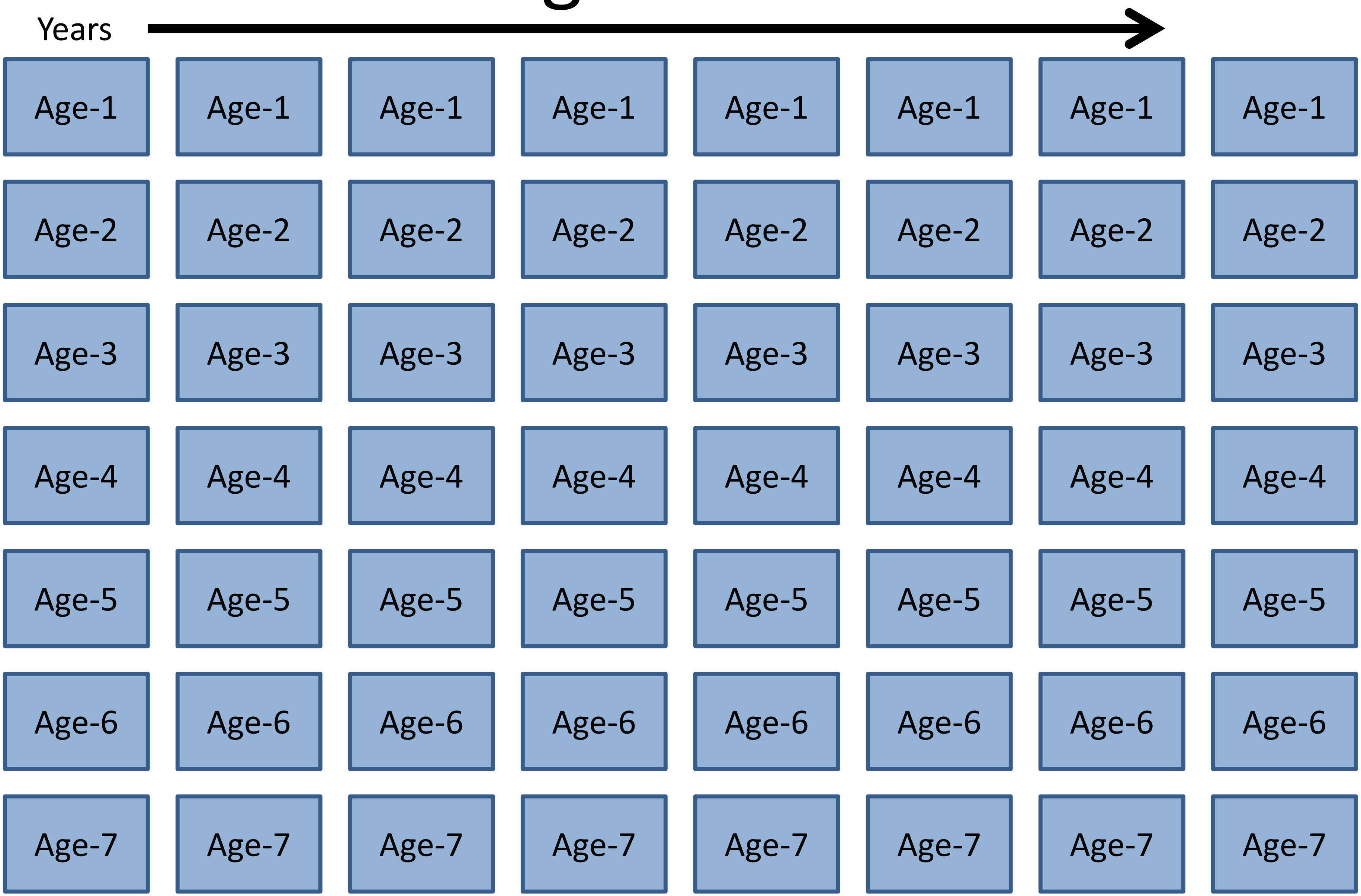
When would these rates make sense?

- Finite?
- Instantaneous?

Sometimes we need to know what a fish might weigh for a given age. To do that we need to predict the length at age for a fish and then convert that length to a weight.

PUTTING IT TOGETHER: MORTALITY & GROWTH

Age & time


Years
Age-1
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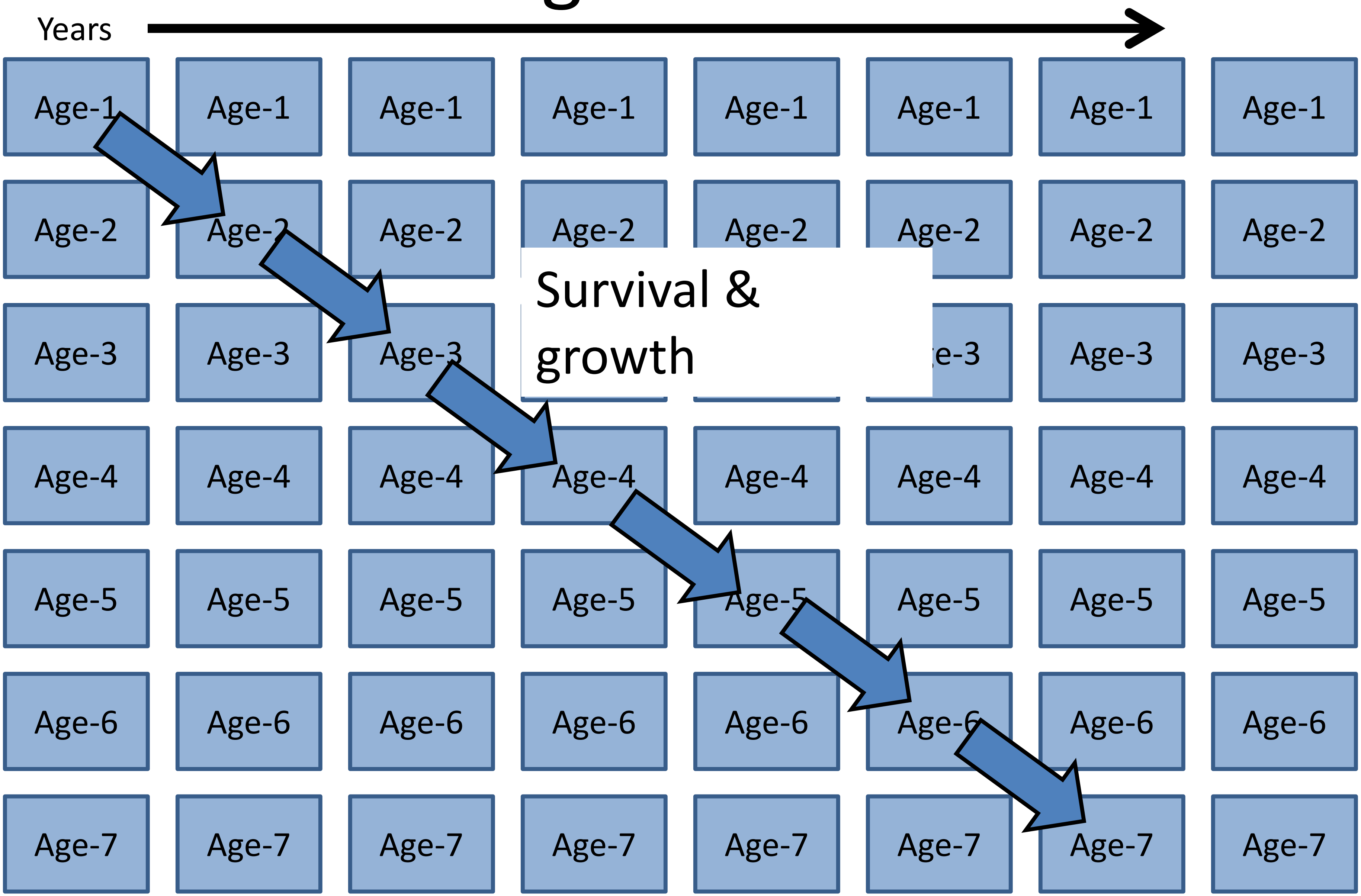
Age & time


Years
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Survival & growth
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Trade off

1. Harvesting a lot of fish
2. Harvesting fewer, but larger fish

Lets look at this

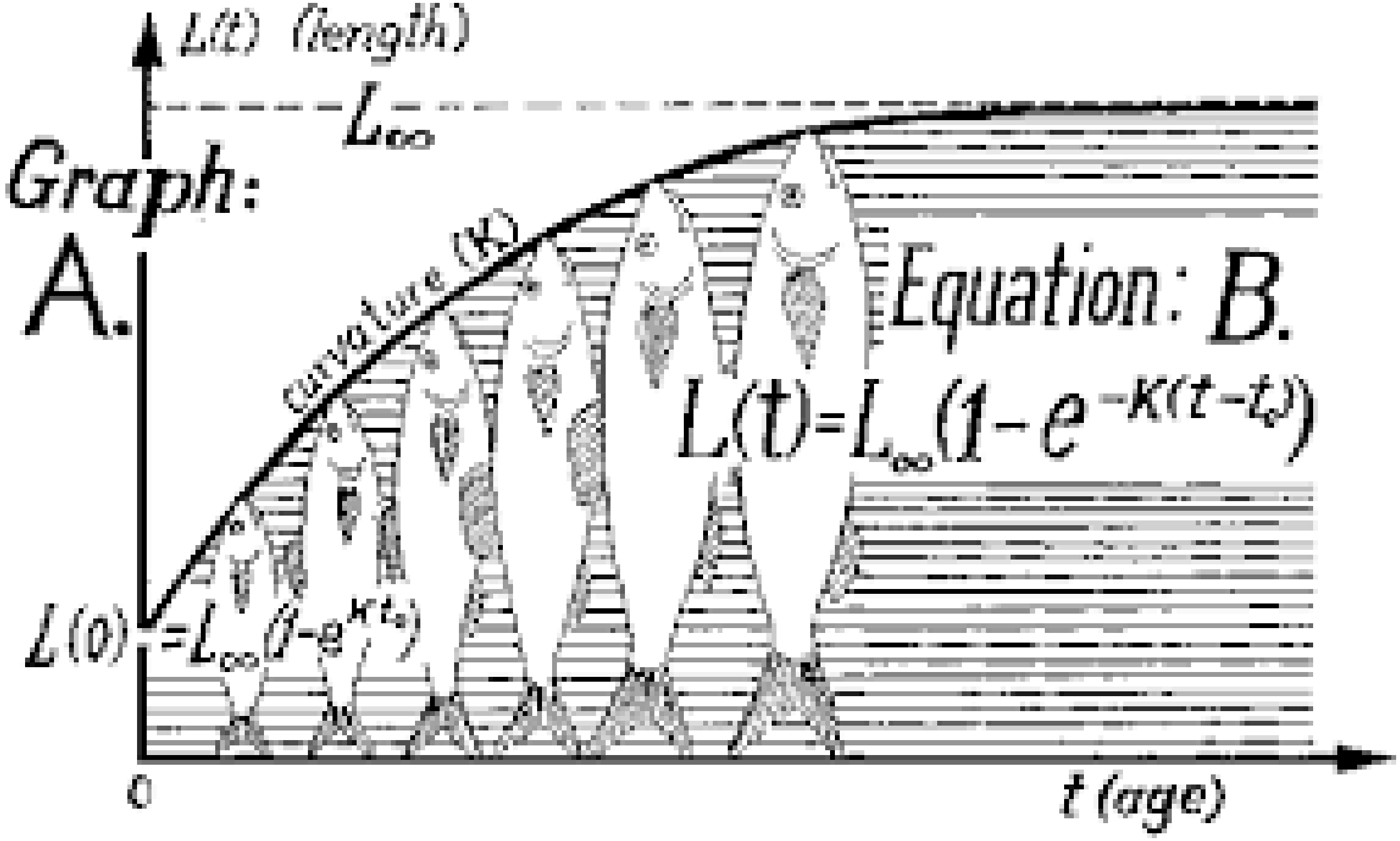
Some management parameters

Management can control*

- Gear-catchability
- Effort
- **Harvested fish size-Minimum length limit**

*Not a complete list

Why set a minimum length limit (MLL)



Cohort based

Follow a cohort over its lifetime

- Recruits: defined by age
- Maximum age (longevity)
- Survival (finite) = 0.20 (0.222 instantaneous)

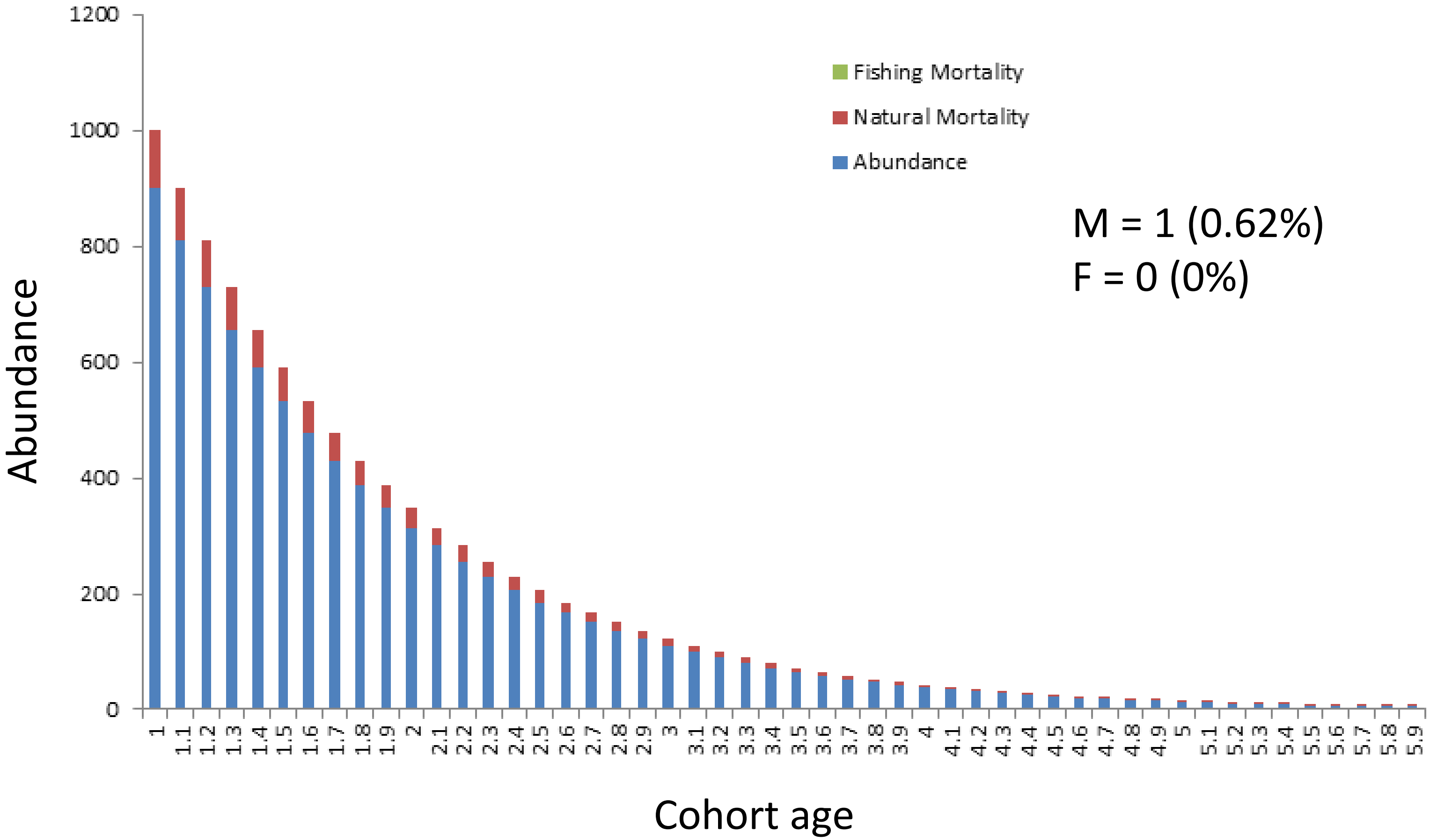
Age-1	Age-2	Age-3	Age-4	Age-5
1000→	200→	40→	8→	2

Cohort recruited

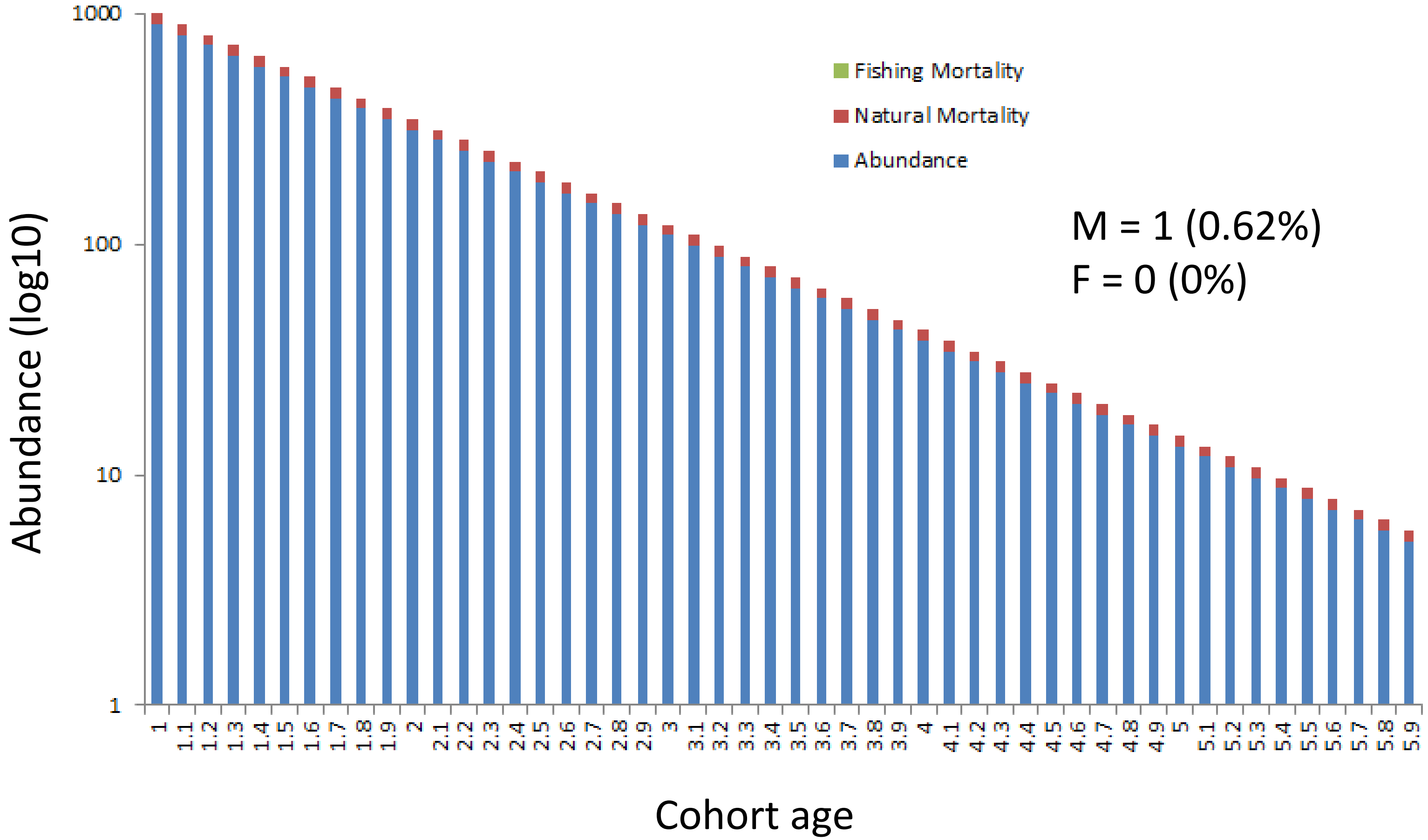
Age-1	Age-2	Age-3	Age-4	Age-5
1000→	200→	40→	8→	2

1000 age-1 fish recruited

No fishing mortality



No fishing mortality



Fishing mortality

Minimum length limit-Applies to certain size fish and above

Slot limit-applies to a fish within a minimum and maximum size limits

ISSUE: Cohort dynamics a function of age (or time)…How do we relate length limits to age?

Flip the VBGF

Recall, the VBGF predicts length at age

$$Length_{age} = Length_{\infty} \cdot (1 - e^{-K \cdot (age - t_0)})$$

Can rearrange equation to predict age given length

Proof

$$Length_{age} = Length_{\infty} \cdot (1 - e^{-K\cdot(age - t_0)})$$

$$\frac{Length_{age}}{Length_{\infty}} = (1 - e^{-K\cdot(age - t_0)})$$

$$-1 + \frac{Length_{age}}{Length_{\infty}} = -e^{-K\cdot(age - t_0)}$$

$$1 - \frac{Length_{age}}{Length_{\infty}} = e^{-K\cdot(age - t_0)}$$

$$\log\left(1 - \frac{Length_{age}}{Length_{\infty}}\right) = -K \cdot (age - t_0)$$

$$\frac{\log\left(1 - \frac{Length_{age}}{Length_{\infty}}\right)}{-K} = (age - t_0)$$

$$t_0 + \frac{\log\left(1 - \frac{Length_{age}}{Length_{\infty}}\right)}{-K} = age$$

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

$$t_0 + \frac{\log\left(1 - \frac{Length_{age}}{Length_{\infty}}\right)}{-K} = age$$

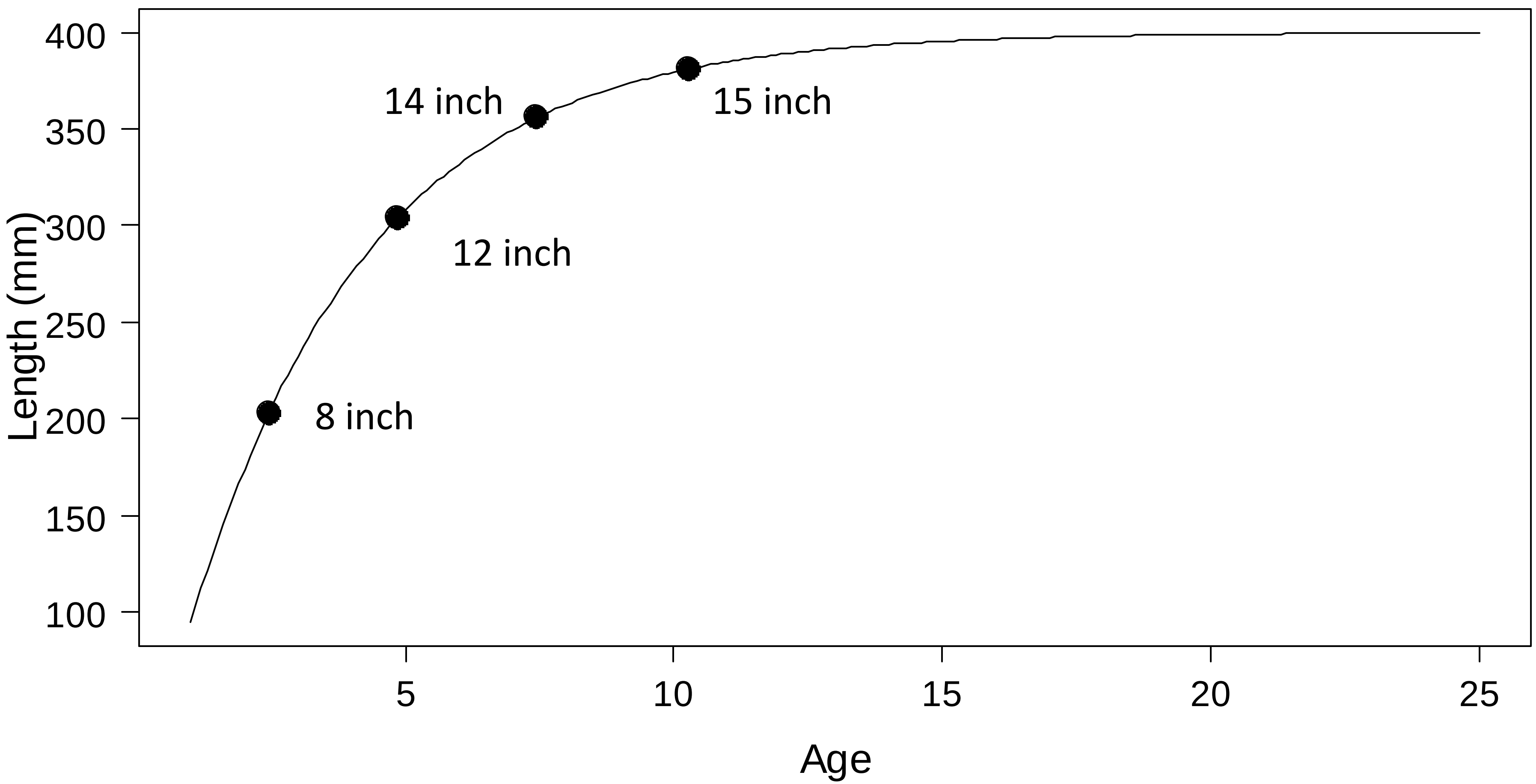
$$0.1 + \frac{\log\left(1 - \frac{304}{400}\right)}{-0.3} = age$$

$$0.1 + \frac{-1.427}{-0.3} = age$$

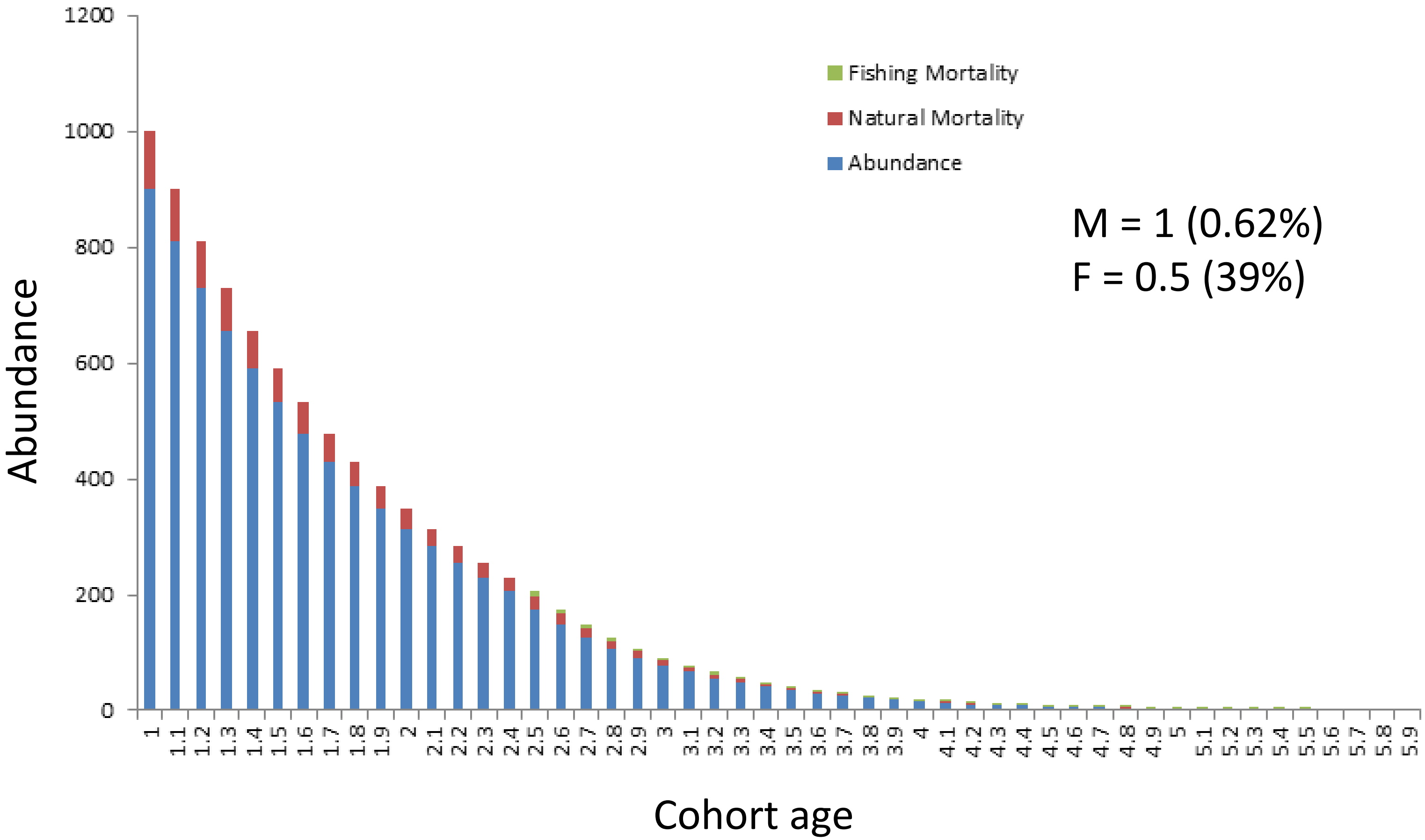
$$0.1 + 4.757 = age$$

$$4.857 = age$$

Length limit & growth

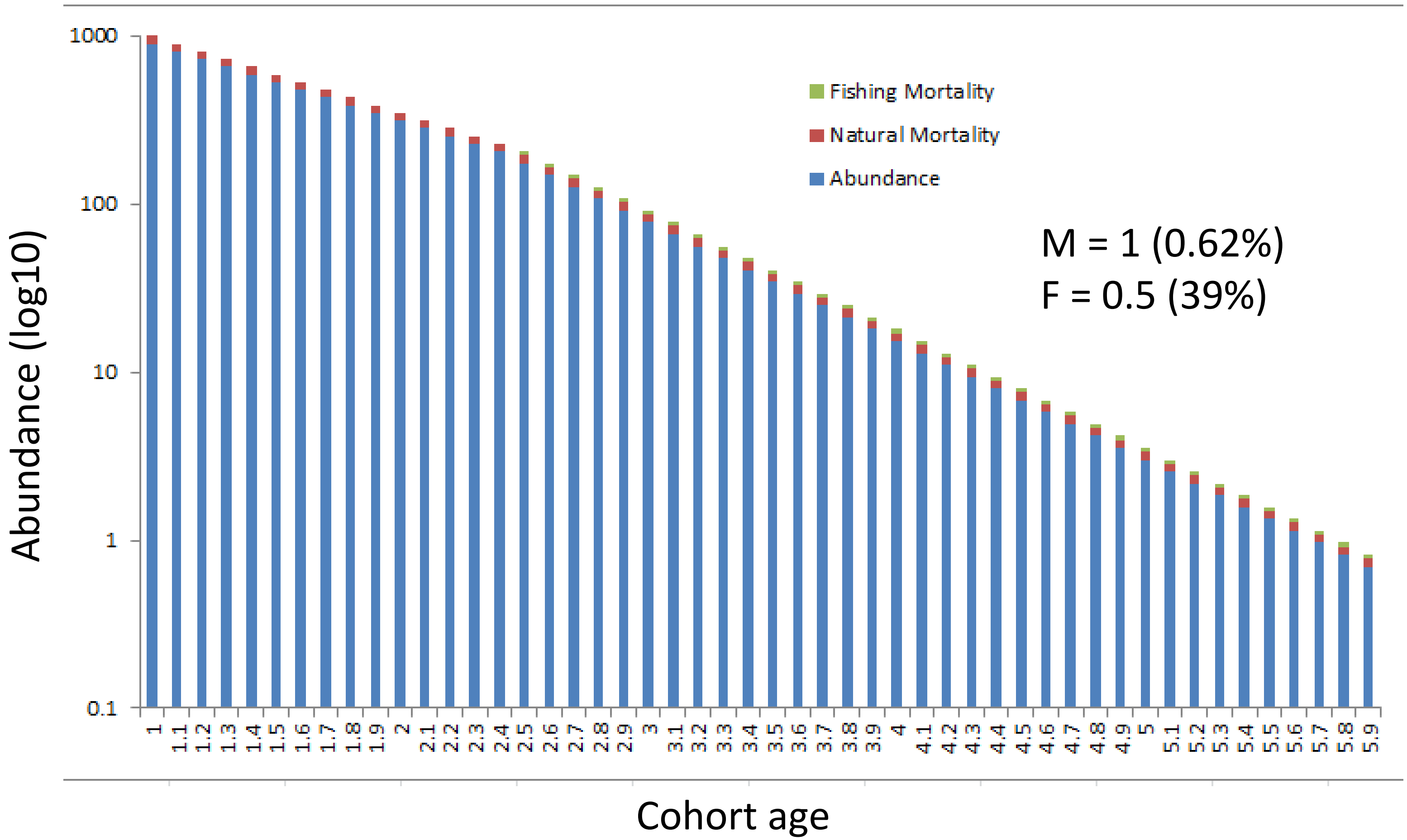


8 inch limit



M = 1 (0.62%)
F = 0.5 (39%)

8 inch limit



1000
100
10
1
0.1
Abundance (log10)
Fishing Mortality
Natural Mortality
Abundance
M = 1 (0.62%)
F = 0.5 (39%)
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3
3.1
3.2
3.3
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3.6
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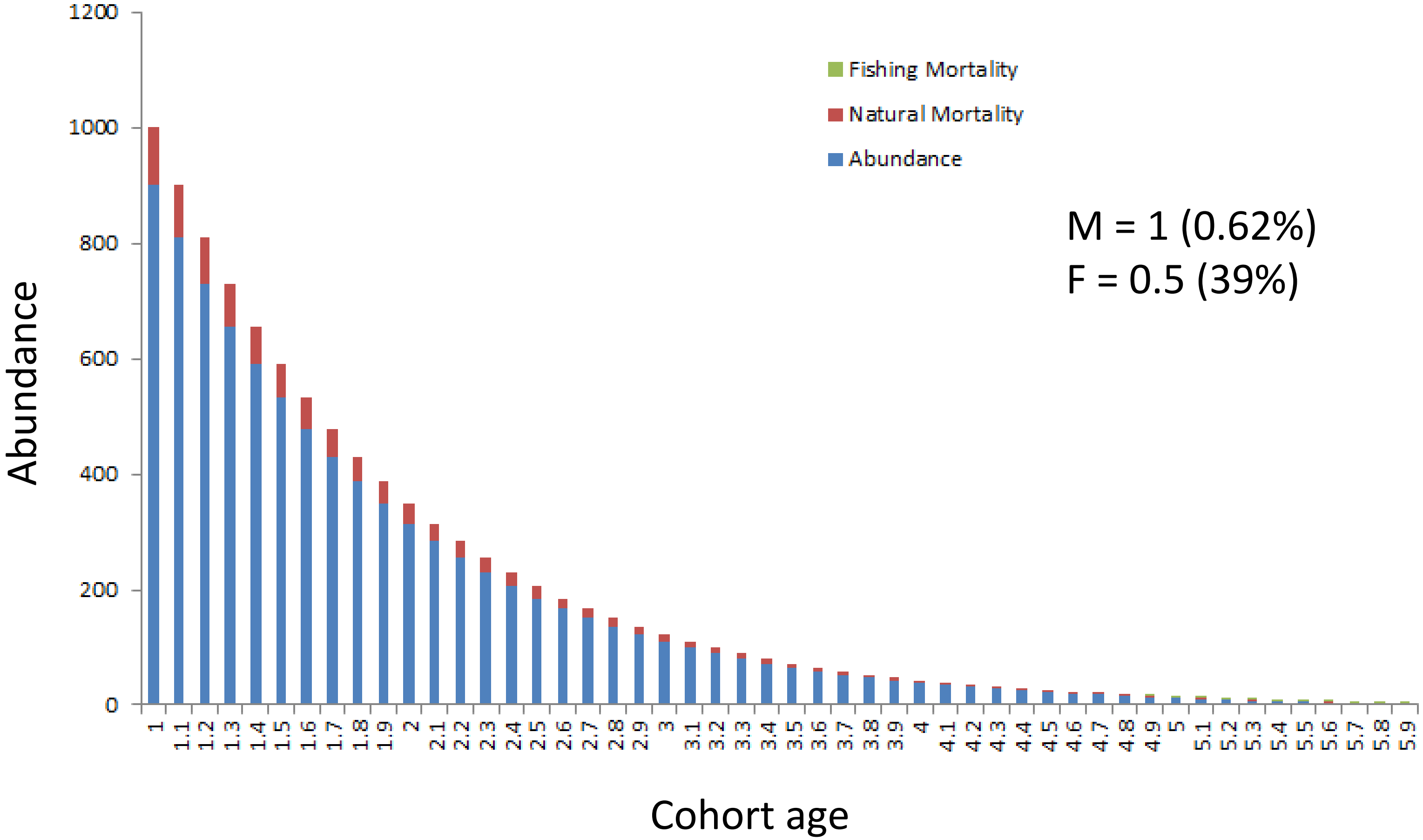
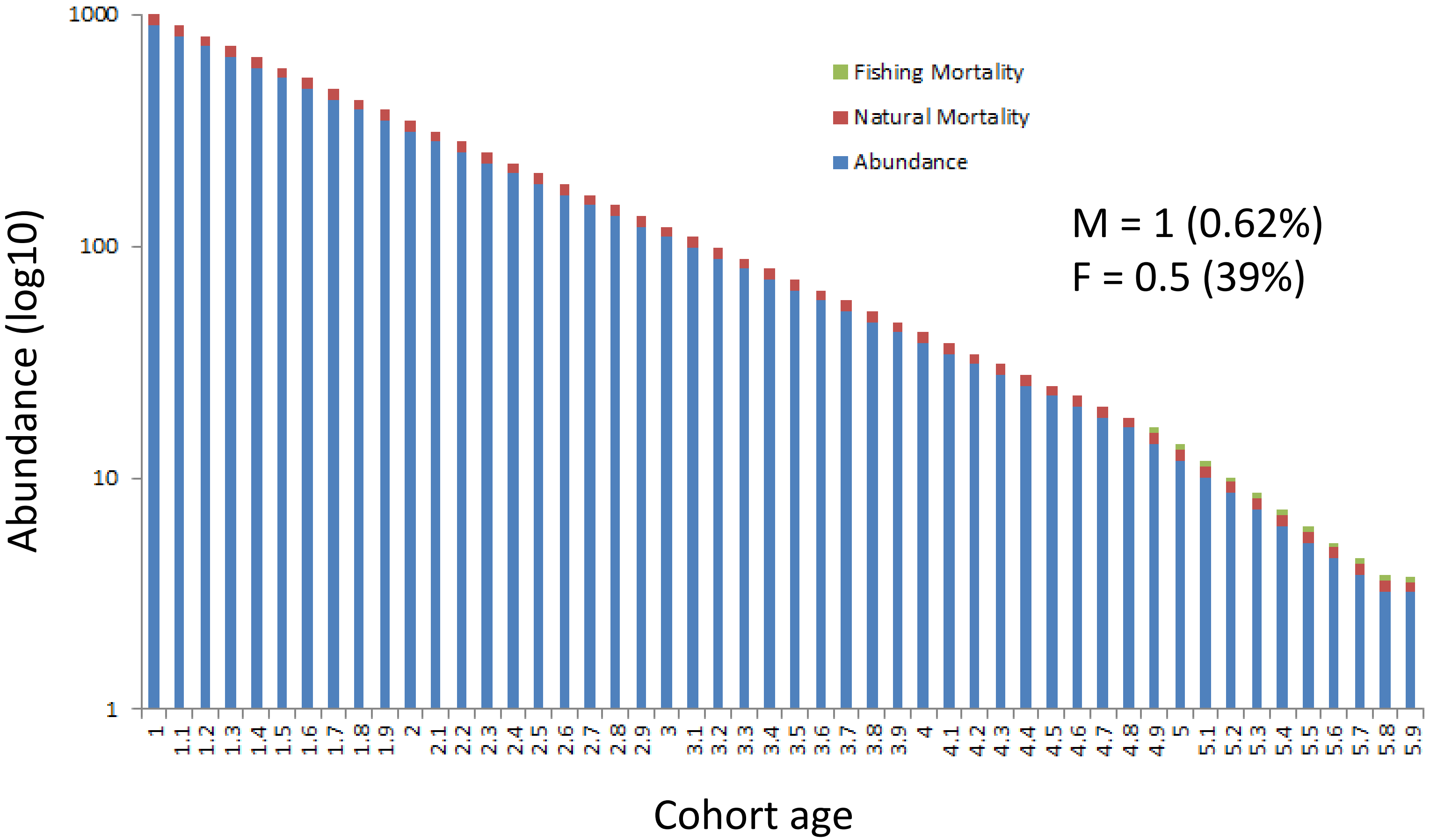
5.9
Cohort age

12 inch limit



12 inch limit



Sometimes we need to know what a fish might weigh for a given age. To do that we need to predict the length at age for a fish and then convert that length to a weight.

LAST PIECE OF THE PUZZLE: LINKING WEIGHT TO ESTIMATE YIELD!