WF4113-Fisheries Science

Class 3-Sampling & Population Size Structure

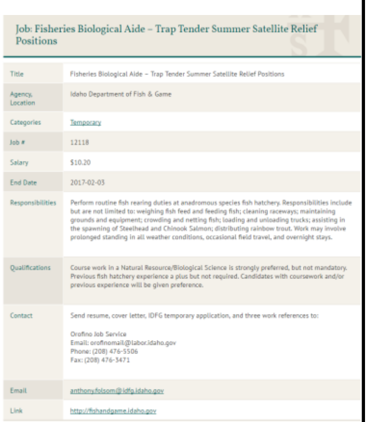
Housekeeping

Supplemental reading has been posted to class website.

1. Guy, C. S., R. M. Neumann, and D. W. Willis. 2006. New terminology for proportional stock density (PSD) and relative stock density (RSD): Proportional size structure (PSS). Fisheries **31**:86-87.
2. Neumann, R. M., C. S. Guy, and D. W. Willis. 2013. Length, Weight, and Associated Indices.*in* A. V. Zale, D. L. Parrish, and T. M. Sutton, editors. Fisheries Techniques, Third Edition. American Fisheries Society, Bethesda, MD.

Housekeeping

Job of the week…


Job: Fisheries Biological Aide – Trap Tender Summer Satellite Relief Positions

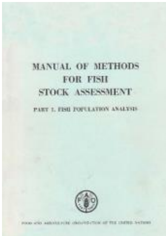
Title	Fisheries Biological Aide – Trap Tender Summer Satellite Relief Positions
Agency, Location	Idaho Department of Fish & Game
Categories	Temporary
Job #	12118
Salary	$10.20
End Date	2017-02-03
Responsibilities	Perform routine fish rearing duties at anadromous species fish hatchery. Responsibilities include but are not limited to: weighing fish feed and feeding fish; cleaning raceways; maintaining grounds and equipment; crowding and netting fish; loading and unloading trucks; assisting in the spawning of Steelhead and Chinook Salmon; distributing rainbow trout. Work may involve prolonged standing in all weather conditions, occasional field travel, and overnight stays.
Qualifications	Course work in a Natural Resource/Biological Science is strongly preferred, but not mandatory. Previous fish hatchery experience a plus but not required. Candidates with coursework and/or previous experience will be given preference.
Contact	Send resume, cover letter, IDFG temporary application, and three work references to: Orofino Job Service Email: orofinomail@labor.idaho.gov Phone: (208) 476-5506 Fax: (208) 476-3471
Email	anthony.folsom@idfg.idaho.gov
Link	http://fishandgame.idaho.gov

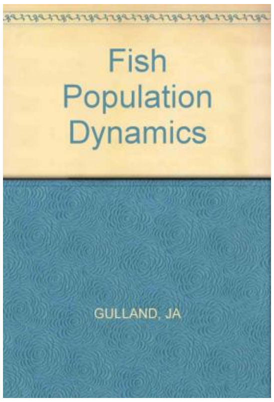
Fisheries icon: Dr. John Gulland.

Dr John Alan Gulland, FRS

26 September 1926 – 24 June 1990

Gulland is famous for …





Scientific contributions

- Virtual population analysis (VPA)
- Introduce the $F_{0.1}$ concept
- Developed a number of short cut methods for assessing tropical fish stocks

Thinking *inside* the box

Fish | Value | Habitat

Stock aka state variable

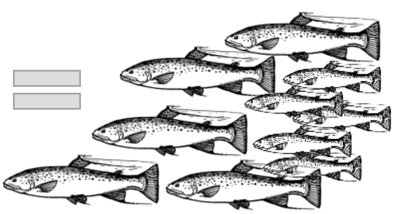
Something **measureable & can stored or lost over time**:

- Abundance
- Biomass

Thinking *inside* the box

Fish | Value | Habitat

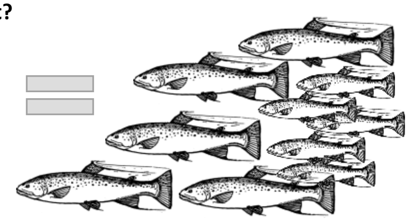
10 Fish or 28 Kilograms =



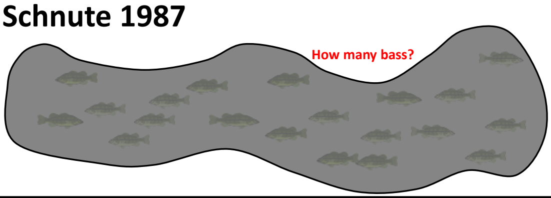
Quantifying a fish population (aka a state variable) is fundamental to fisheries science

How do we figure this nubmer out?

10 Fish or 28 Kilograms =



"The trouble with fish is that you never get to see the whole population. They're not like trees, whose numbers can be estimated by flying over a forest. Mostly you see fish only when they're caught…" Schnute 1987

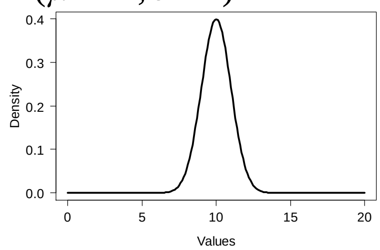


Our "view" of fish populations comes from a variety of sources: anglers, commercial fisheries, and sampling gears. Each has inherent biases, and we rarely have complete information about the fishery of concern.

SAMPLING AND ESTIMATION

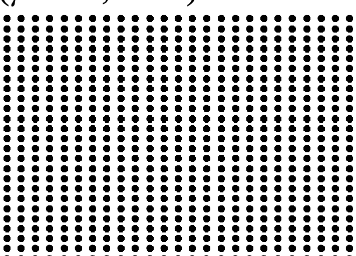
Sampling is designed to provide an unbiased estimate of the sampling frame.

$$Y_i \sim Normal(\hat{\mu} = 10, \sigma = 1)$$

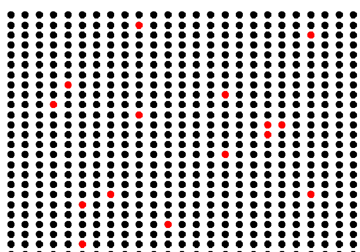


Example: A population has 625 individuals and the true mean is 10 and variance is 1

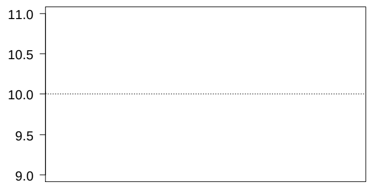
$$Y_i \sim Normal(\hat{\mu} = 10, \sigma = 1)$$



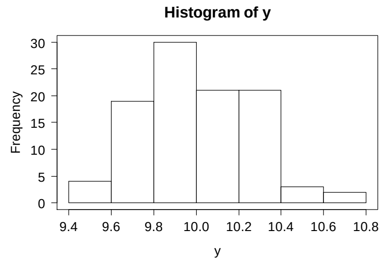
A simple random sample assumes each sampling unit has an equal probability of being selected



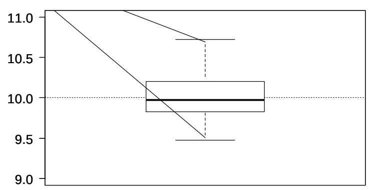
We know that the mean of the population is 10.



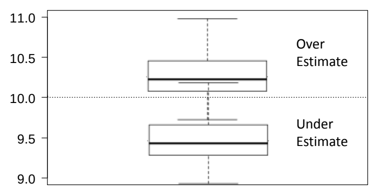
If we sample the population many times, again, taking 15 observations, the estimated means should be centered ~10 …. Right?



Yes, they are centered around 10, the mean using a random sample is <u>unbiased</u>



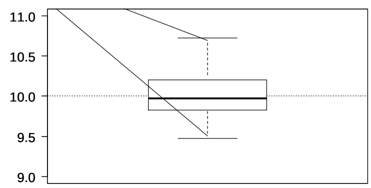
Yes, they are centered above or below 10, the mean using a random sample is <u>biased</u>



In some cases we want to know something about the total population, like total weight

$$Mean\ Weight = \mu = 9.68$$
$$Total\ Weight = N \cdot \mu$$
$$Total\ Weight = 625 \cdot 9.68$$
$$Total\ Weight = 6050$$

Yes, they are centered around 10, the mean using a random sample is unbiased



In some cases we want to know something about the total population, like total weight

$$Mean\ Weight = \mu = 9.68$$
$$Total\ Weight = N \cdot \mu$$
$$Total\ Weight = 625 \cdot 9.68$$
$$Total\ Weight = 6050$$

But the estimate of total weight is an estimate, it is not absolutely certain.

$$\text{var}(Total\ Weight) = N^2 \cdot \sigma^2 / n$$
$$\text{var}(Total\ Weight) = 625^2 \cdot 0.98^2 / 15$$
$$\text{var}(Total\ Weight) = 390625 \cdot 0.96 / 15$$
$$\text{var}(Total\ Weight) = 25000$$

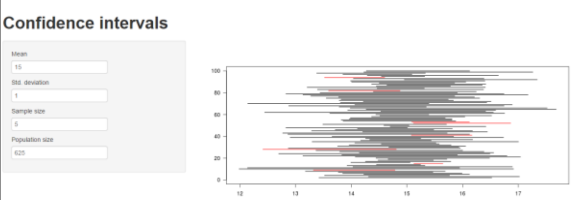
From the estimated variance for the total weight estimate we can calculate 95% confidence intervals

$$Estimate \pm 1.96 \cdot \sqrt{\sigma^2_{estimate}}$$

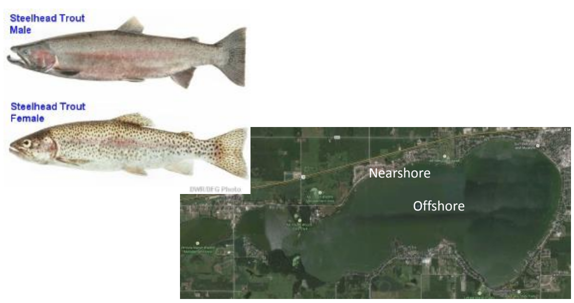
For the weight example the upper and lower 95% confidence interval can be calculated

$$Upper\ 95\%\ C.I. = 6050 + 1.96 \cdot \sqrt{25000}$$
$$Upper\ 95\%\ C.I. = 6359.9$$
$$Lower\ 95\%\ C.I. = 6050 - 1.96 \cdot \sqrt{25000}$$
$$Lower\ 95\%\ C.I. = 5740.1$$

Let's explore confidence intervals

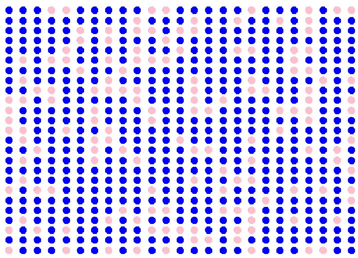


Sometimes there are reasons to stratify the sampling units.



475 Males (mean =12, variance = 2, 76%)

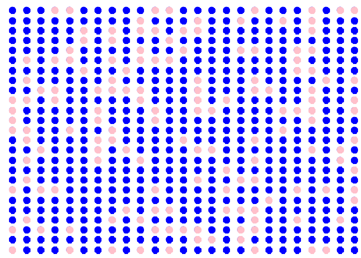
150 Females (mean = 9, variance = 3, 24%)



Lets sample 30 individuals, proportionally to strata

Males: 30*0.76=22.8

Females: 30*0.24=7.2



Estimate the overall mean

$$\mu_{overall} = \sum_{Sex=1}^{2} W_{sex} \cdot \mu_{sex}$$

$$\mu_{overall} = 0.76 \cdot 11.3 + 0.24 \cdot 11.0$$

$$\mu_{overall} = 8.59 + 2.64$$

$$\mu_{overall} = 11.23$$

Estimate the total weight

$$Total\,Weight = \sum_{Sex=1}^{2} N_{sex} \cdot \mu_{sex}$$

$$Total\,Weight = 475 \cdot 11.3 + 150 \cdot 11.0$$

$$Total\,Weight = 5367.5 + 1650$$

$$Total\,Weight = 7017.5$$

Estimate the variance of the estimate

$$Var(Total\,Weight) = \sum_{Sex=1}^{2} N_{sex}^2 \cdot \frac{\sigma_{sex}^2}{n_{sex}}$$

$$Var(Total\,Weight) = 475^2 \cdot \frac{1.98^2}{23} + 150^2 \cdot \frac{3.12^2}{7}$$

$$Var(Total\,Weight) = 38458.3 + 31289.1$$

$$Var(Total\,Weight) = 69747.41$$

From the estimated variance for the total weight estimate we can calculate 95% confidence intervals

$$Estimate \pm 1.96 \cdot \sqrt{\sigma_{estimate}^2}$$

For the weight example the upper and lower 95% confidence interval can be calculated

$$\mu \pm 1.96 \cdot \sqrt{\sigma^2_{estimate}}$$

$$Upper\,95\%\,C.I. = 6050 + 1.96 \cdot \sqrt{25000}$$

$$Upper\,95\%\,C.I. = 6359.9$$

$$Lower\,95\%\,C.I. = 6050 - 1.96 \cdot \sqrt{25000}$$

$$Lower\,95\%\,C.I. = 5740.1$$

Stratified sampling strategies

- Equal- nothing is known or assumed about the population
- Proportional-probably best in general
- Optimal- requires estimates of stratum variances (pilot data)

Once design is selected then figure out sample size

- Depends on
- Parameter of interest:
  - Mean
  - Total
- Study objectives
  - Research: More precise
  - Management: Less precise

Considerations for sample size

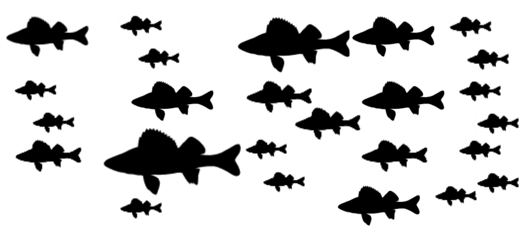
1. Biological versus statistical effects
2. Number of critters handled
3. Cost

What can you live with…?

Guidelines for the Use of Fishes in Research

Use of Fishes in Research Committee members:
J. A. Jenkins, Chair, H. L. Bart, Jr., J. D. Bowker, P. R. Bowser, J. R. MacMillan
J. G. Nickum, J. D. Rose, P. W. Sorensen, and G. W. Whitledge on behalf of the
American Fisheries Society; J. W. Rachlin and B. E. Warkentine on behalf of the
American Institute of Fishery Research Biologists; and H. L. Bart on behalf of the
American Society of Ichthyologists and Herpetologists

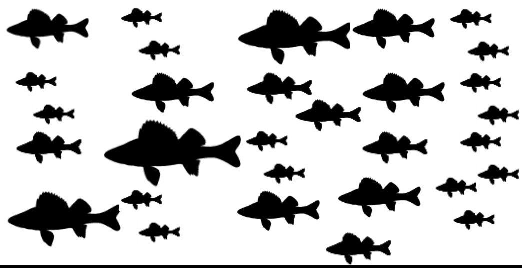
American Fisheries Society
Bethesda, Maryland
2014



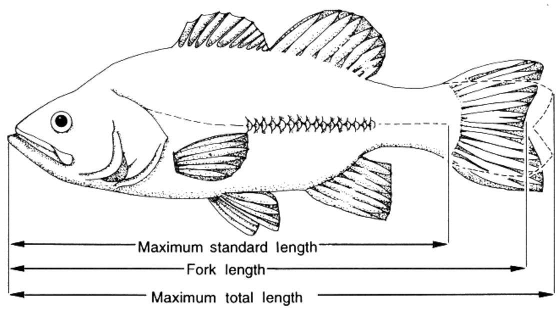
POPULATION CHARACTERISTICS-SIZE STRUCTURE

Population characteristics

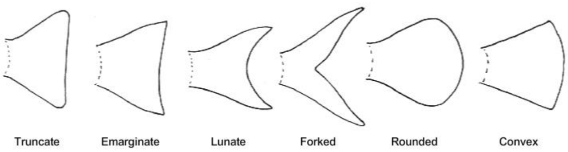
Quantities and indices of a population



Measuring length



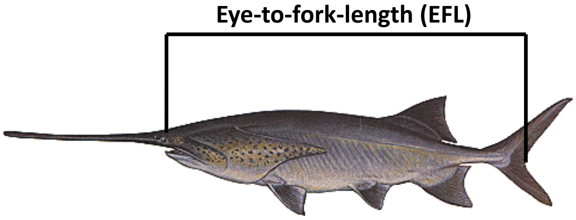
Type of tails



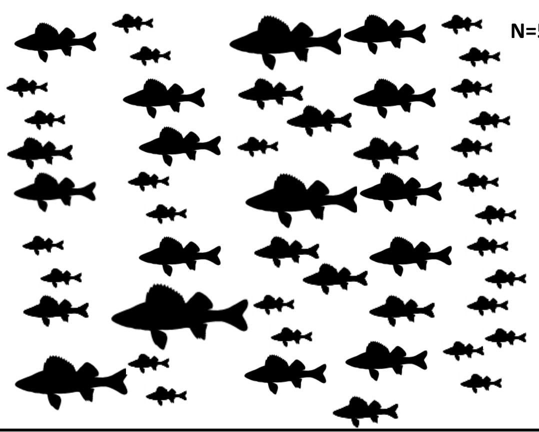
Generally determines what type of length to take!

Did you know that over 5700 pounds of caviar was harvested over the season in 2010 and 2011 in Moon Lake?
It is worth over <u>1.6 million dollars</u>

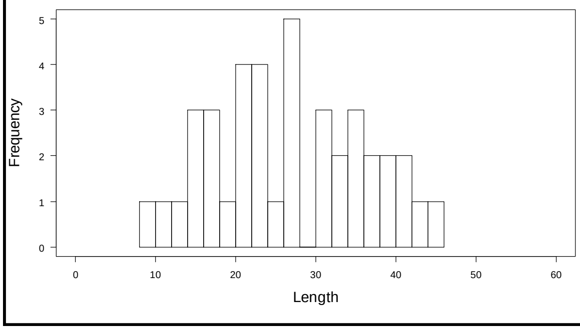
Eye-to-fork-length (EFL)



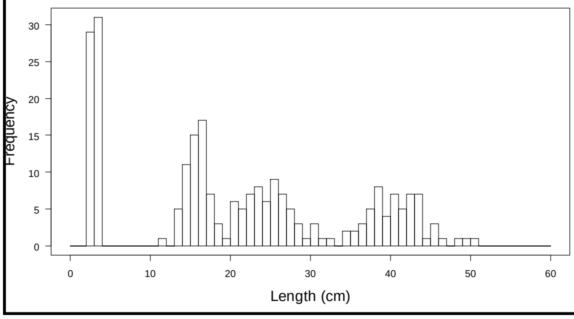
N=50



Presenting length data



We can learn things from length frequency data



We can also obscure things…