WF4133-Fisheries Science

Lecture 6: Recruitment

Last class

1. Population dynamics

This class

Recruitment

1. Effects on population dynamics
2. Effects on size structure

Fishy stuff

Angler Facing $24,000 Fine For Catching Too Many Bluegills

By Daniel Kelly on January 29, 2016

Bluegill fishing can be fun, but is catching the little fish worth a fine? For one Wisconsin angler, it appears so, after he was cited by the state's department of natural resources for keeping too many fillets of the fish in his freezer and is facing a fine in excess of $24,000.

Fisheries biologists were first suspicious of the angler, Stanley Paalksnis of Onalaska, Wisconsin, after they watched him catch more than 20 bluegills one morning on Lake Onalaska. That very same afternoon, he returned and caught 25 more, which is the daily limit for the lake.

Upon searching his home, state officials found more than 150 fillets stored in his freezer and refrigerator. Paalksnis got four citations for all the bluegill in his possession and is facing a total fine of $24,682.

Should there be such large fines for catching too many fish? Why or why not? Please consider leaving a comment to share your thoughts!

Top image: Bluegill. (Credit: David A. Brown / Wired2Fish)

http://magazine.fishsens.com/angler-facing-24000-fine-for-catching-too-many-bluegills.htm

ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

POSITION ANNOUNCEMENT

Job Classification: **Hourly Assistant – 40 hours per week**

Position: Aquatic Field Technician (6 possible positions)

Employer: Illinois River Biological Station, Illinois Natural History Survey, a division of the Prairie Research Institute at the University of Illinois, Champaign, Illinois. ***Position is located in Havana, Illinois.***

JOB DESCRIPTION

Field technicians are needed to conduct applied research in the area of aquatic ecology and large river systems throughout the state of Illinois. Technicians will assist large river ecologists in the collection of standardized long-term river monitoring data with additional targeted data collection.

QUALIFICATIONS

Must have or be in the process of working toward a bachelor degree in aquatic ecology, biology, zoology or a biological related field. Must demonstrate a working knowledge of, and ability to collect biological data, such as fisheries and water quality in a large river system. Understanding and experience with standardized long-term monitoring (LTRM) sampling protocols is preferred. Experience using large boats, outboard motors, trailers, four wheel drive vehicles and maintaining field equipment. Candidate will participate in boat electrofishing, netting and other appropriate gear types as well as be expected to perform field station maintenance duties when needed. This position requires significant physical exertion (including carrying 40 or more pounds of gear), commitment to safety, and meticulous data recording. The individual must have a valid driver's license and a strong ability to swim. Must be able to work in extreme weather conditions, long days with possible nights and weekends.

"The University of Illinois conducts criminal background checks on all job candidates upon acceptance of a contingent offer."

Salary: $9.00 to $11.00 per hour depending on experience

Available: May-October 2017 with likely extension to December 2017.

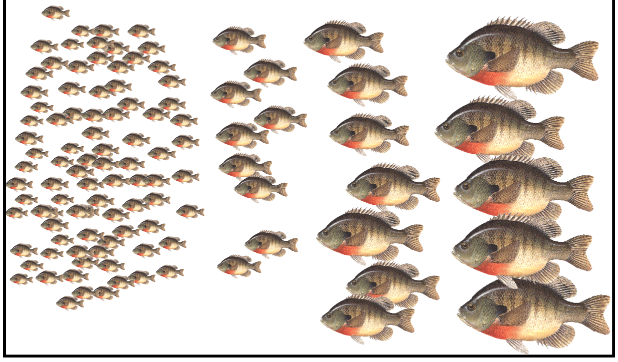
Application: For full consideration, applications should be received by **3/1/2017,** but the position may be filled sooner when a suitable candidate is found. **Electronic applications required.** To apply, please email cover letter, resume/CV and contact information for three professional references to: hroffice@inhs.illinois.edu - **(Reference "IRBS Field Tech" in subject line).**

Direct technical questions to Levi Solomon at soloml@illinois.edu.

Illinois is an equal opportunity employer and all qualified applicants will receive consideration for employment without regard to race, religion, color, national origin, sex, sexual orientation, gender identity, age, status as a protected veteran, or status as a qualified individual with a disability. Illinois welcomes individuals with diverse backgrounds, experiences, and ideas who embrace and value diversity and inclusivity. (www.inclusiveillinois.illinois.edu).

RECAP

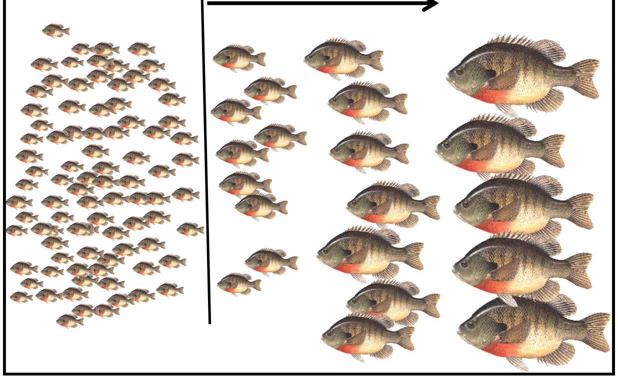
PSD review



PSD review

Stock (21)

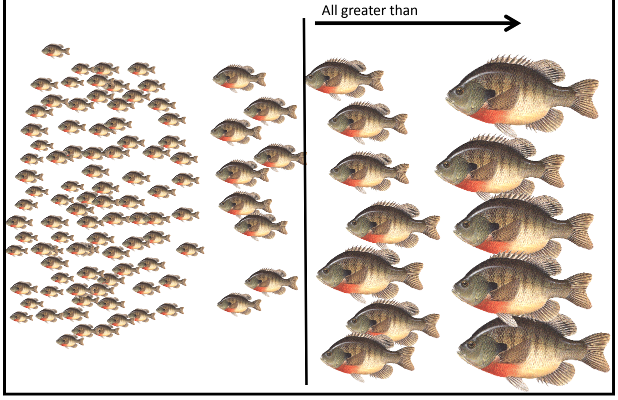
All greater than



PSD review

Quality (12)

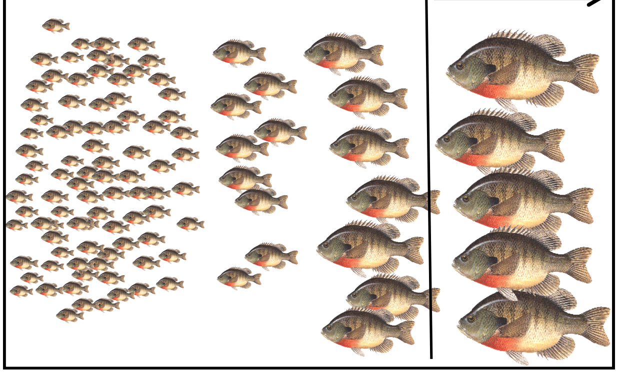
All greater than



PSD review

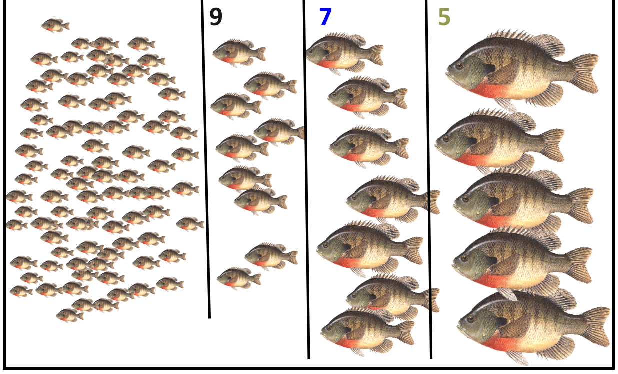
Preferred (5)

All greater than



Incremental

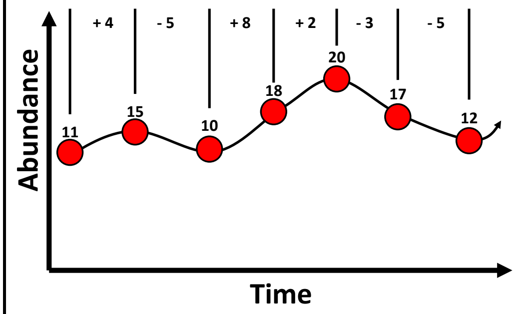
Stock	Quality	Preferred
9	7	5



Counts

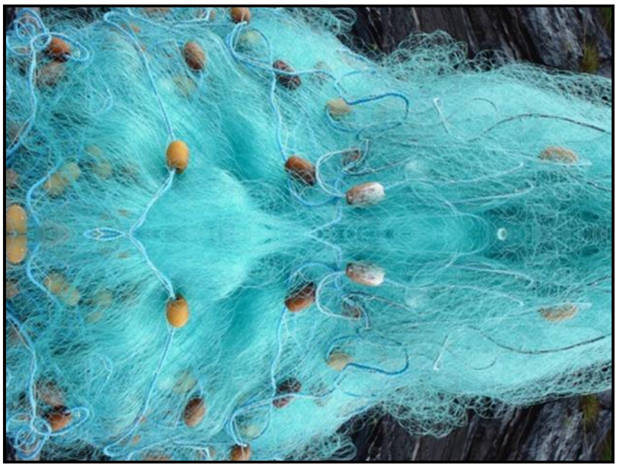
Size class	Total	Increment
Stock	21	9
Quality	12	7
Preferred	5	5

Change in population abundance over time



Year	Abundance	$Abundance_{year}$-$Abundance_{year-1}$
2014	11	? = 11 – ?
2015	15	4 = 15 – 11
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
2018	20	2 = 20 – 18
2019	17	-3 = 17 – 20
2020	12	-5 = 12 – 17

$$\frac{dAbundance}{dt} = Abundance_{year+1} - Abundance_{year}$$



POPULATION DYNAMICS CONTINUED

These are 'net changes' in the population over time

Year	Abundance	$Abundance_{year}$-$Abundance_{year-1}$
2014	11	? = 11 – ?
2015	15	4 = 15 – 11
2016	10	-5 = 10 – 15
2017	18	8 = 18 – 10
2018	20	2 = 20 – 18
2019	17	-3 = 17 – 20
2020	12	-5 = 12 – 17

Gains and losses

Reflect the <u>balance</u> of population gains and losses

Year	Abundance	$Abundance_{year}$-$Abundance_{year-1}$
2014	11	? = 11 – ?
2015	15	4 = 15 – 11
2016	10	-5 = 10 – 15
2017	18	8 = 18 – 10
2018	20	2 = 20 – 18
2019	17	-3 = 17 – 20
2020	12	-5 = 12 – 17

Gains and losses

Population dynamics in a nutshell:

Gains → Abundance → Losses

[Population change] = [Gains] – [Losses]

Gains and losses

Population dynamics in a nutshell:

Gains → Abundance → Losses

$$\frac{dAbundance}{dt} = gains - losses$$

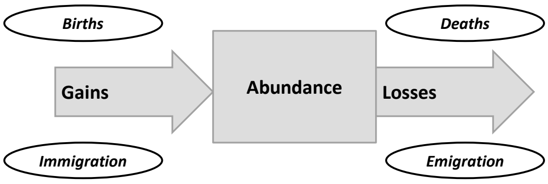
Gains and losses

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

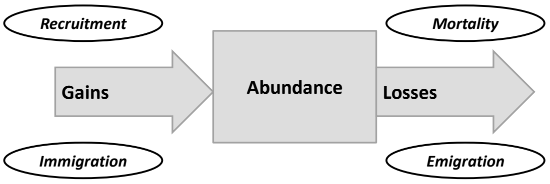
Population dynamics (BIDE model)

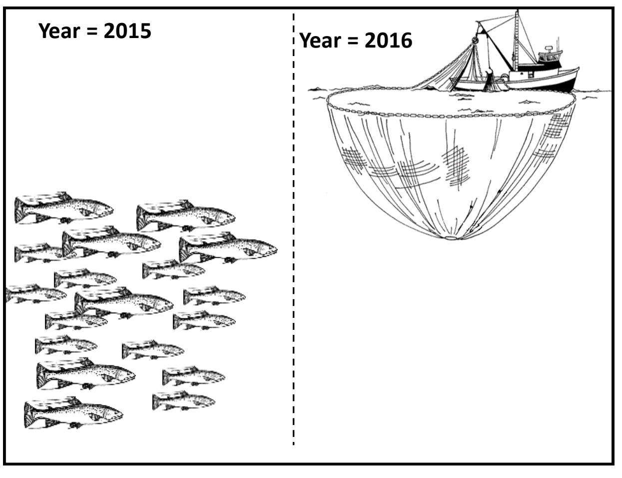
Birth+Immigration-Death-Emigration

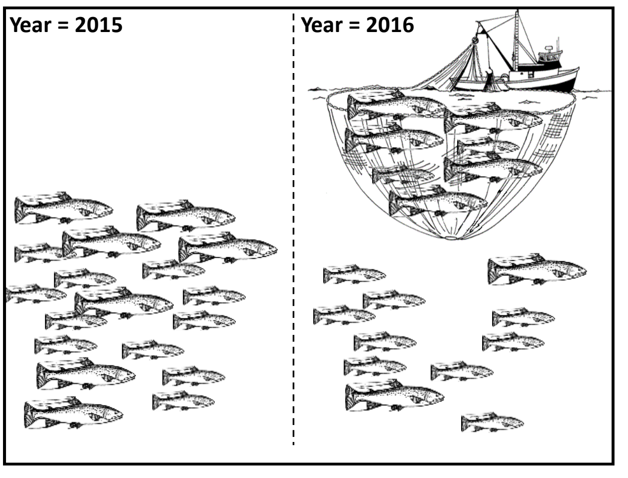


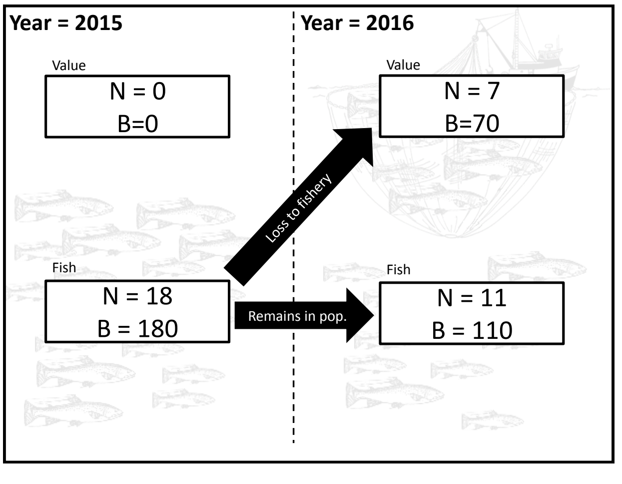
Fish dynamics

More conventional jargon



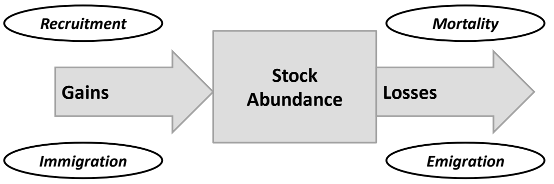


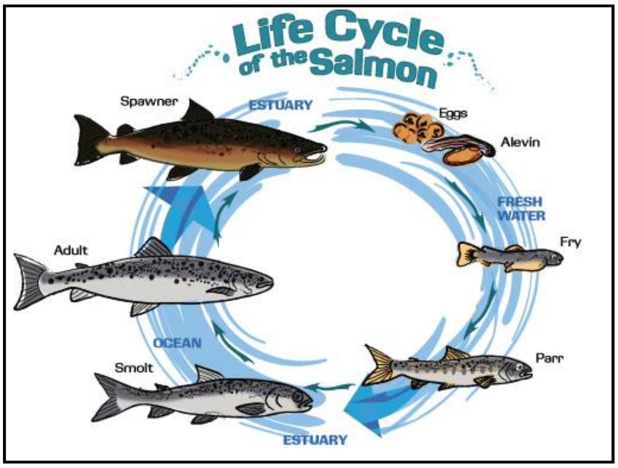


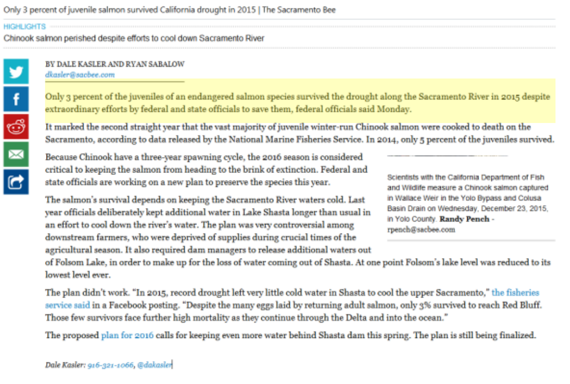


RECRUITMENT

Fish dynamics







Only 3 percent of juvenile salmon survived California drought in 2015 | The Sacramento Bee

HIGHLIGHTS

Chinook salmon perished despite efforts to cool down Sacramento River

BY DALE KASLER AND RYAN SABALOW
dkasler@sacbee.com

Only 3 percent of the juveniles of an endangered salmon species survived the drought along the Sacramento River in 2015 despite extraordinary efforts by federal and state officials to save them, federal officials said Monday.

It marked the second straight year that the vast majority of juvenile winter-run Chinook salmon were cooked to death on the Sacramento, according to data released by the National Marine Fisheries Service. In 2014, only 5 percent of the juveniles survived.

Because Chinook have a three-year spawning cycle, the 2016 season is considered critical to keeping the salmon from heading to the brink of extinction. Federal and state officials are working on a new plan to preserve the species this year.

Scientists with the California Department of Fish and Wildlife measure a Chinook salmon captured in Wallace Weir in the Yolo Bypass and Colusa Basin Drain on Wednesday, December 23, 2015, in Yolo County. **Randy Pench** - rpench@sacbee.com

The salmon's survival depends on keeping the Sacramento River waters cold. Last year officials deliberately kept additional water in Lake Shasta longer than usual in an effort to cool down the river's water. The plan was very controversial among downstream farmers, who were deprived of supplies during crucial times of the agricultural season. It also required dam managers to release additional waters out of Folsom Lake, in order to make up for the loss of water coming out of Shasta. At one point Folsom's lake level was reduced to its lowest level ever.

The plan didn't work. "In 2015, record drought left very little cold water in Shasta to cool the upper Sacramento," the fisheries service said in a Facebook posting. "Despite the many eggs laid by returning adult salmon, only 3% survived to reach Red Bluff. Those few survivors face further high mortality as they continue through the Delta and into the ocean."

The proposed plan for 2016 calls for keeping even more water behind Shasta dam this spring. The plan is still being finalized.

Dale Kasler: 916-321-1066, @dakasler

What is *recruitment*?

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

Catchable, harvestable, or adult?

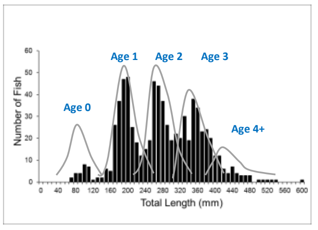
- Varies among fish
  - Species
  - Locations
  - Studies

The definition of a recruit is vague!

Defining a "recruit"

Typically defined by fish length or age

- Length: stock-size (200 mm) largemouth bass
- Age: age-1 white crappie



Recruit definitions

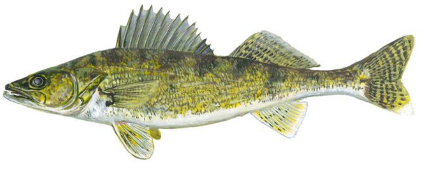
Froese (2004) – Coho salmon, OR

The data represent females migrating upstream to spawn (S), and the resulting female smolts migrating downstream approximately 1.5 years later (R).

Recruit definitions

- Beard et al. (2003) – Walleye, WI

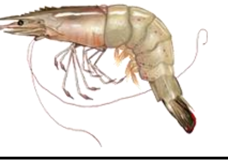
where *R* is the number of age-0 recruits per kilometer, *S* is the number of adult walleyes per hectare,



Recruit definitions

- Belcher & Jennings (2004) – White shrimp, GA

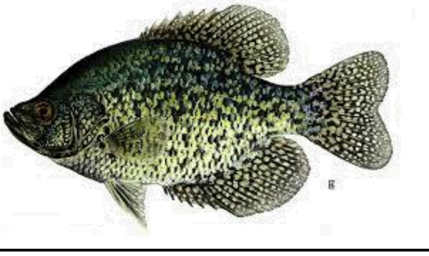
The total pounds of white shrimp caught during May–June represented spawners, whereas the total pounds of white shrimp caught during August–January represented recruits.



Recruit definitions

- Allen & Miranda (2001) – Black crappie, MS

where *R* is recruits (number of age-1 fish), *S* is stock (number of fish older than age 1),

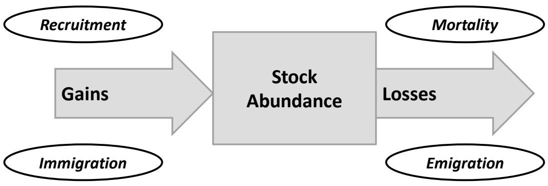


Recruit definitions

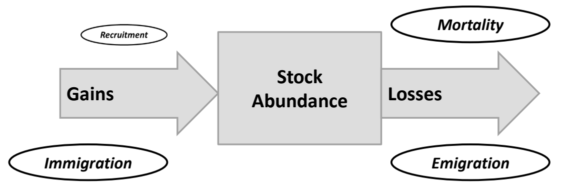
- Richards et al. (2004) – Lake Trout, MI

and Sitar 2000). To account for the time lag between spawning and recruitment at age 7, spawning stock CPE measured during 1970–1990 was matched with CPE of age-7 recruits during 1978–1998 to model recruitment of the 1971–1991 year-classes.

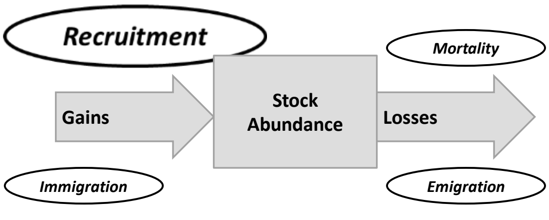
Effects of recruitment on fish population dynamics



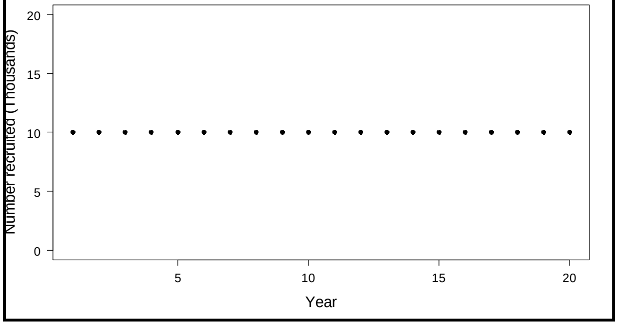
Recruitment can vary-low



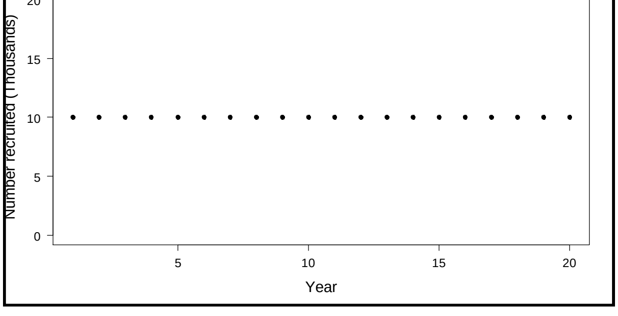
Recruitment can vary-high



Constant recruitment



Do you think this is reasonable?



Factors influencing recruitment

Density Independent
- Changes in water level or flow
- Aquatic plant abundance or species composition
- Water temperature

Density Dependent
- Spawning stock abundance
- Year-class strength
- Can stabilize recruitment

IMPORTANT:

Recruitment is not determined solely by how many young-of-year (YOY = baby) fish are produced. You can have low recruitment in a year when YOY production is very high, or high recruitment when YOY production is relatively low.

Why do you think this is?

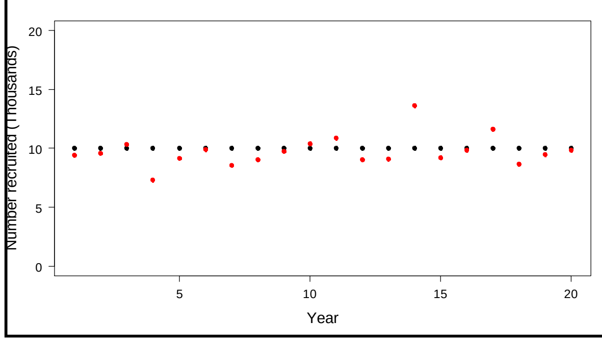
Quantifying recruitment variability

Most straightforward measure of recruitment variability is the coefficient of variation (CV):

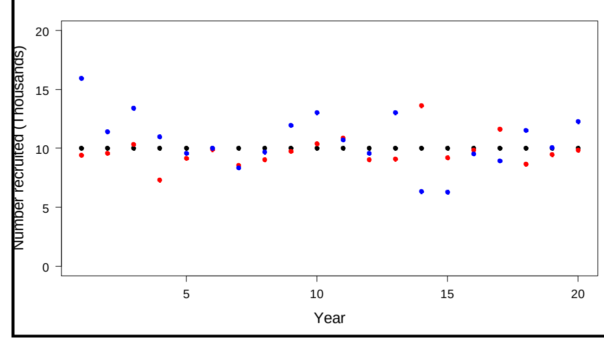
$$CV = \frac{\sigma}{\mu}$$

High CV values in recruitment will cause population characteristics and associated angler catch rates to fluctuate.

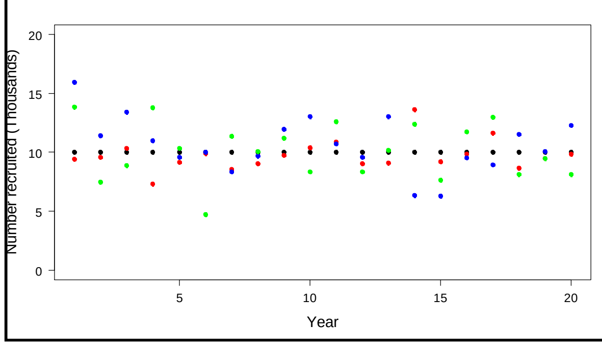
CV = 10%



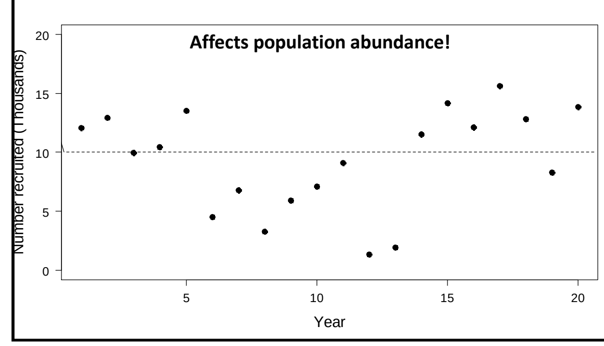
CV = 20%



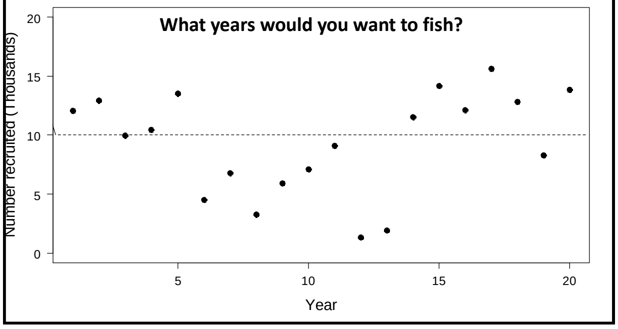
CV = 30%



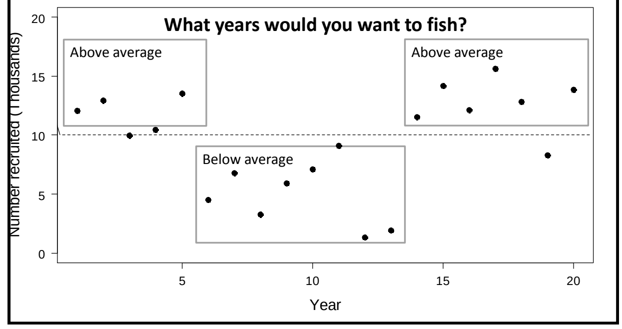
The magnitude of recruitment variation is important to because…



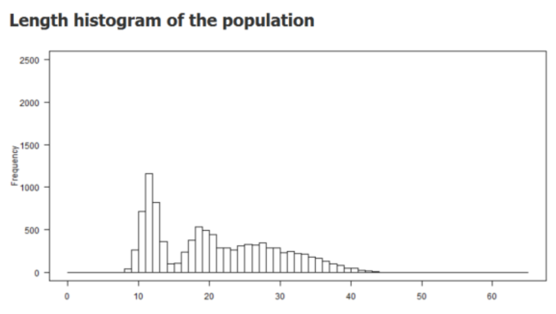
The magnitude of recruitment variation is important to because…



The magnitude of recruitment variation is important to because…



Effects of recruitment



Why do we measure recruitment?

- Recruitment can vary from year to year by orders of magnitude!
- Influences:
    - Population abundance
    - Age structure
    - Size structure
    - Growth rates (when recruitment very high)

Important when evaluating harvest policies!

How do we measure recruitment?

Catch per unit effort (CPUE *or Cf*) indices are the standard measure of recruitment

<u>**Sampling gears for *Cf* of small fish**</u>

- Electrofishing
- Trawls
- Trap nets
- Hoop nets
- Seines

Some sampling considerations

- **Annual samples, depending on life history**
- **Taken the same time each year**
- **Ideally under similar conditions**

Cautionary note

Preferably gears that can be quantified…

For example, light traps have less utility because they sample an unknown volume of water, but can provide relative abundance from year to year.

The catch process

$$Catch = q \cdot f \cdot N$$

Where:

Catch = catch

f = fishing effort (e.g., trawl time or net night)

q = the catchability coefficient (fraction of population caught per unit effort)

N = fish abundance

Catch per unit effort

$$Catch = q \cdot f \cdot N$$

$$\frac{Catch}{f} = q \cdot N$$

$$CPUE = \frac{Catch}{f} = q \cdot N$$

Using *C/f* assumes that there is a linear relationship between *C/f* and abundance.

Catch per unit effort

$$Catch = q \cdot f \cdot N$$

$$\frac{Catch}{f} = q \cdot N$$

$$CPUE = \frac{Catch}{f} = q \cdot N$$

Using *Cf* assumes that there is a linear relationship between *Cf* and abundance

Example of calculating CPUE

Perform 5 seine halls at a small pond

Catch: 87, 103, 103, 92, 105 age-1 bluegills

Effort = 5 hauls

$$Cf = \frac{\sum_{i=1}^{n} Catch_i}{n_{hauls}}$$

$$Cf = \frac{87 + 103 + 103 + 92 + 105}{5}$$

$$Cf = 93\ fish \cdot haul^{-1}$$

In the next year

Perform 5 seine halls at a small pond

Catch: 74, 58, 55, 62, 81 age-1 bluegills

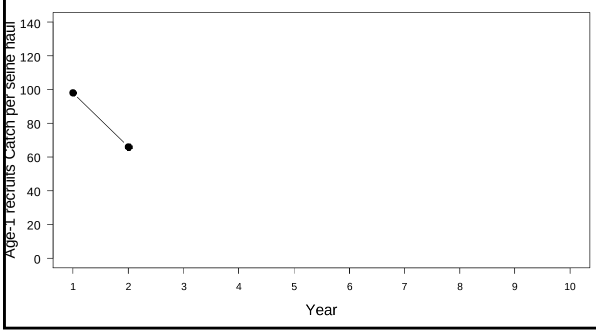
Effort = 5 hauls

$$Cf = \frac{\sum_{i=1}^{n} Catch_i}{n_{hauls}}$$

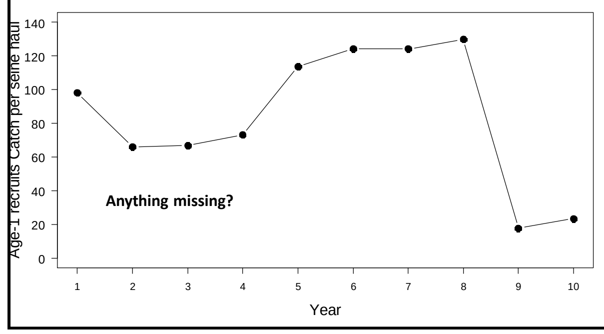
$$Cf = \frac{74 + 58 + 55 + 62 + 81}{5}$$

$$Cf = 66\ fish \cdot haul^{-1}$$

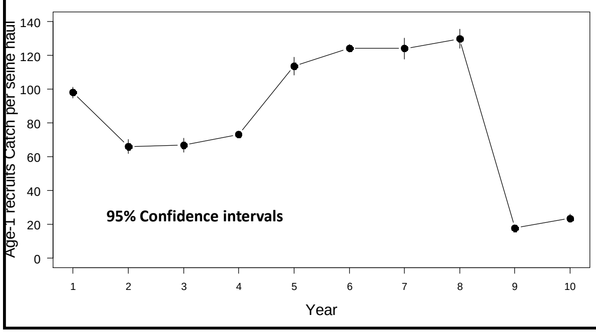
Monitoring recruitment



Monitoring recruitment



Addressing uncertainty



Recruitment

Year	Recruitment	Immigration	Mortality	Emmigration
1	**3**	**0**	**3**	**0**
2	2	0	3	0
3	1	0	3	0
4	2	0	3	0
5	4	0	3	0
6	1	0	3	0
7	1	0	3	0
8	1	0	3	0
9	1	0	3	0
10	1	0	3	0

Initial population = 5

What's wrong with these dynamics?