WF4113-Fisheries Science

Lecture 9: Mortality & Harvest

Last class

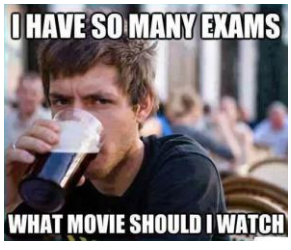
1. Recruitment
2. Mortality

This class

1. Mortality
2. Harvest

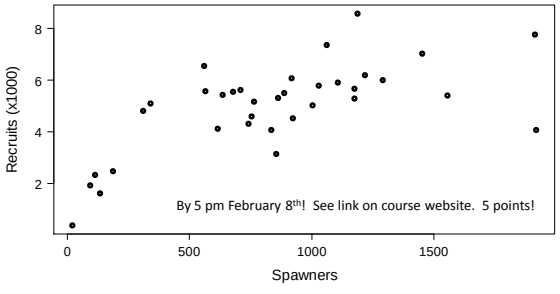
Housekeeping

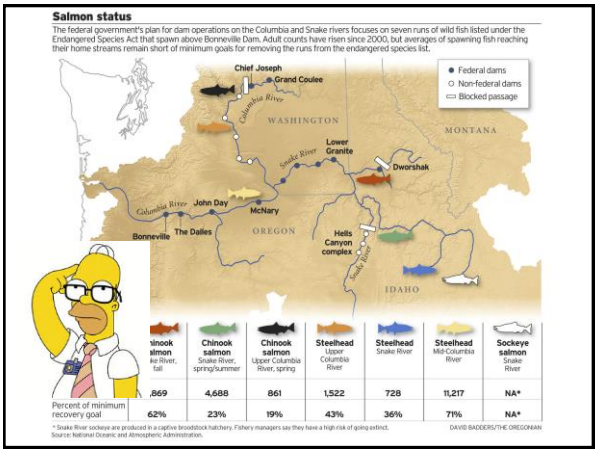
- Exam I is Wednesday February 15th.
- Homework 1 due by 5pm.



Housekeeping

Which model would you fit?





Scientists confirm dorado catfish as all-time distance champion of freshwater migrations

Full migratory life-cycle distance of dorado catfish stretches from Amazon River estuary to the Andes Mountains

Date: February 6, 2017

Source: Wildlife Conservation Society

Summary: An international team of scientists has confirmed that the dorado catfish (Brachyplatystoma rousseauxii) of the Amazon River basin holds the record for the world's longest exclusively freshwater fish migration, an epic life-cycle journey stretching nearly the entire width of the South America continent.

This is an image of a live dorado catfish in a tank. A newly published study on the dorado and other "goliath" catfish has revealed that the dorado's full life-cycle migration stretches more than 7,200 miles in length.

Credit: Michael Goulding/WCS

Growing up to six feet in length, the dorado catfish is sometimes called the gilded catfish due to its silver and gold skin. Credit: Michael Goulding/WCS

Shedd's 'Granddad' — world's oldest aquarium fish — dies

Australian lungfish, Neoceratodus forsteri, Granddad, 1982. | Patrice Ceisel/Shedd Aquarium photo

Maureen O'Donnell

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Granddad is sleeping with the fishes.

The Shedd Aquarium's beloved Australian lungfish — the longest-living fish in any aquarium in the world — was euthanized on Sunday because of complications from old age, the Shedd announced on Monday.

http://chicagoist.com/2017/02/06/granddad_oldest_aquarium_fish_in_th.php#photo-1

Standard Common Name

Australian Lungfish

Identification

The Australian Lungfish has a long, heavy body with large scales. It has small eyes and paddle-like pectoral fins and pelvic fins. Its dorsal fin starts midway along the back and is continuous with the caudal and anal fins.

The species is usually olive-green to brown on the back and sides with some scattered dark blotches, and whitish ventrally.

The species was described in 1870 by Australian Museum staff member Gerard Krefft.

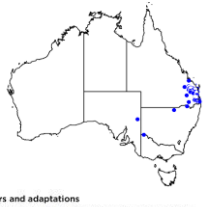
Size range

It grows to about 1.5 m in length and over 40 kg.

Distribution

It occurs naturally in the Burnett and Mary River systems although has been introduced into other rivers and reservoirs in south-eastern Queensland and north-eastern New South Wales.

The map below shows the Australian distribution of the species based on public sightings and specimens in Australian Museums. Click on the map for detailed information. Source: Atlas of Living Australia.



Other behaviours and adaptations

The Australian Lungfish has a single lung, whereas all other species of lungfishes have paired lungs. During dry periods when streams become stagnant, or when water quality changes, lungfishes have the ability to surface and breathe air. When the Australian Lungfish surfaces to empty and refill its lung the sound is reportedly like that of the "blast from a small bellows". Under most conditions, this species breathes exclusively using its gills.

Life cycle

The species can live to at least 20–25 years of age. The Shedd Aquarium's Australian Lungfish, affectionately known as 'Granddad' (see image) lived to over 80 years of age and was possibly the oldest fish in captivity. He was finally euthanised on 5 Feb 2017.

https://australianmuseum.net.au/australian-lungfish-neoceratodus-forsteri-krefft-1870

The world's oldest aquarium fish, a longtime Shedd Aquarium resident, has sadly shuffled off this mortal, aquatic coil. Granddad, a male Australia lungfish and Chicago mainstay since 1933 (!), was euthanized after the old timer stopped eating and exhibited hallmarks of organ failure, according to press release from Shedd on Monday.

Granddad arrived from Australia just days before the 1933 World's Fair and has been seen by over a million visitors, according to Shedd.

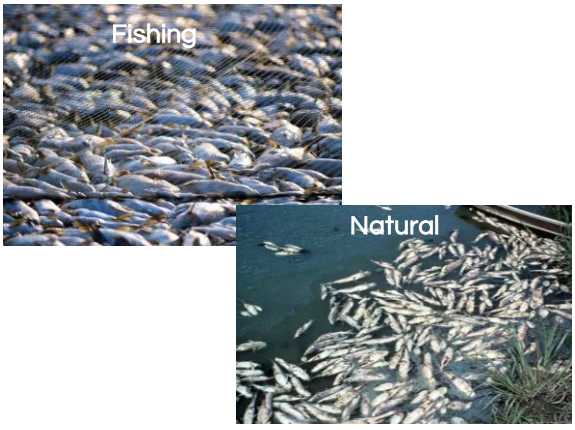
"For a fish who spent much of his time imitating a fallen log, he sparked curiosity, exci… would hear his story and lea… cies a living fossil and one… et," President and CEO Bric…

Shedd notes… for over 100 million years.… to a comfortable …

"Granddad lived a pretty relaxed life, enjoyed interactions with us, including gentle pats along his back, and loved to eat his leafy greens," Michelle Sattler, collections manager of Granddad's care provider for three decades, said in a statement. "But, worms were definitely his favorite and he would become quite animated on what became Earthworm Wednesdays, when they were dropped into his habitat—animated for a very slow-moving fish. We loved him. And he will be sorely missed."

2017-1933 = 84 Years!!!

Ballpark survival (*A*) = (1-1/84)=0.99



Total mortality (*Z*)

$Z = F + M$

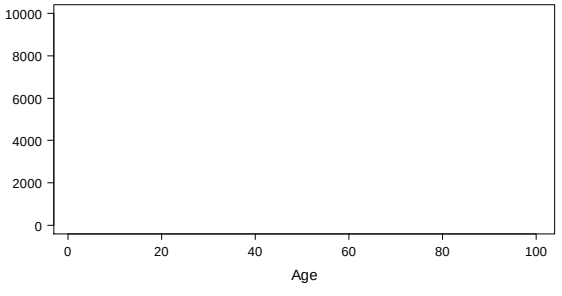
Where,

F = Fishing mortality

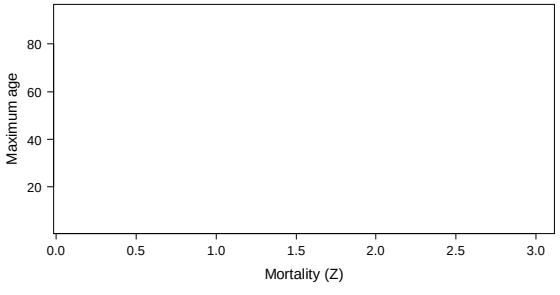
M = Natural mortality

Difficult to estimate *F* and *M*

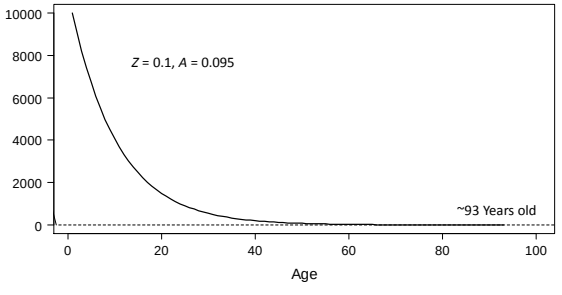
Effect of mortality on age

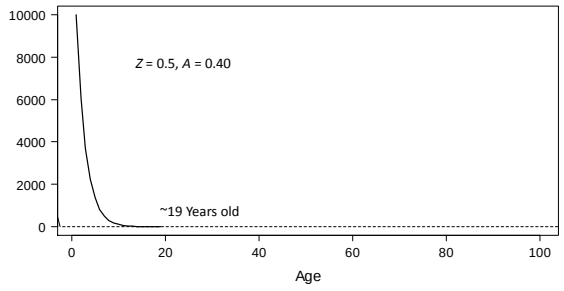


Effect of mortality on maximum age

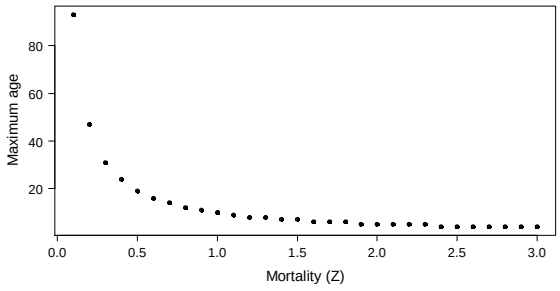


Effect of Mortality

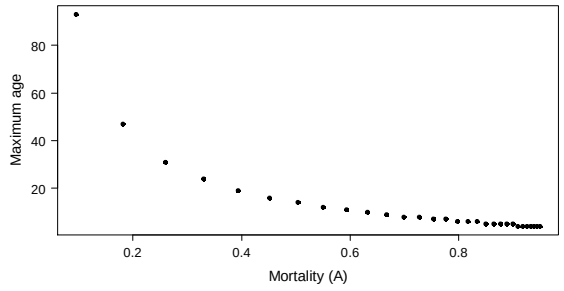




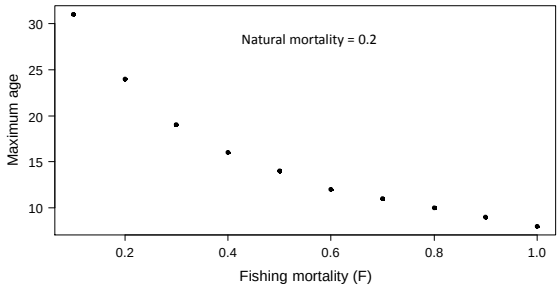
Maximum age decreases with *Z*



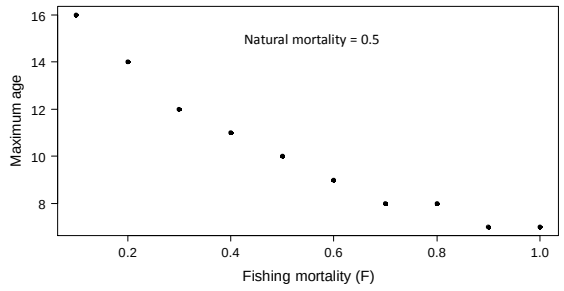
Maximum age decreases with *A*



Total mortality (*Z= F + M*)



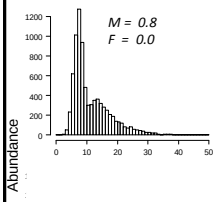
Total mortality (*Z= F + M*)



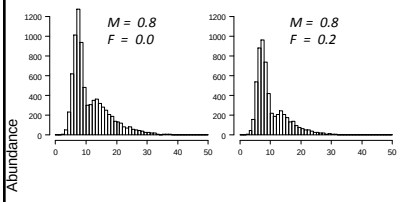
Size structure

Lets look at a population of Black Crappie with a natural mortality rate (*M*) of 0.8 for the following levels of fishing mortalities: 0.0, 0.2, and 0.4, 0.6, 0.8

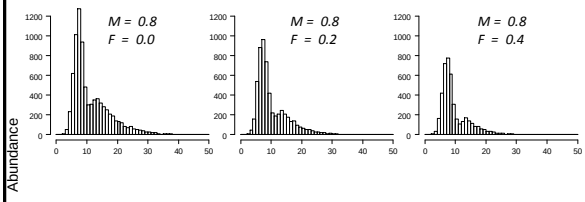
Size structure



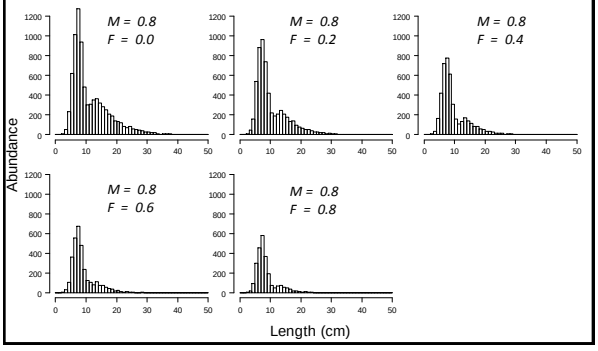
Size structure



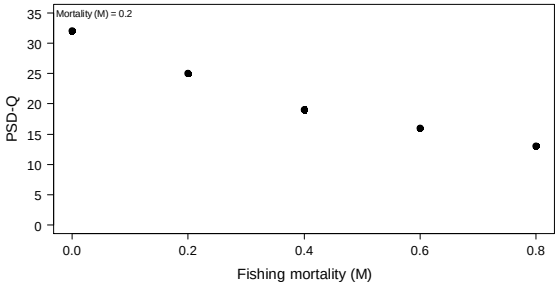
Size structure



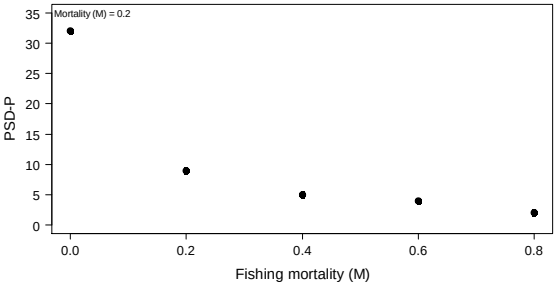
Size structure



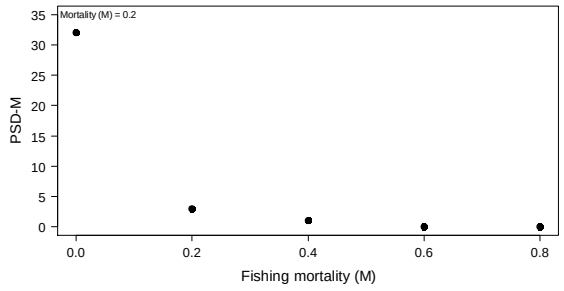
PSD-Q



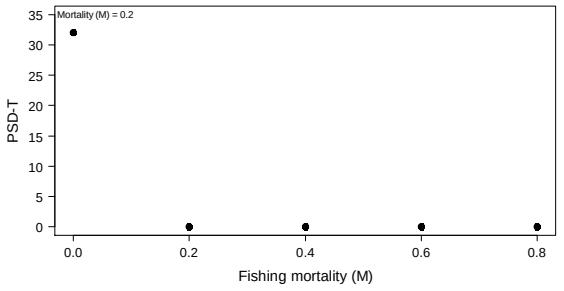
PSD-P



PSD-M



PSD-T

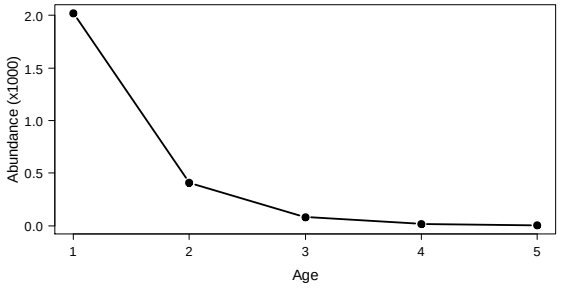


The effects of fishing may be obfuscated

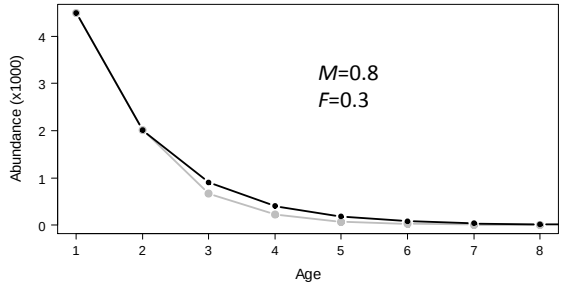
Lake	County	Length Limit	Creel Limit
Enid Lake	Yalobusha, Lafayette, Panola	12" MLL	20
Grenada Lake	Grenada, Calhoun, Yalobusha	12" MLL	20
Horn Lake	Desoto Co.	10" MLL	30
Lake Okhissa	Franklin	10"MLL	10
Lake Washington	Washington	10" MLL	30 (5 under 10")
Moon Lake (includes part east of Hwy 1)	Coahoma	10" MLL	30 (5 under 10")
Pickwick & Tenn-Tom Waterway	Hwy 25 in Divide Section to Aliceville Lock & Dam	9" MLL	30
Sardis Lake	Lafayette, Marshall, Panola	11" MLL	15
Spillways of Arkabutla	To Prichard Road Bridge		20
Enid	To I-55		20
Grenada	To Hwy 51		20
Sardis & Barrow Lake	To Spaulding Creek		20

http://www.mdwfp.com/media/218652/creel_limits_pt._3_chaper_1.pdf

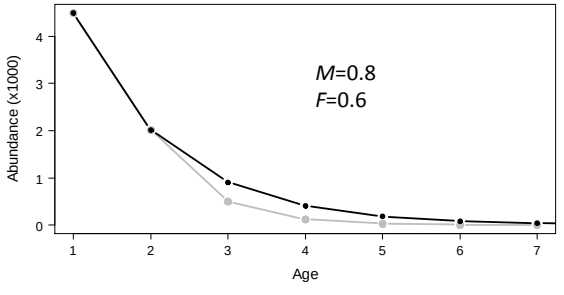
Fishing mortality depends on size



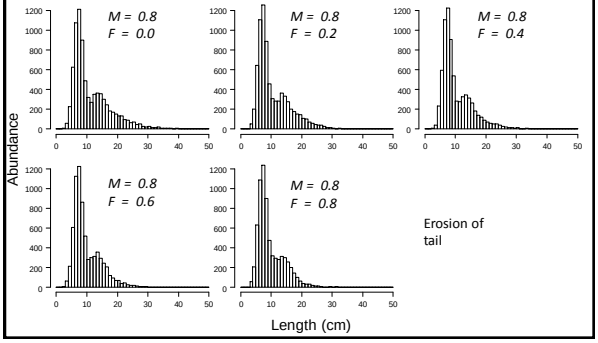
Effect of fishing



Effect of fishing



Fish > age 2 recruited to fishery



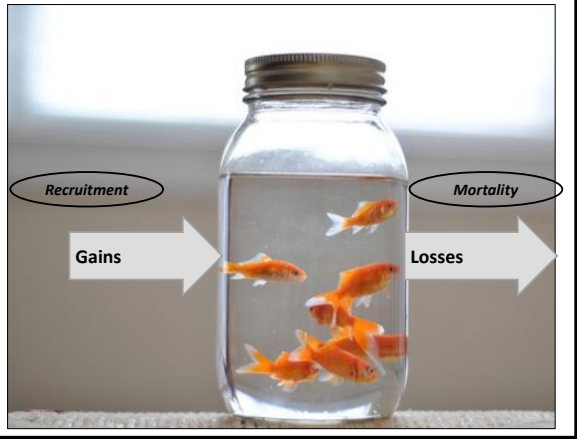
Recruitment

1. Stock
2. Gear
3. Fishery-Knife edge, abrupt, i.e, size limits

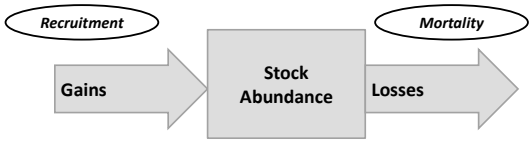
Effects of fishing

- Reduces abundance, if mortality is additive
- Erodes size structure
- Erodes age structure

GAINS AND LOSSES DEPENDENT ON POPULATION ABUNDANCE



Fish population dynamics



What if rates vary over time?

Time (years)	Gains (fish year^{-1})	Losses (fish year^{-1})
1	2	2
2	3	3
3	4	9
4	6	5
5	8	4
6	9	1
7	12	2
8	4	5
9	1	6
10	6	4

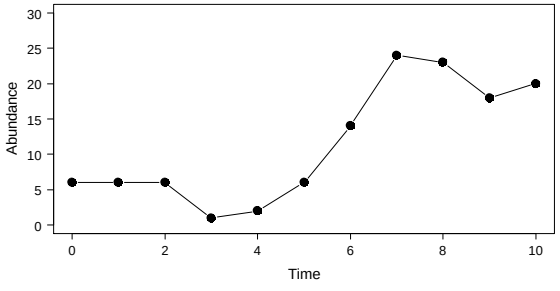
Time (years)	Gains (fish year^{-1})	Losses (fish year^{-1})	Net (fish year^{-1})
1	2	2	0
2	3	3	0
3	4	9	-5
4	6	5	1
5	8	4	4
6	9	1	8
7	12	2	10
8	4	5	-1
9	1	6	-5
10	6	4	2

How do the dynamics play out?

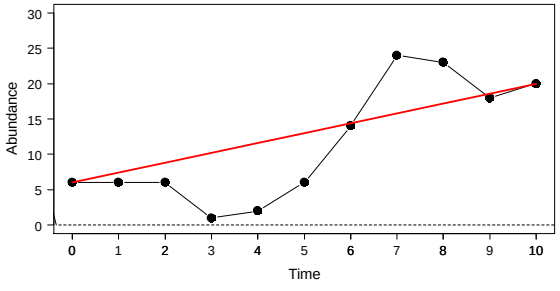
An interesting thing…

Time (years)	Gains (fish year^{-1})	Losses (fish year^{-1})
1	2	2
2	3	3
3	4	9
4	6	5
5	8	4
6	9	1
7	12	2
8	4	5
9	1	6
10	6	4
Mean	5.5	4.1

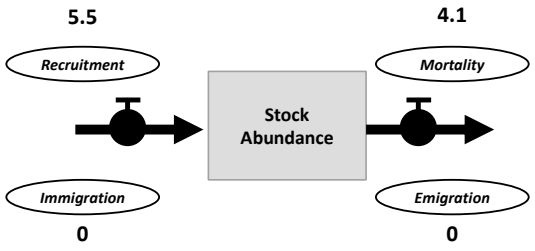
True population dynamics



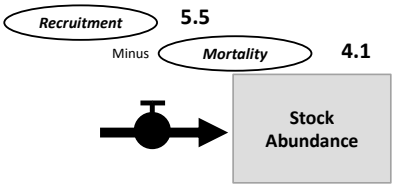
Average population dynamics



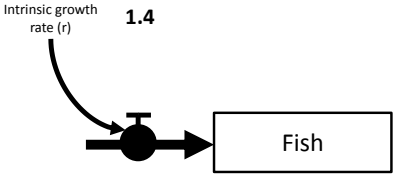
Fish dynamics



Fish dynamics

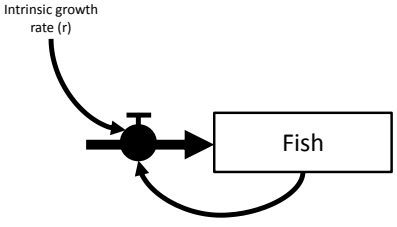


Population model



$$\frac{dA}{dt} = r$$

Exponential population model



$$\frac{dA}{dt} = r \cdot A$$