Fisheries Management Techniques FT 211

Joel Markis
Asst Professor
Fisheries Technology
University of Alaska Southeast

Chapter 14

Length, Weight,
and Associated Indices

Outline

This Module will Contain 5 Main areas

- Importance of Length & Weight
- Length measurements
- Weight measurements
- Length vs weight
- Length Frequency

Student Learning Outcomes

Students will be able to:

- Summarize length and weight measurements and why they are important in fisheries.
- Describe length measurement provide examples of the various techniques
- Describe weight measurement provide examples of the various techniques
- Describe the relationship between fish length and weight and provide examples of its usefulness
- Summarize length frequency information and how it can be used in fisheries

Length and weight data

Provide information that are cornerstones of fisheries research and management (aquaculture)

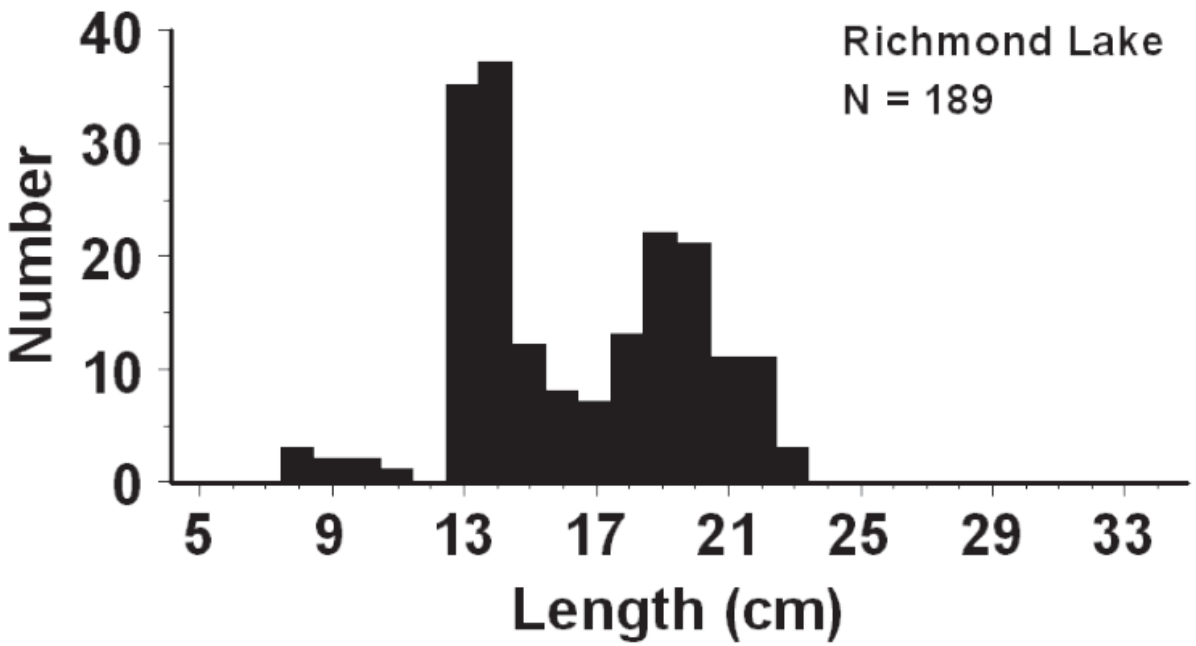
- Number and Size of fish determine its potential to provide benefits for commercial and recreational fisheries
- Estimates of:
  - Growth
  - Standing Crop (Biomass)
  - Production (Tissue Growth kg/area/yr)
- True In Natural Settings, Laboratories, Hatcheries (4g fish)

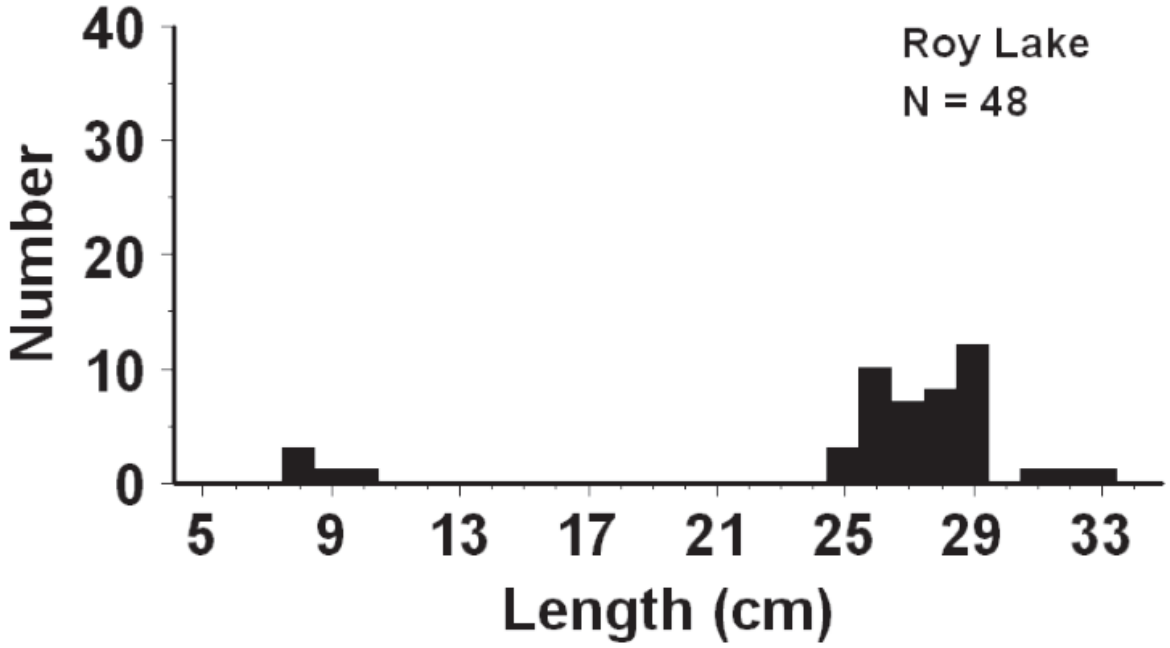
Length Frequency Data

- One challenge for a fisheries manager is to identify problems and opportunities presented by existing population structures
  - Altering mortality rates with length-limit regulations / slot limits

Introduction

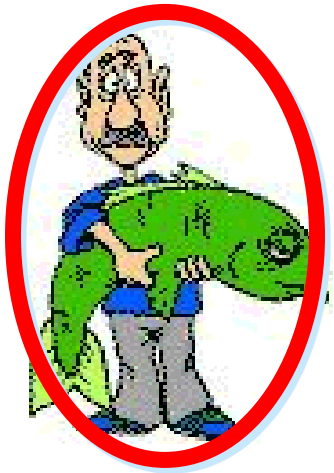
- Population ‘Structure’
  - Number of individuals at each age / size in Population





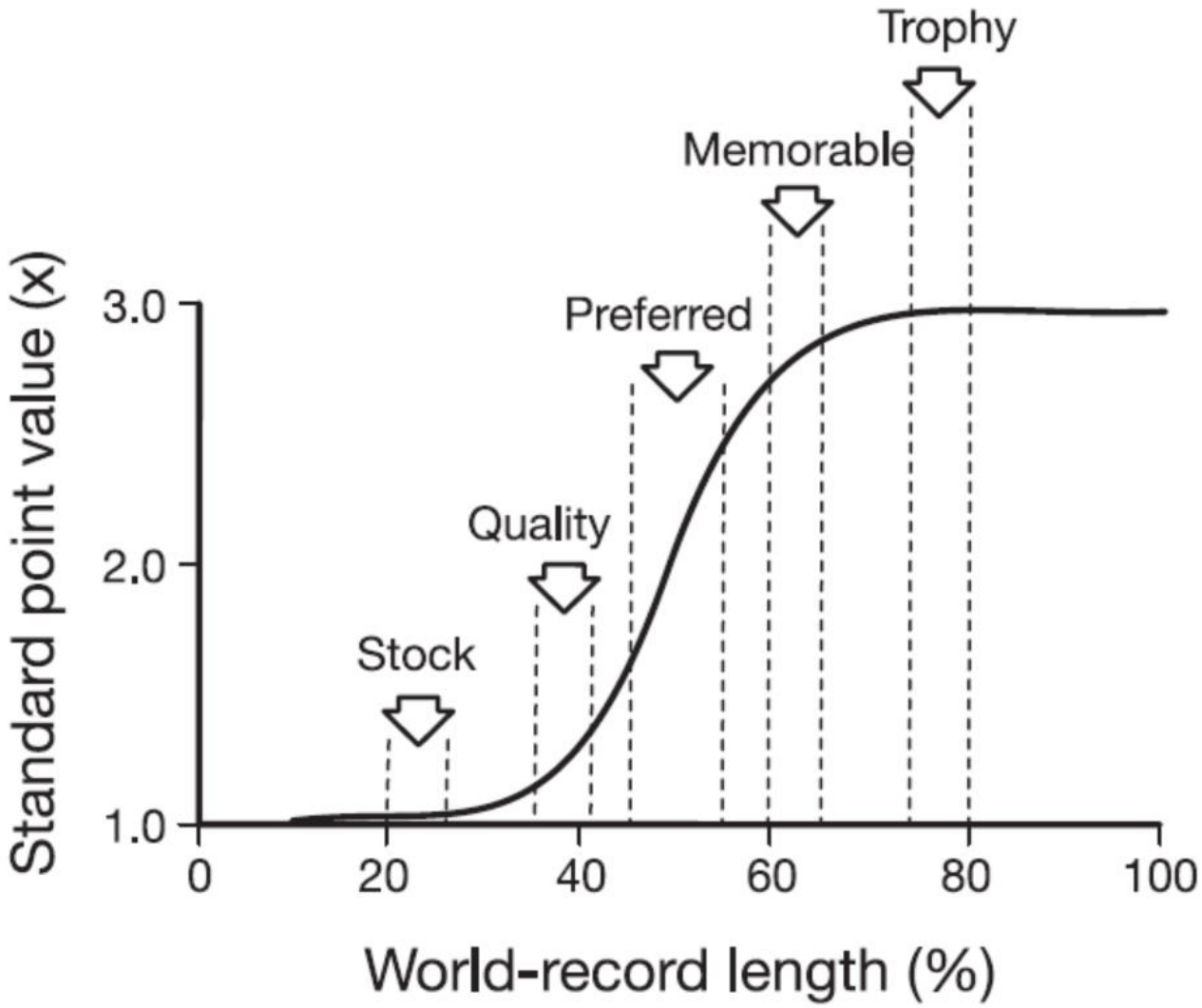
Fish Length & Weight

- Length defines legal size for harvest
- Relative number of fish in certain size categories
  - Measure of management objectives (lots of big fish)
  - Reproductively Mature (small fish don't reproduce)
- Weight can tell us about Biomass
  - Harvest (metric tons)
  - Standing Stock (kg/area)

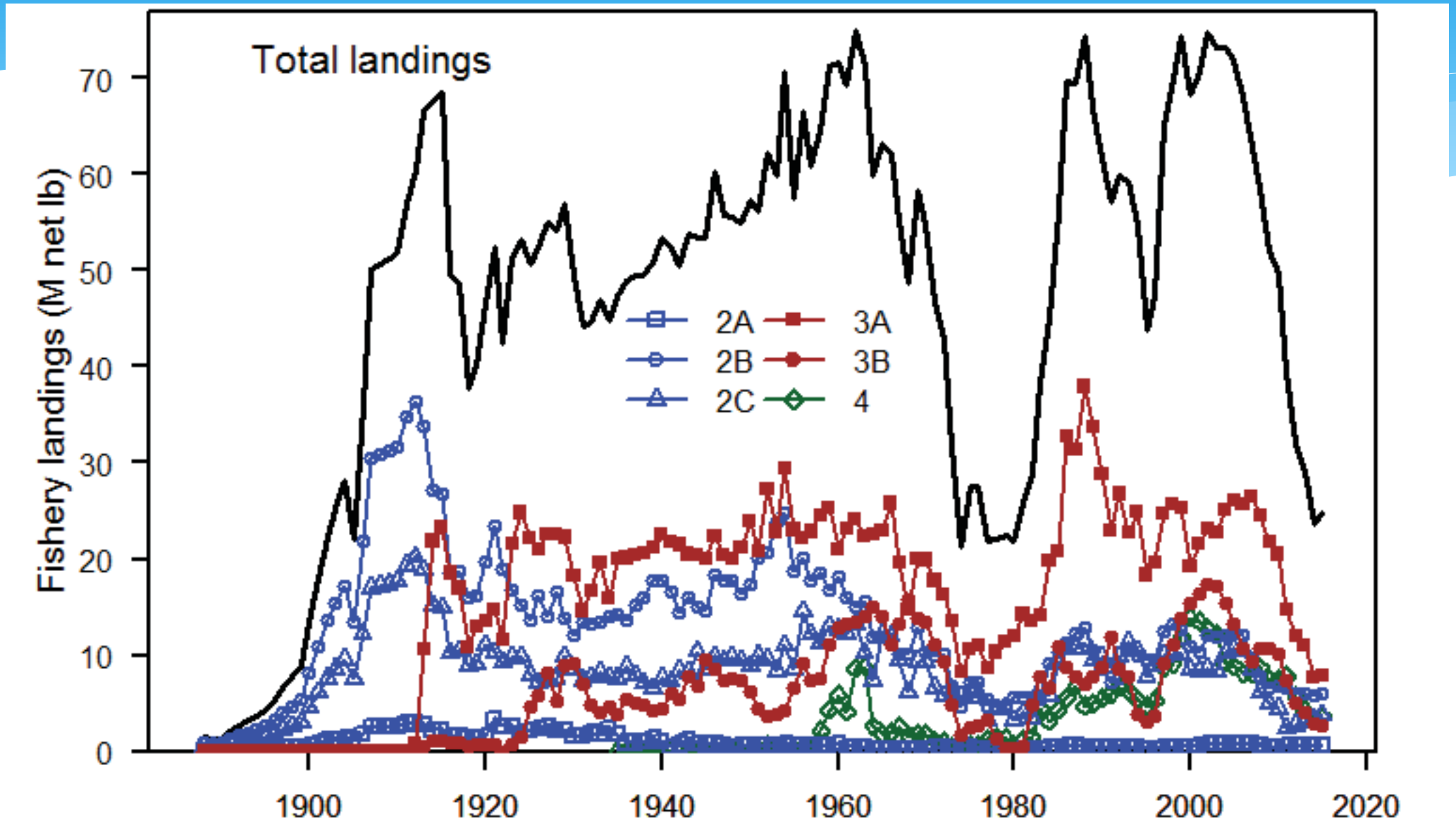


Length Categories

- Could use as management targets



Halibut Coastwide



Halibut length restrictions for Guided Anglers

Area 2C **Southeast** AK

- 1 Fish
- <42” or >80” (reverse slot limit)

Area 3A **Southcentral** AK

- 2 fish
- 1 any size, 1 <29 in”

Eastern Bering Sea Tanner Crab Size Limit Reduction

- This research focused on analysis of the minimum size limit for Eastern Bering Sea Tanner crab fisheries. The goal of this work was to evaluate the merits of a reduced minimum size limit for the Tanner crab fisheries

- 51/2 – 51/4?
  - Increased harvest quota
  - Required more time to catch quota (lengthened the season)

History of fish L, W, & Indices

- In 1940's made a bunch of ponds – irrigation / soil stabilization
  - Mosquitos cause malaria
  - Ponds with fish have less malaria
- Ponds can be used to raise fish for food
  - Drain ponds look at biomass (weight of all fish)
  - Biomass – relative plumpness
  - Size structure indices based on length
  - Fish condition (relative weight)
- L + W are cornerstone to fisheries community analysis
  - Tell us a lot about population Health & Condition

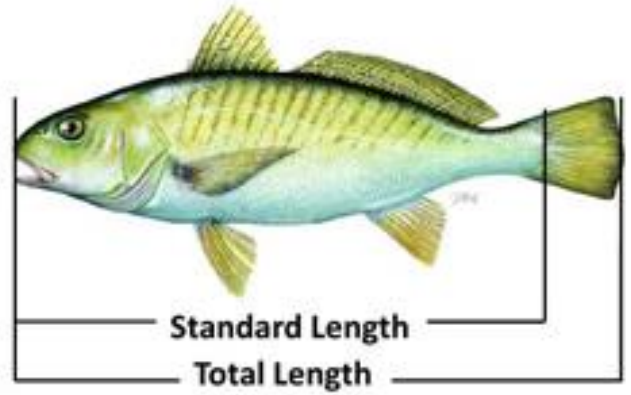
Self Check

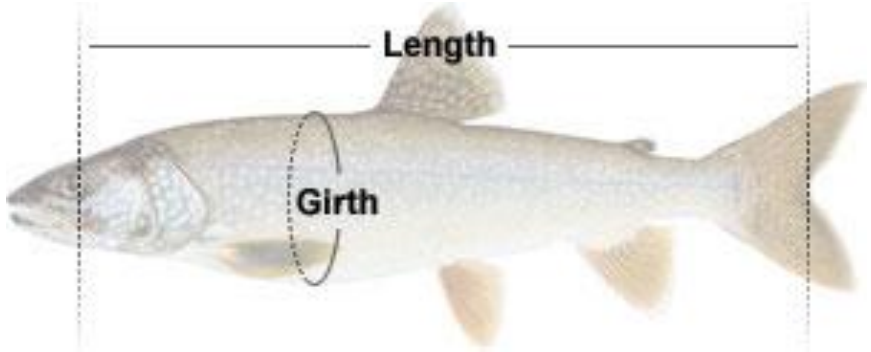
- Measuring fish length and weight became important to determine pond productivity around the turn of the century
  - **True**
  - False

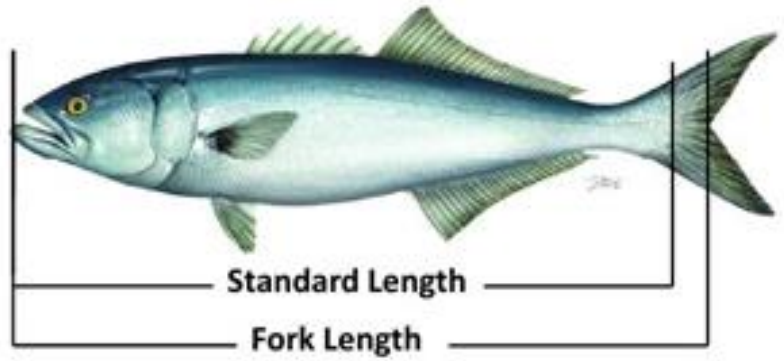
- Fish length can be used to help achieve management goals throught the use of size limits
  - **True**
  - False

Length

- Used to define legal size for harvest
  - Commercial and recreational
- Numerous ways to measure length
  - Standard Length
  - Fork Length
  - Total Length

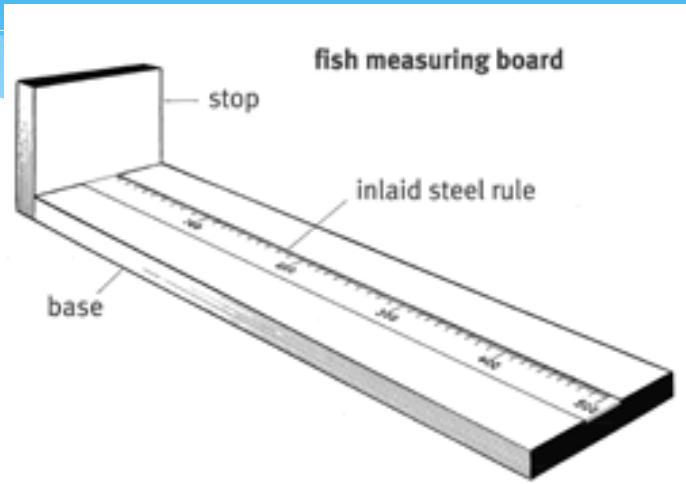


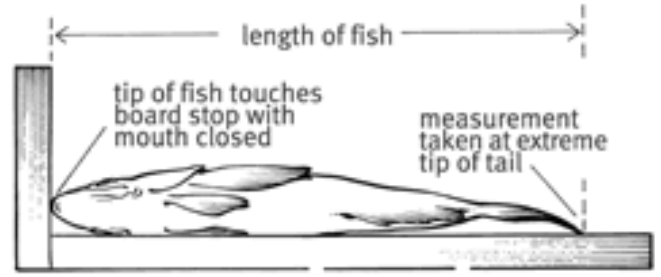


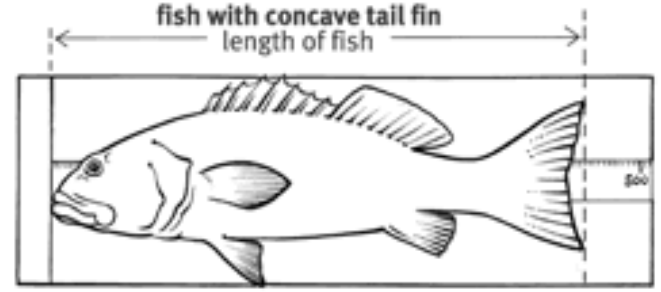


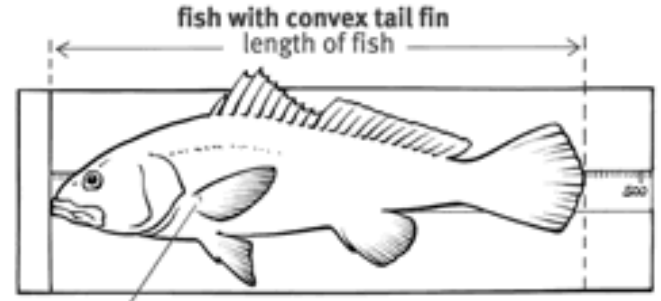
Measuring Conventions

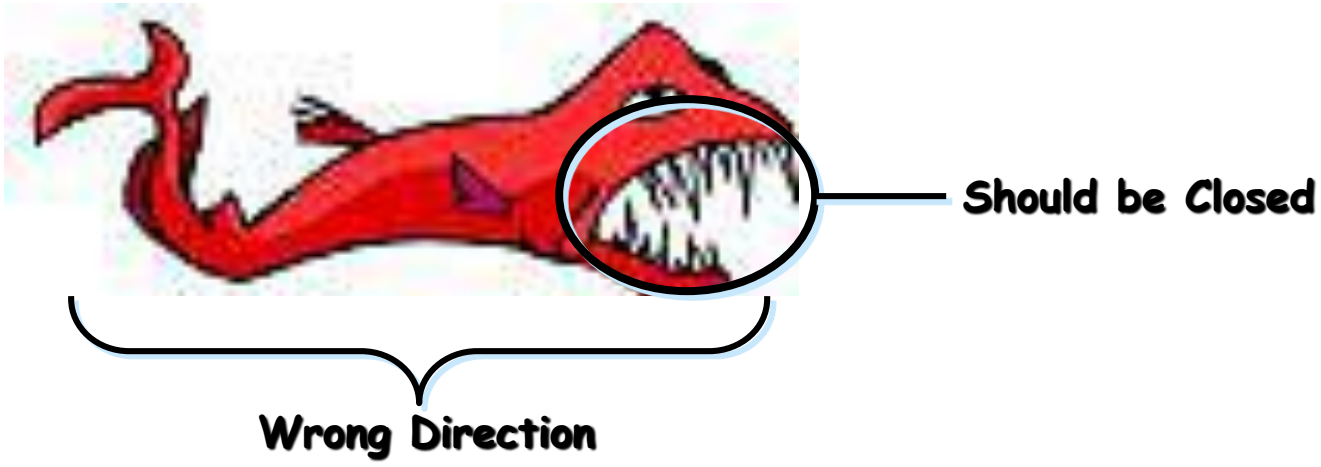
- Fish mouth closed
- Head left, tail right
- Measure fresh to avoid shrinkage and rigor mortis







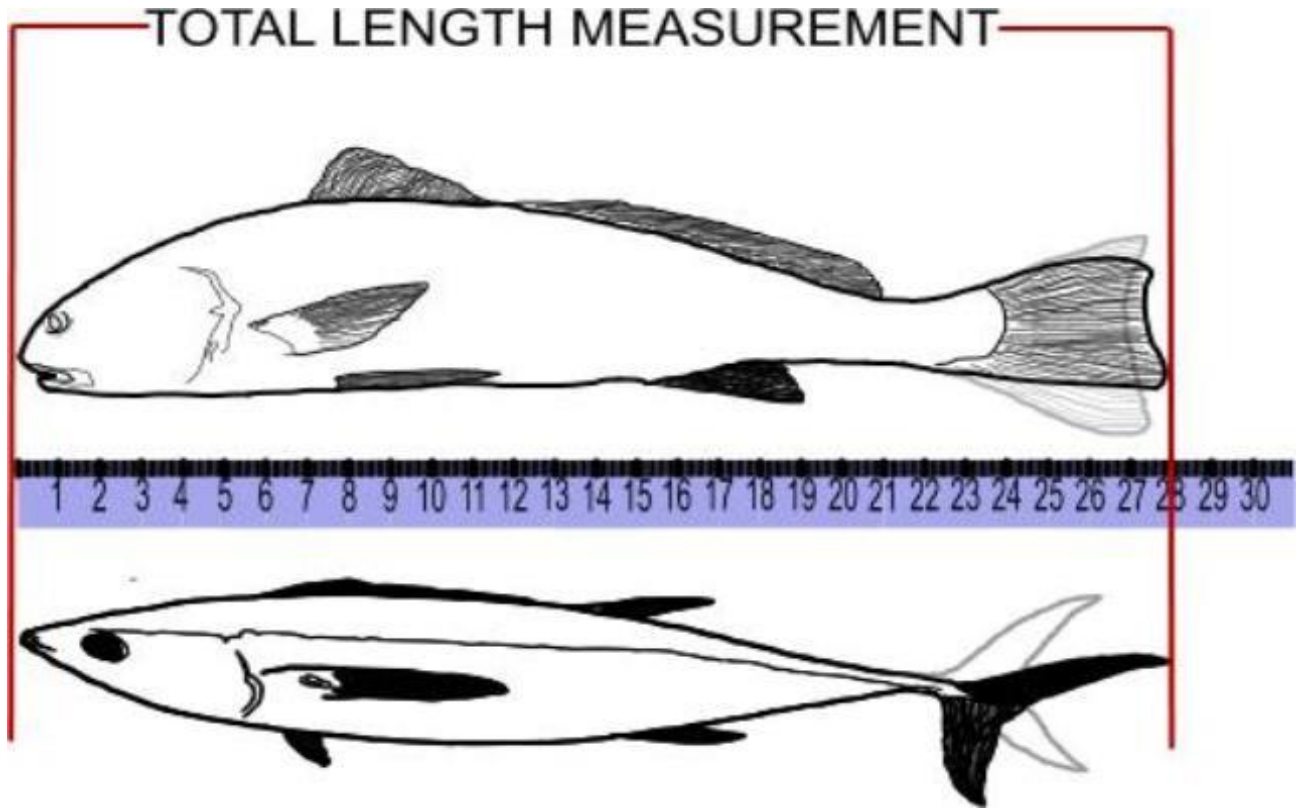




Fin fish pectoral fin

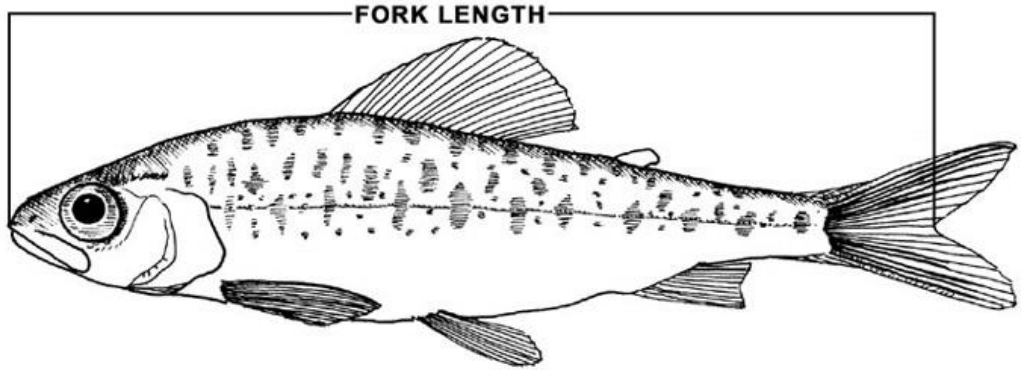
Total Length

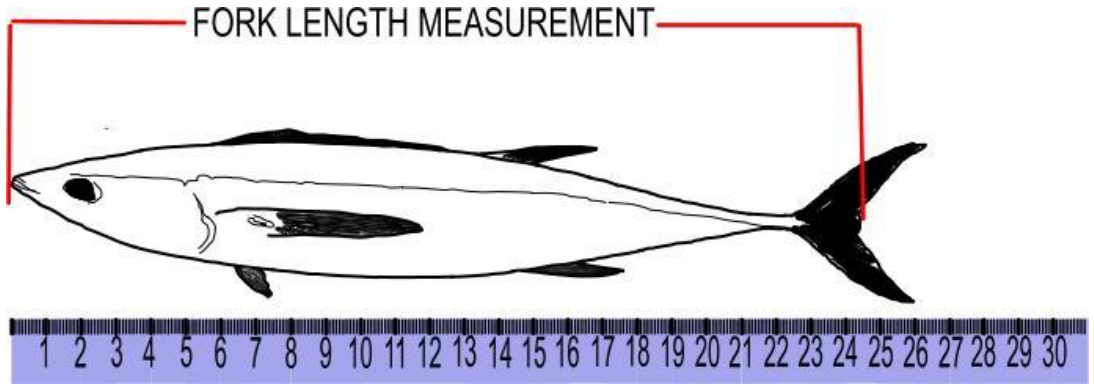
- Maximum length of the fish, with the mouth closed
- Mouth closed and nose up against a flat surface
- Do NOT pull a flexible tape measure along the curve of the fish



Fork Length

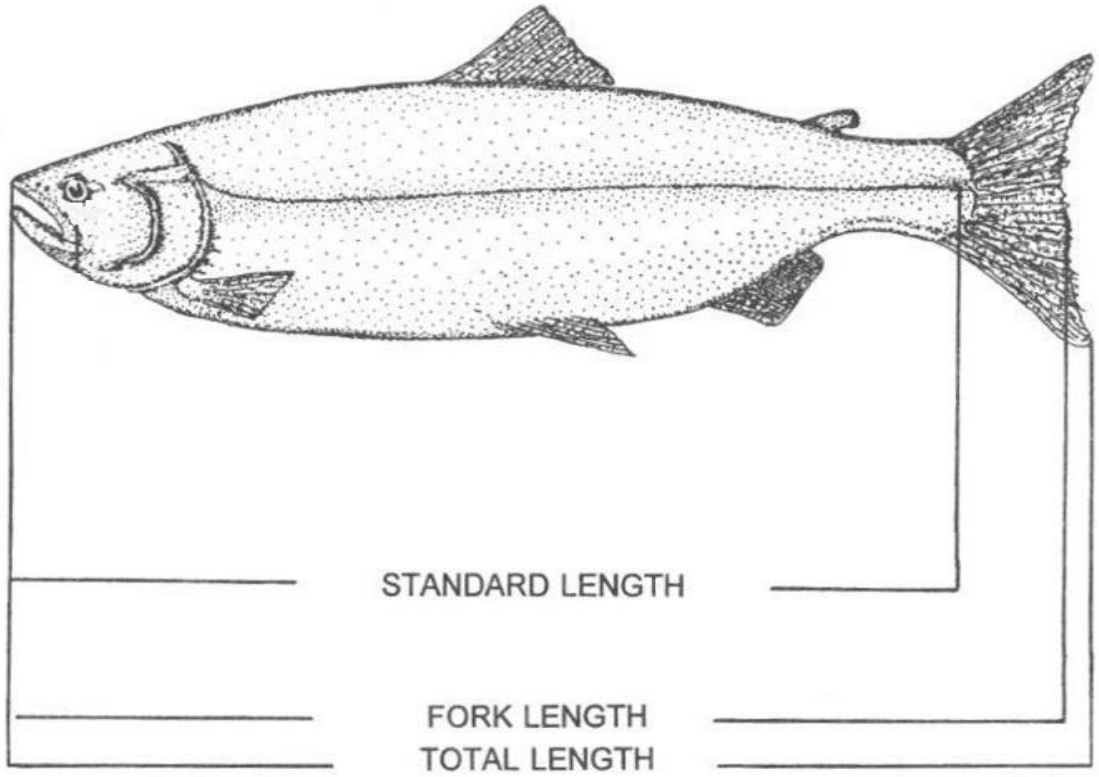
- Tip of snout to fork in tail

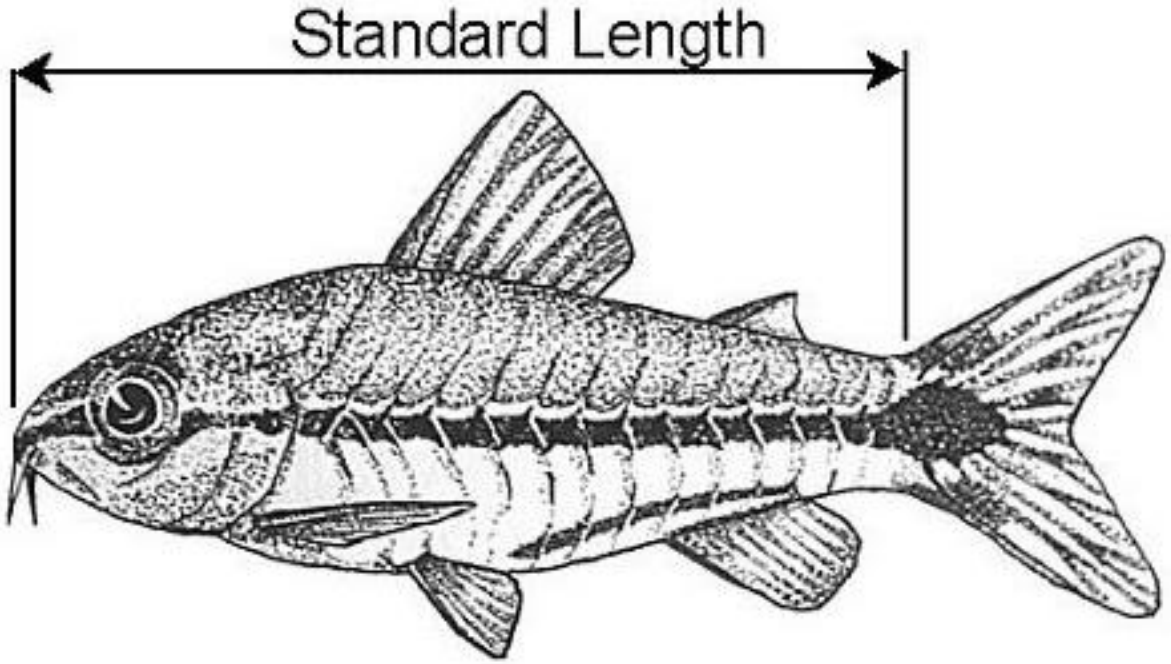




Standard Length

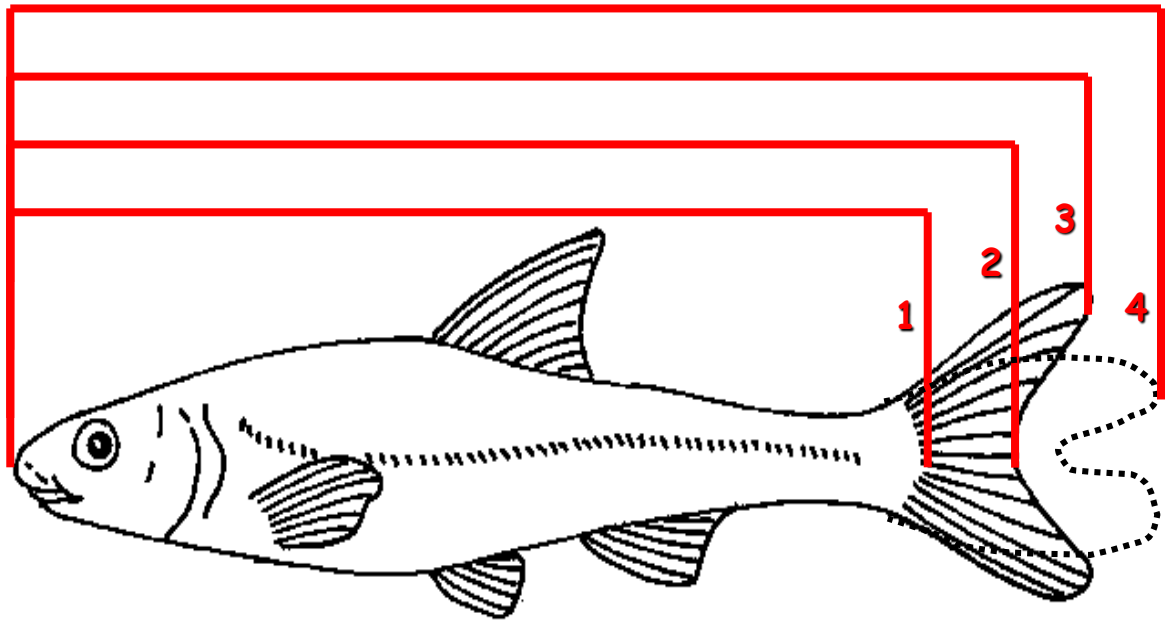
- Tip of snout to base of caudal peduncle
  - Area where fleshy part of tail ends
  - Not affected by tail damage





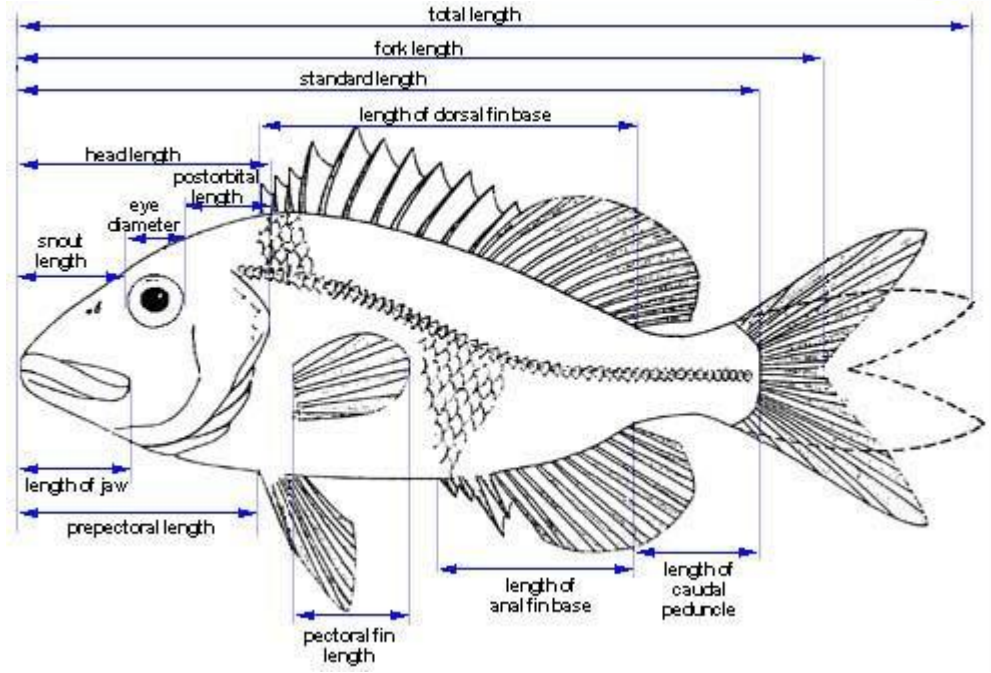
Length

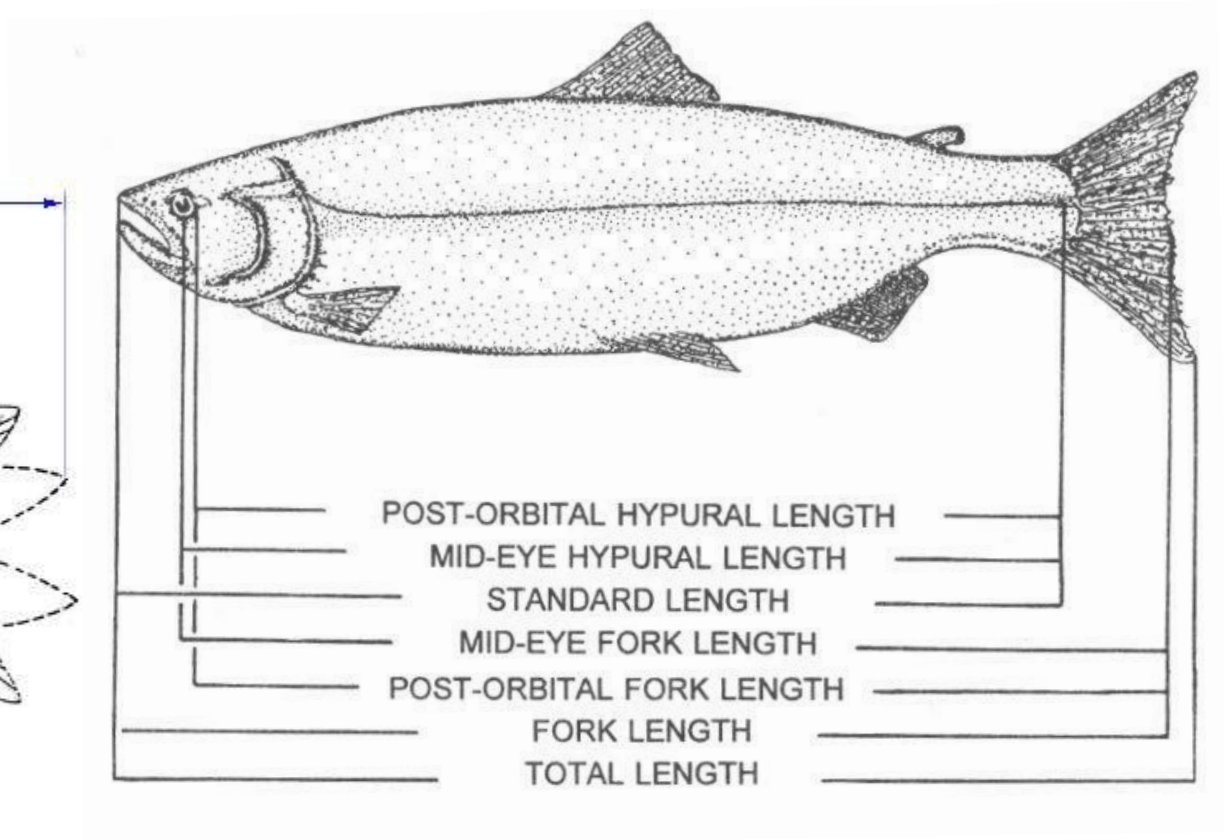
- Typically in mm unless large fish (cm)
  - Standard length (1)
  - Fork length (2)
  - Natural total length (3)
  - Maximum total length (4)



Other Fish lengths

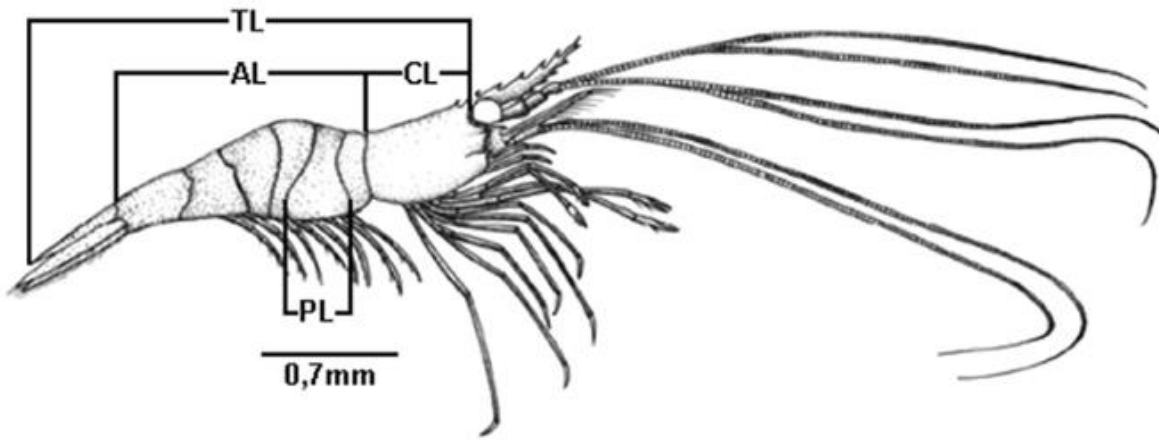
- WHY?
  - Spawning (sockeye)
  - Paddlefish / swordfish
  - Missing parts





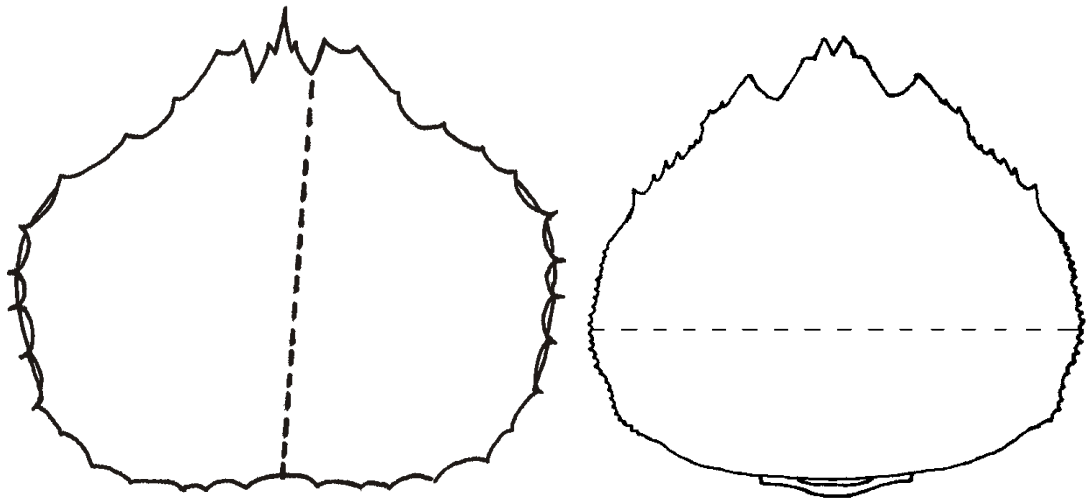
Other Species

- Crabs
- Clams
- Urchins
- Sea Cucumbers
- Shrimp



Carapace length

Carapace width

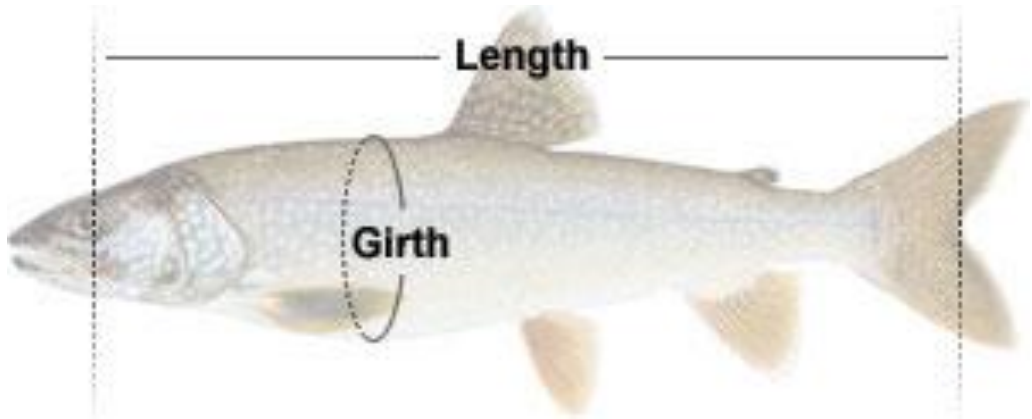


King crabs

Snow, Tanner, Dungeness

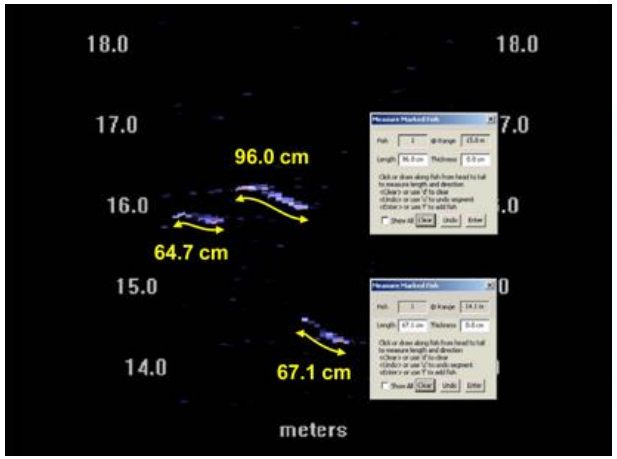
Fish Girth

- Best measured with fabric tape
- String technique
- Measured around of the fattest part of the fish



Measuring devices

- **Measuring boards**
  - 1 person to measure, 1 person to record
- **Calipers** - small fish
- **Measuring tape** - large marine species
- **Electronic measuring boards** - records automatically
- **DIDSON** – Sonar
- **Video**



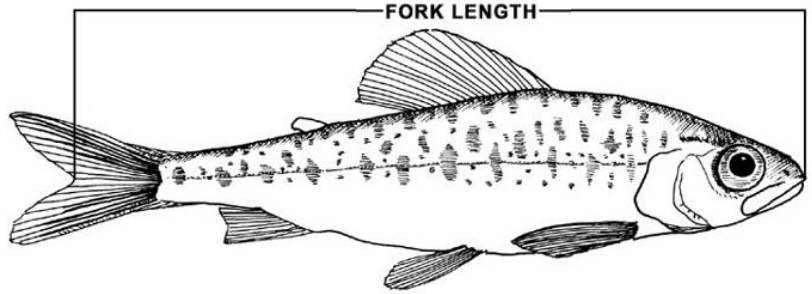
Measuring boards

- Science in metric!
- 3 sided works best (rounded is nice too)
- Waterproof

Self Check

- There is one standard measurement for determining the length of a fish
  - True
  - **False**

- The image above represents the correct way to measure Fork Length
  - True
  - **False**



Fish Weight

- Weight of individuals & biomass of populations is important in understanding fisheries
- Weight or Biomass is often used to describe fish abundance
  - The net weight of fish can be more important than the number (easier to get)
    - Pollock, Cod, Crab
- Fish eat and get bigger (or fatter)
  - Increases in weight comes from incorporating carbon into tissues
- Increases in weight over time describes growth
  - Growth is important in understanding the health or condition of fish and Fisheries

Weight Measurements

Wet weight – the weight of a fish or fish parts after removing any excess water

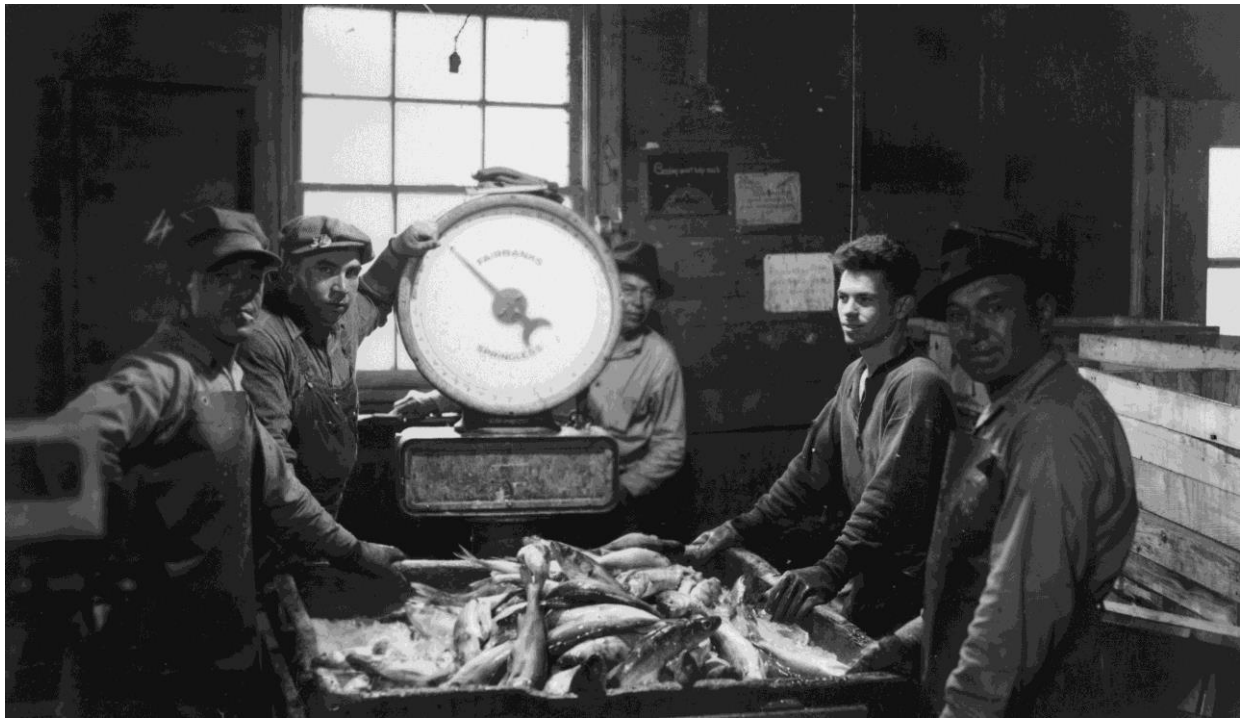
- Measured much more frequently (easier)
- Fish not sacrificed

Dry weight – the weight of a dried or dehydrated fish or fish parts

- Typically between 10 - 30% of wet weight
- Have to sacrifice fish to measure
- Used in energetics and many diet studies

Fish Weight

- Collected using scales of various styles
- Can measure individuals or groups
- Is more labor intensive than collecting length info



Fish Weight

- Remove excess moisture on fish
- Periodic calibration of scales
- Remove excess moisture on scale
- Tare often (every fish)
- Account for wind & fish, boat motion
  - Smaller fish are harder

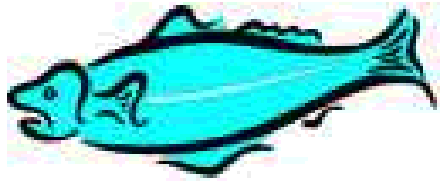
Weighing Devices

- Spring loaded scales
- Electronic scales (battery-powered) with digital readout
- Hanging scales measure fish in bulk or large fish
- Commercial scale

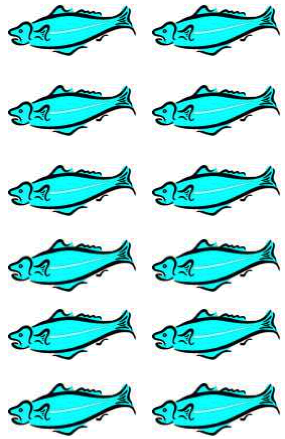
Considerations

- Does gear bias influence length and weight measures?
- How many fish measured or subsampled for measurement?
  - More is better

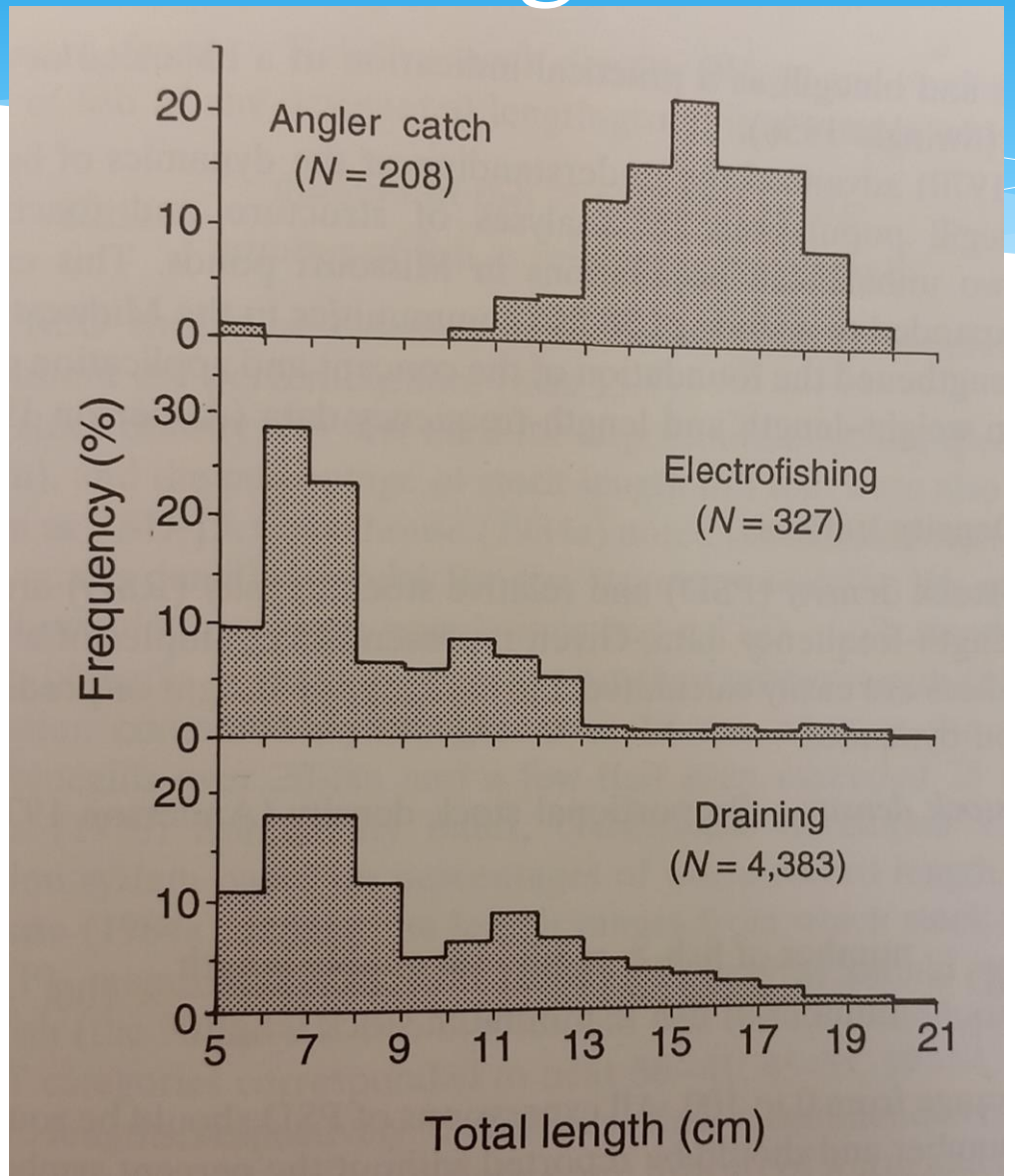
Vs.



Vs.



Gear Bias in Length and Weight



Considerations (cont.)

- Does gender influence length & weight measures?
  - Spawning salmon - kype
  - Halibut – females are larger

- Weight more error-prone than length.
- This is true for field measures
  - Calibration of scales, wind, boat movement
  - Fish movement etc. can influence weight

Preserved specimens

- Weight goes up about 8%
- Length goes down about 2%
- Use fresh specimens if possible

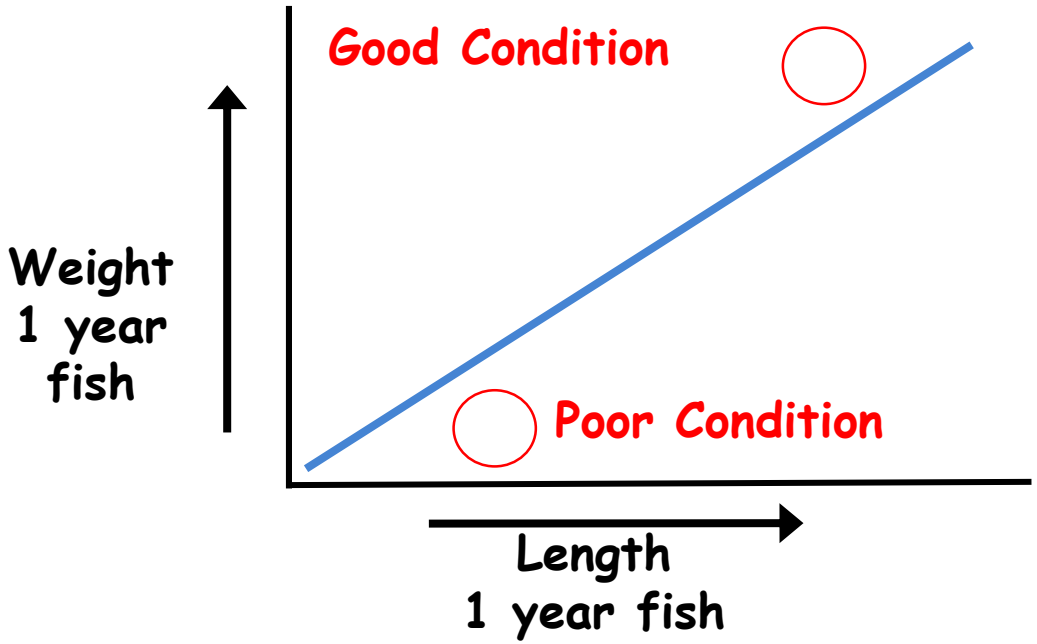
Self Check

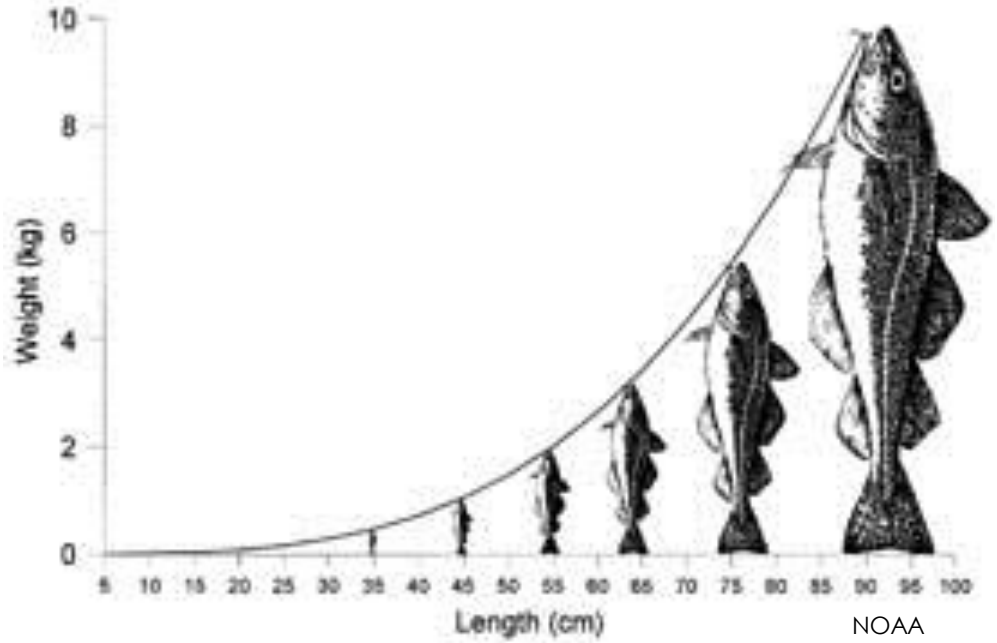
- Weighing fish is typically harder than measuring length
  - **True**
  - False

- An increase in weight over time describes
  - Weight
  - **Growth**
  - Biomass
  - Condition
  - None of the above

Fish Length & Weight

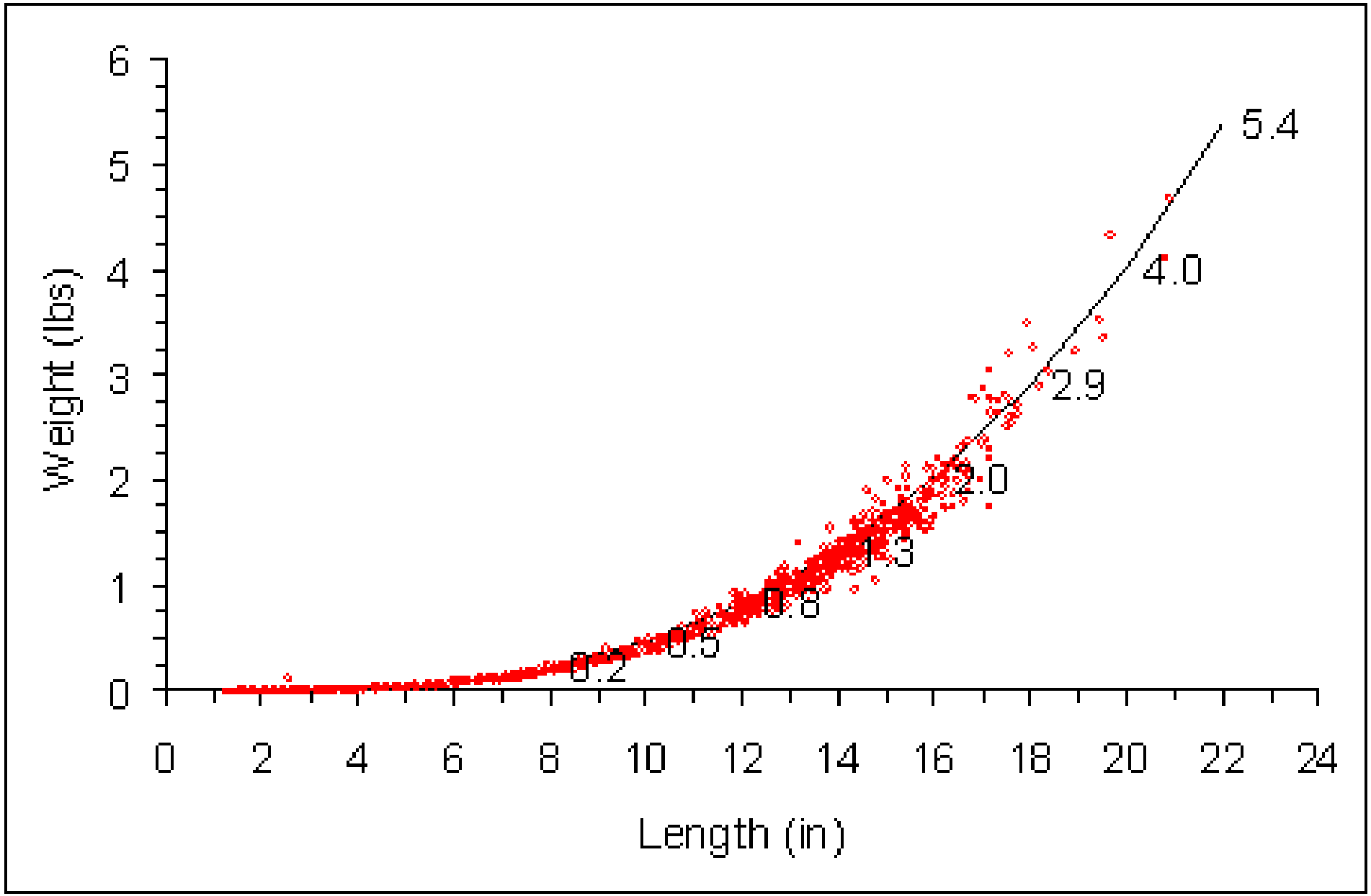
- Growth described by weight at age or weight gain/year
- Weight & Length…condition





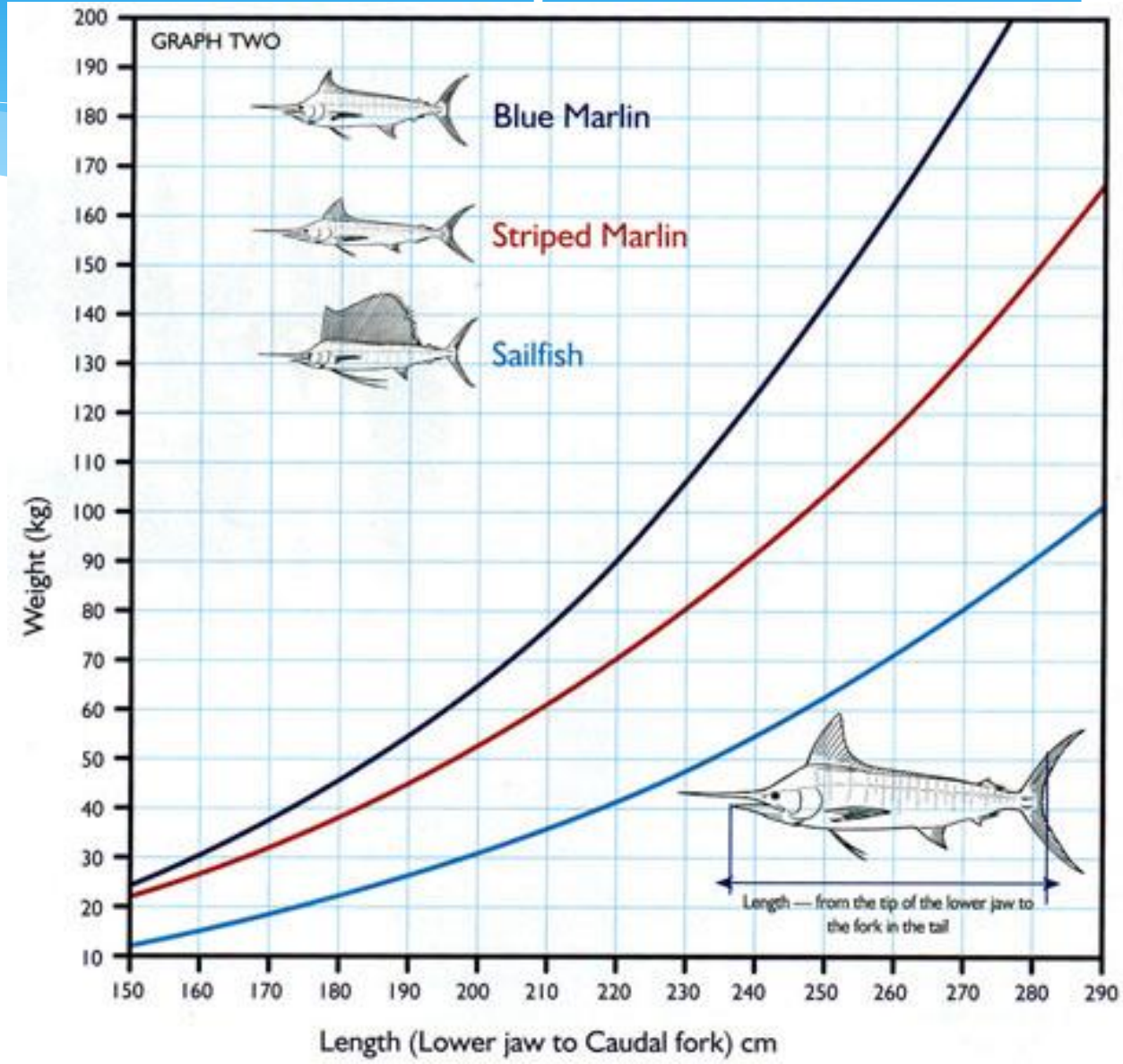
NOAA

Length – Weight Relationships



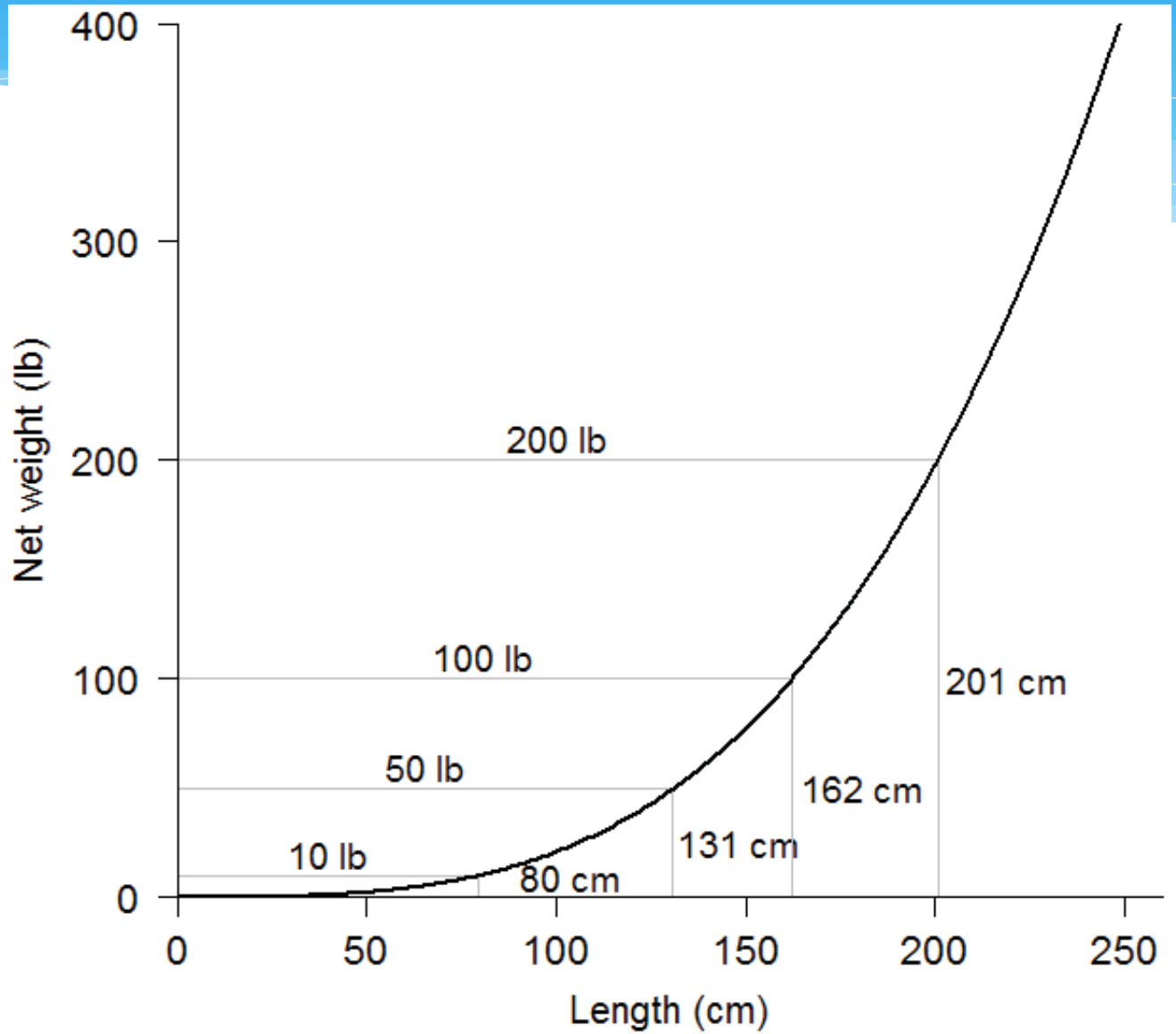
Length-Weight Relationships

- So length can be converted to weight or vice versa
- Condition - variation from expected weight at a given length

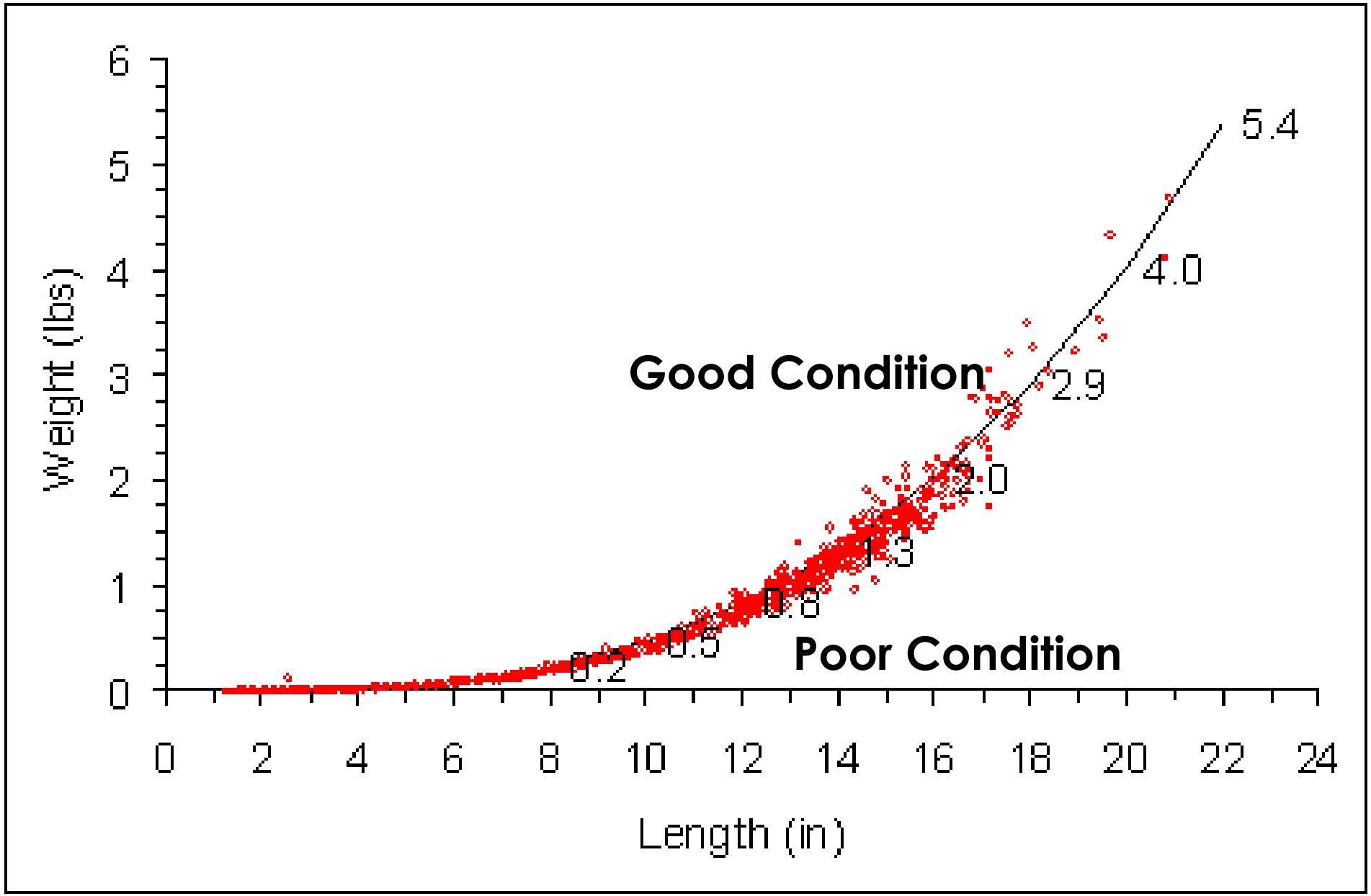


Pacific Halibut Length vs Weight

- 63.7” 5.3’ = 100lb
- 79.1” – 6.5’ = 200lb



Length – Weight Relationships

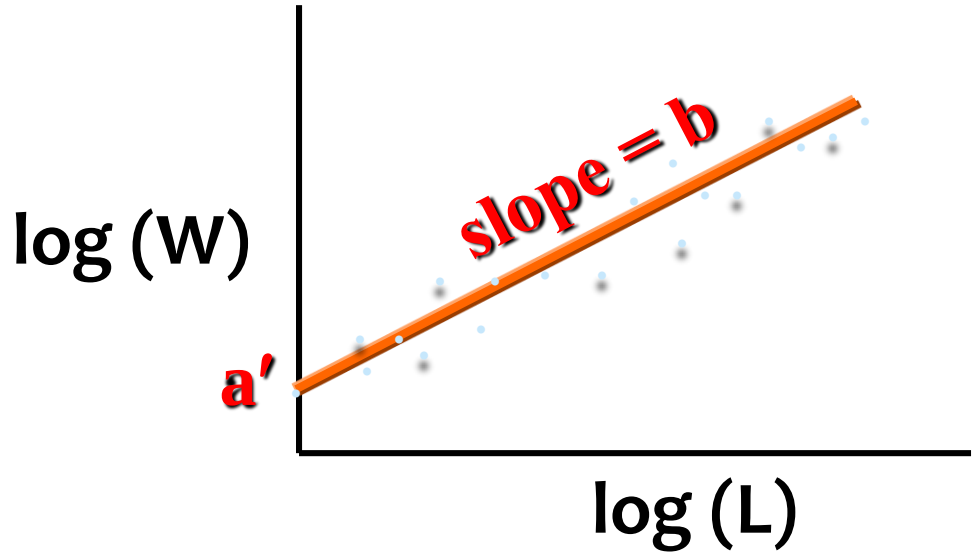


Two objectives of LW data

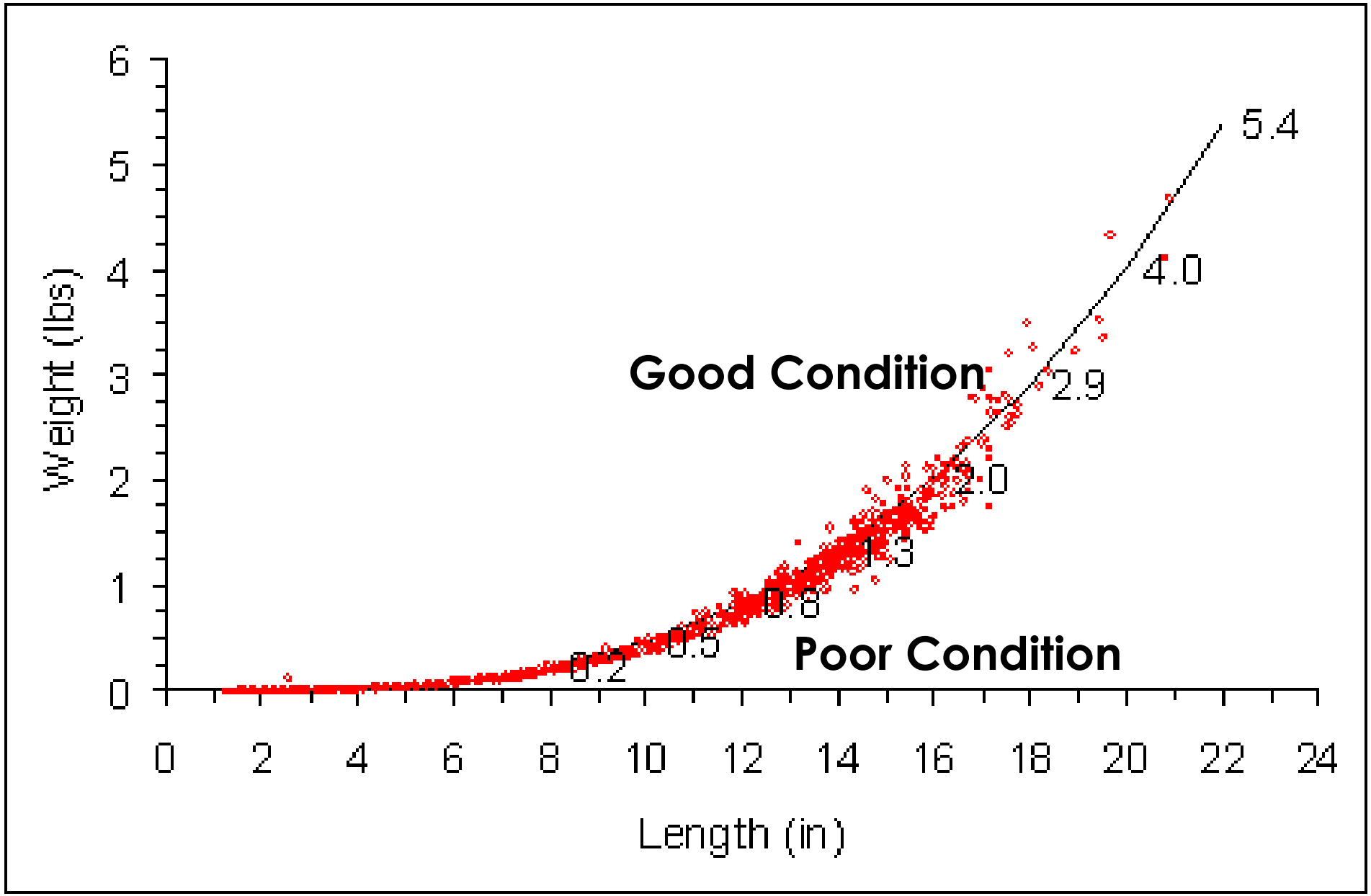
- Mathematically describe L & W relationship for conversion from one to another
- Measure of variation of expected weight for length of individual or group or organisms as indications of
  - **well being, fatness, gonad activity, CONDITION**
  - W = weight; L = length and a and b are parameters;
  - To get ab have to do a linear regression of L and W

Transformation

- Estimate a and b using linear regression
- Y=mx+b
- Log10(W) = Log10(a) + b * Log10(L)
- Y = intercept + slope * X



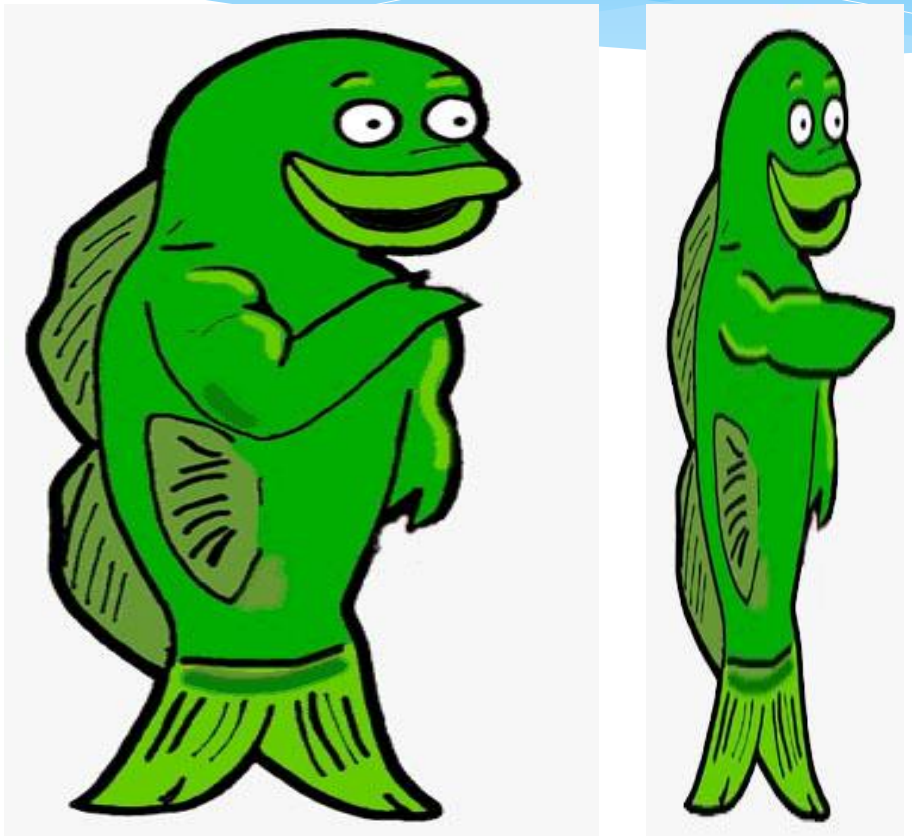
Length – Weight Relationships



Indices of Condition

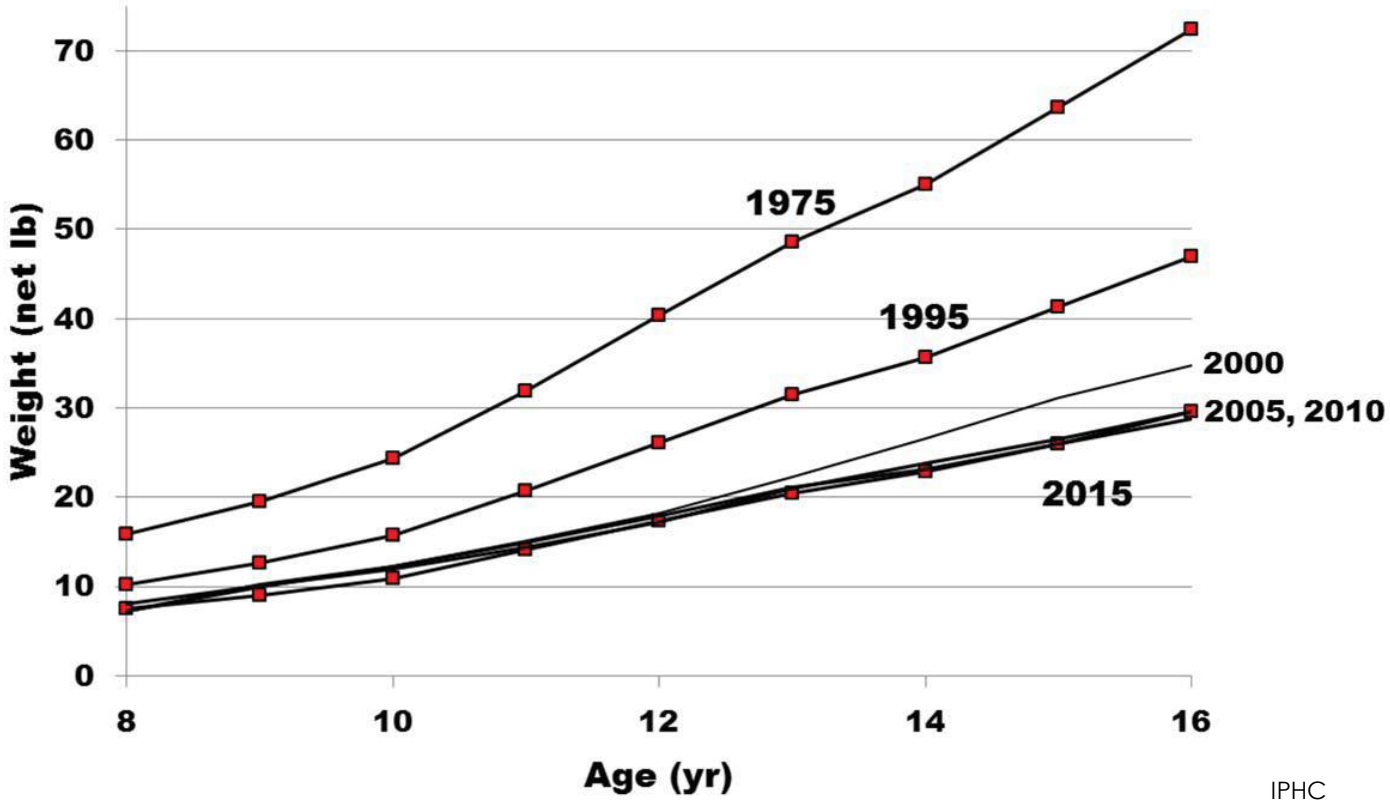
- Fulton condition factor K
  - $K=100(W/L^3)$
- Relative condition factor
- Relative weight
  - $W_r=100(W/W_s)$

- All measures of Condition



Halibut Example Weight at Age

- Halibut coastwide aggregate estimated female average weight-at-age trends from setline survey and fishery data over the last four decades.
- Fish are getting smaller
- Managed by weight
  - Takes more fish
- Bycatch also by weight*



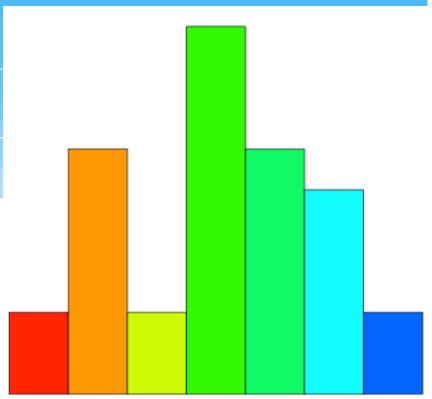
Self Check

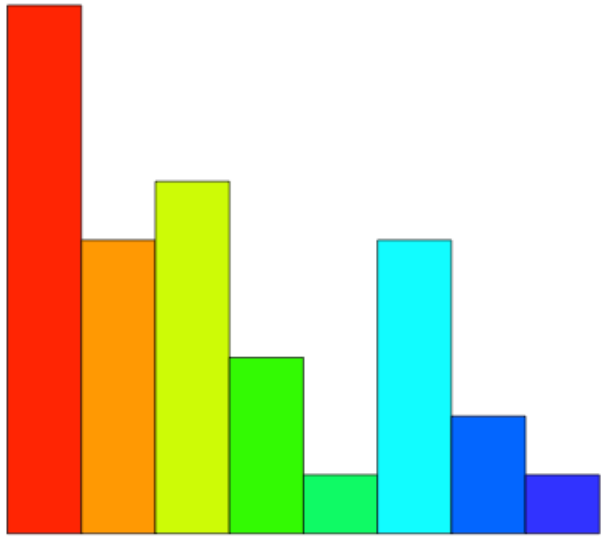
- By looking at the relationship between length and weight we can tell something about the health or condition of a fish or fish stock
  - **True**
  - False

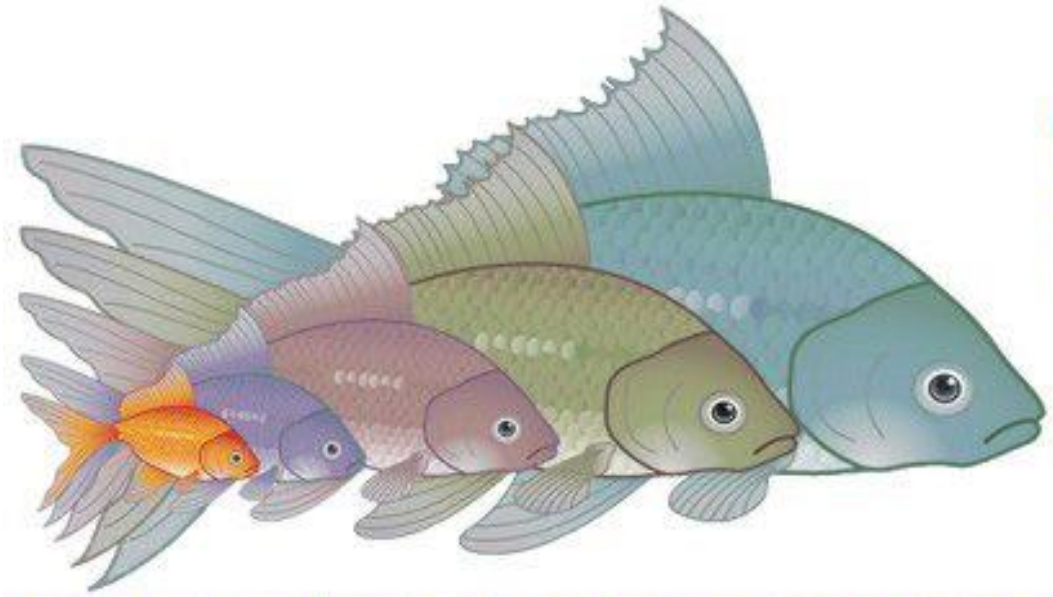
- A fish weighing more at the same size then the average fish from the population could be said to
  - **Be In good condition**
  - Be In poor condition
  - Be Older than the other fish in that year class
  - Have a relative lower weight

Length Frequency Histograms

- Lengths of fish grouped in bins
- Can tell us valuable info about population
- Easier to collect than Length & Weight





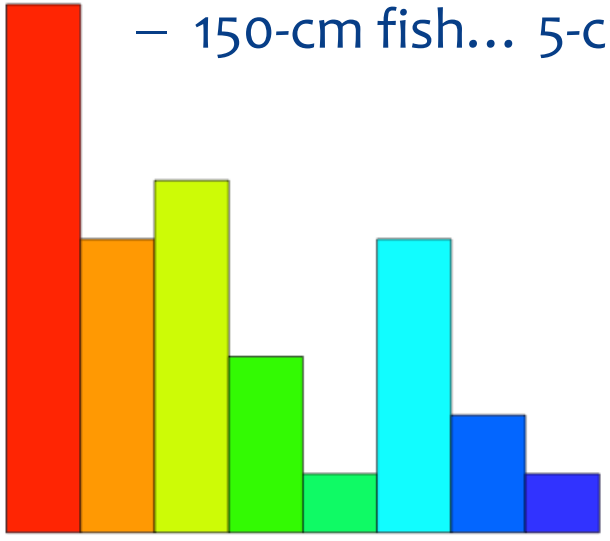


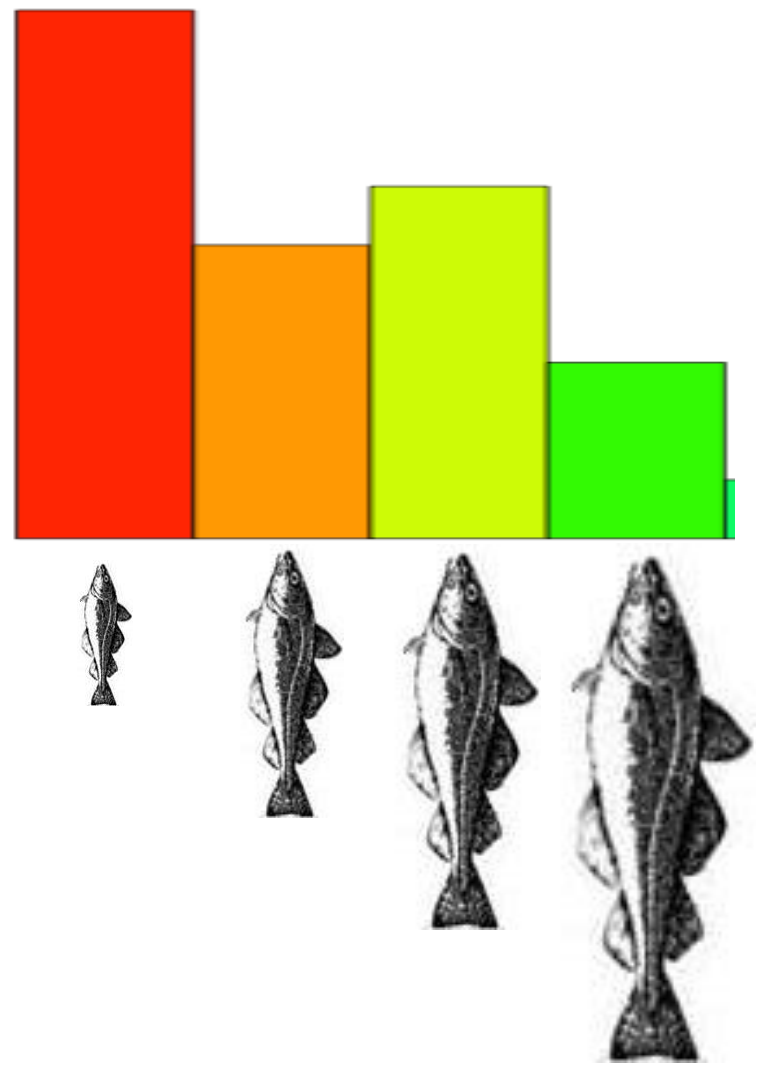
Length-Frequency Histograms reflect:

- Reproduction
- Recruitment
- Growth
- Mortality
- Age
  - Changes over time Help:
    - identifying low recruitment
    - age class problems
    - slow growth
    - excessive annual mortalities

Length Frequency Guidelines

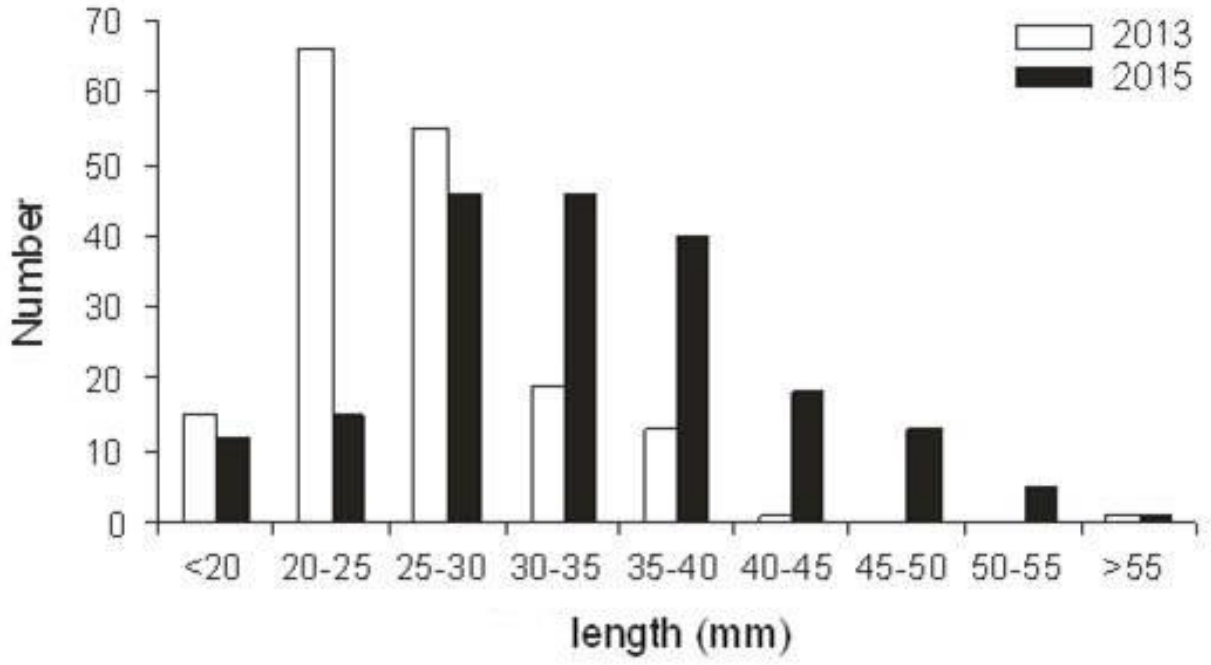
- Sample 100 fish – measure length
- Bin sizes (at least 5-7)
  - 30-cm fish… 1-cm interval
  - 60-cm fish… 2-cm interval
  - 150-cm fish… 5-cm interval





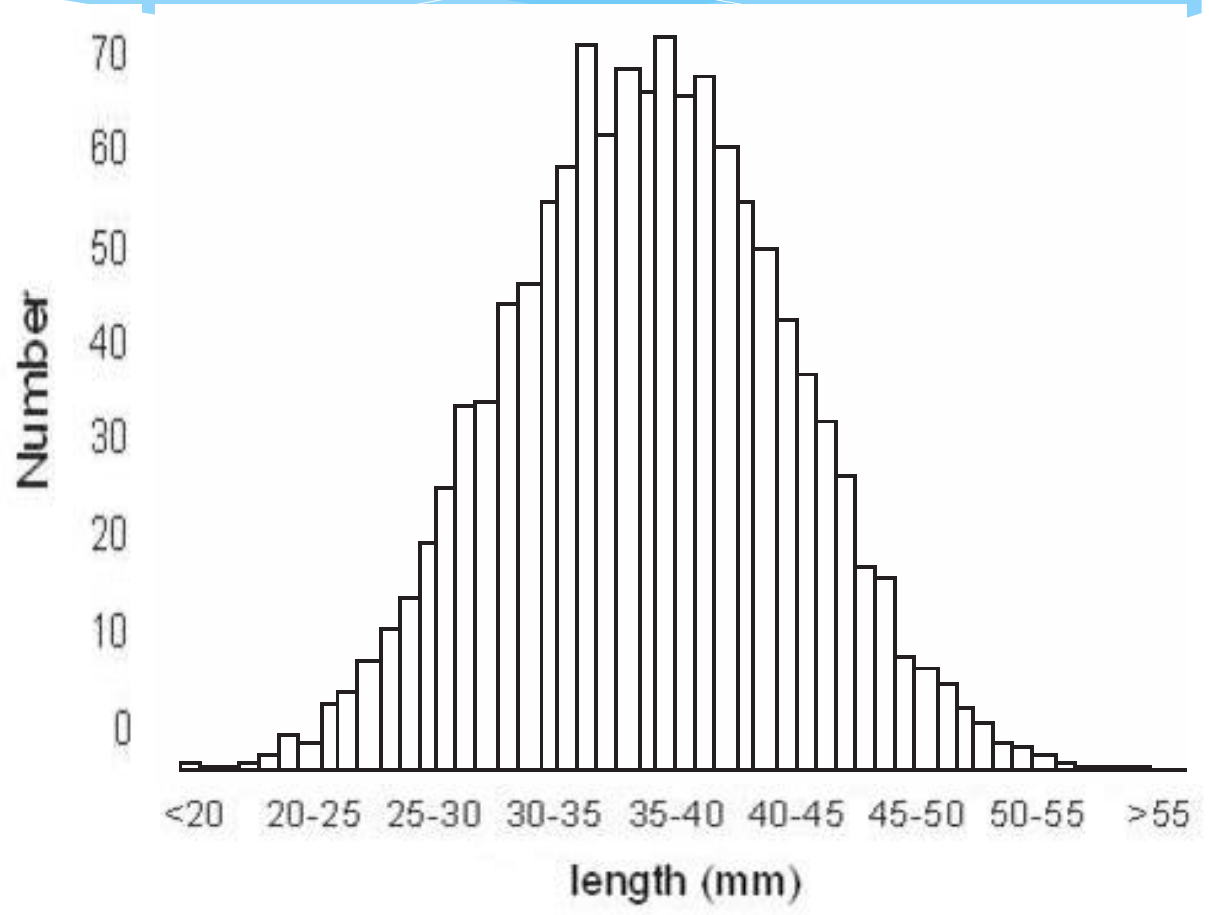
Guidelines

- Y-axis
  - Absolute number of fish per length group
  - Percentage in each length group
- X-axis
  - Bin sizes



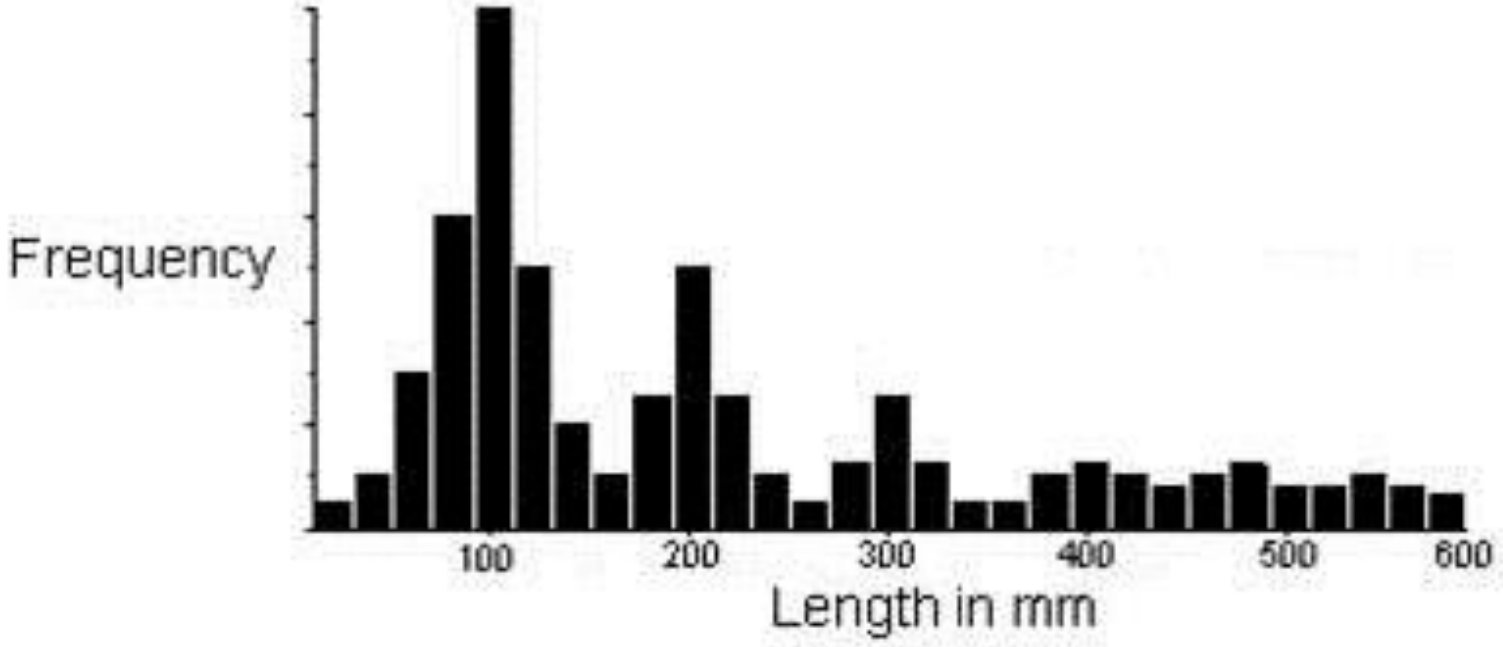
Length Distribution

- Length distribution of same age fish
  - Some large
  - Some small
  - Majority Average



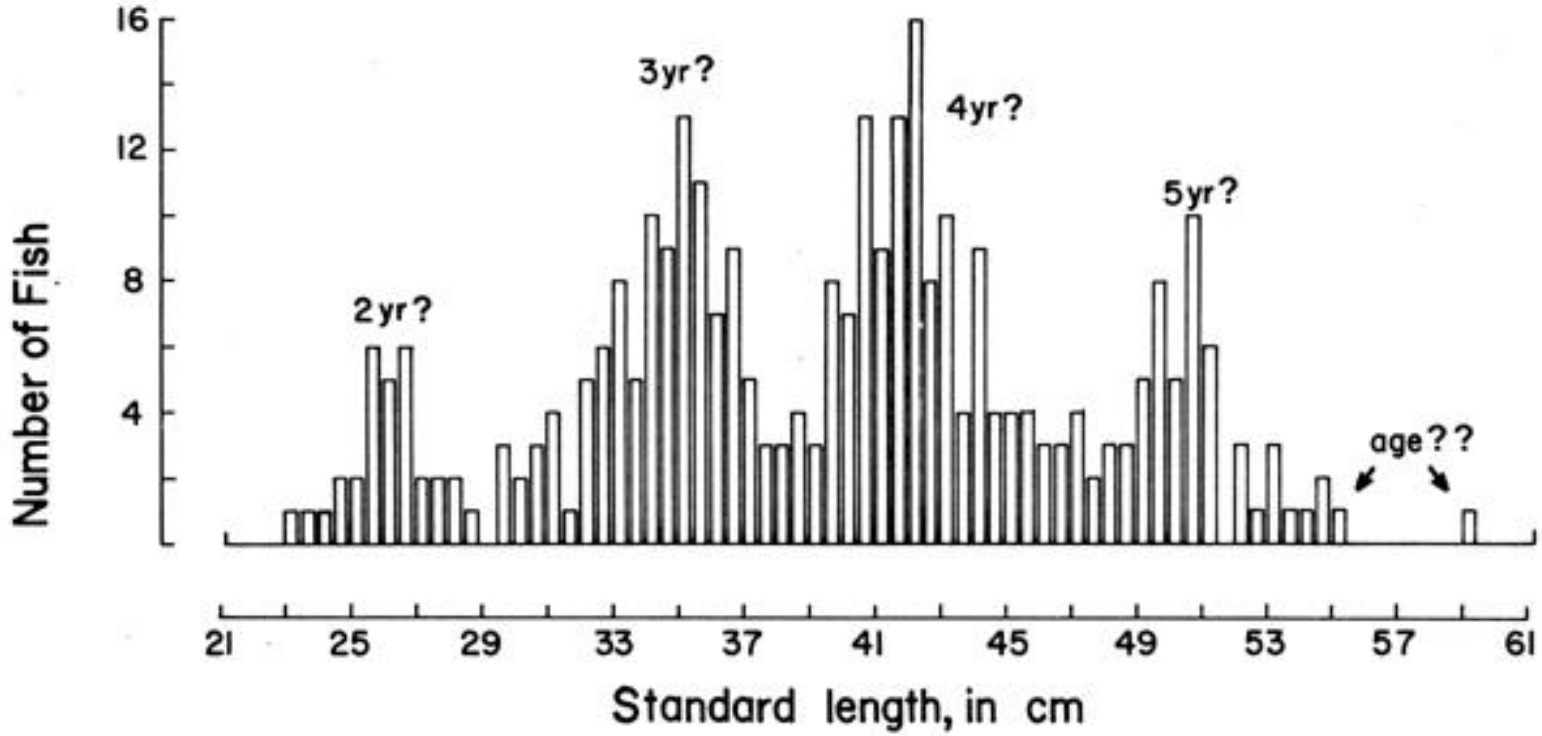
LF Histograms – Spp Length Distribution

- Fewer individuals as fish get larger
  - Lack of small individuals
    - Gear Bias



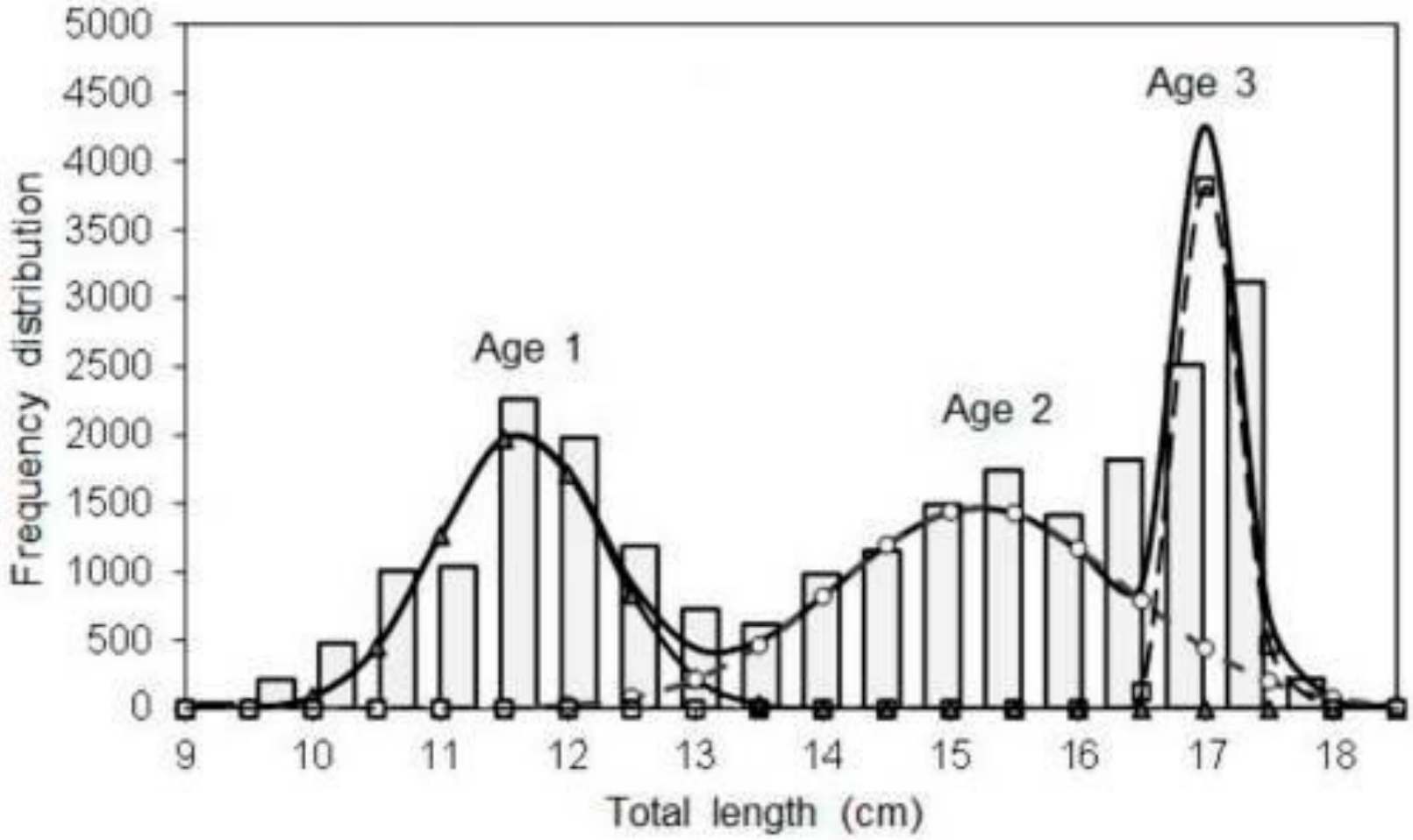
LF Histograms – Age Class

- See **Modes** when plot multiple age classes together
- Older = harder to distinguish



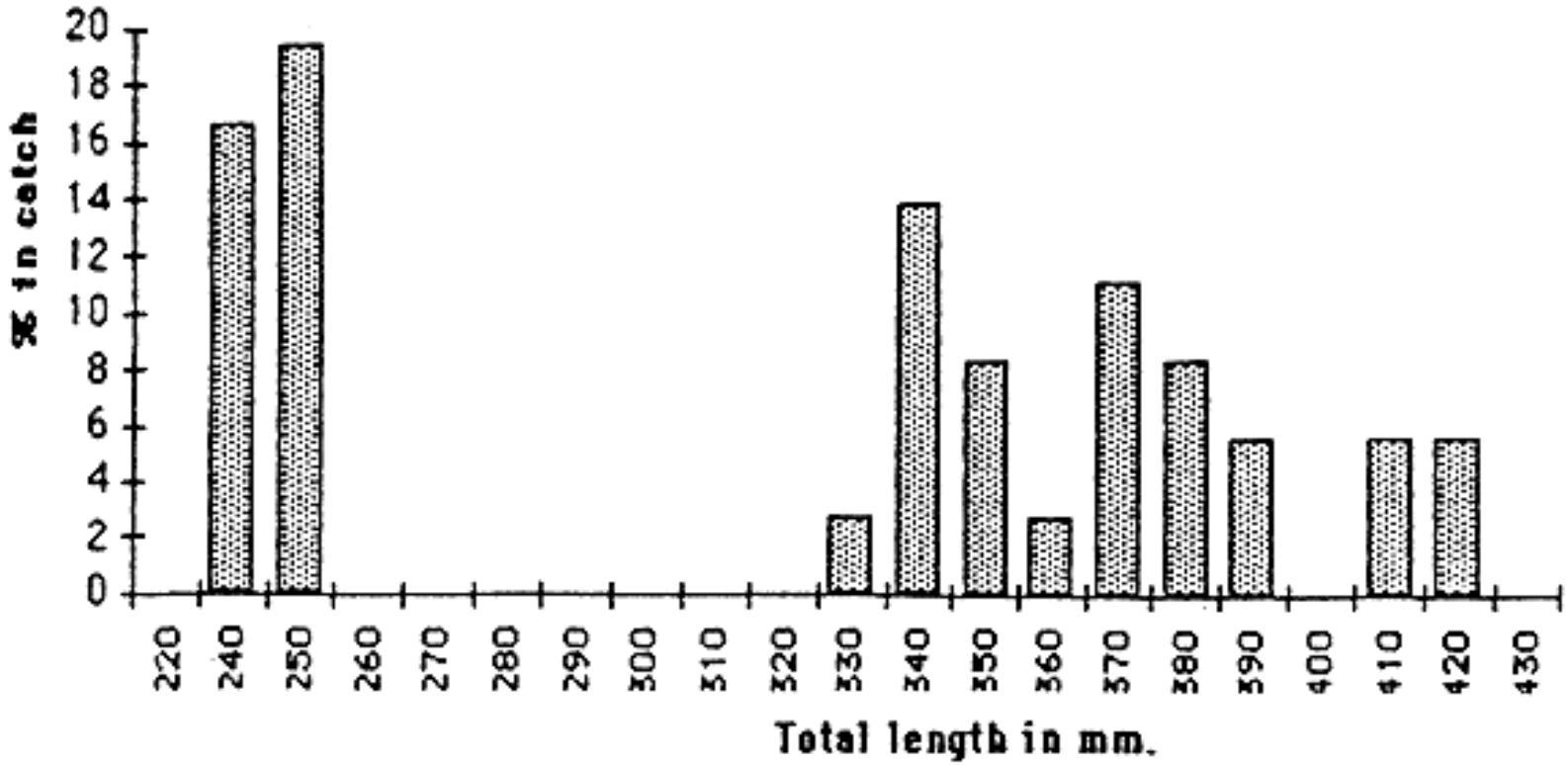
LF Histograms – Age Class

- Strong 3 year age class
  - Still healthy 1 & 2



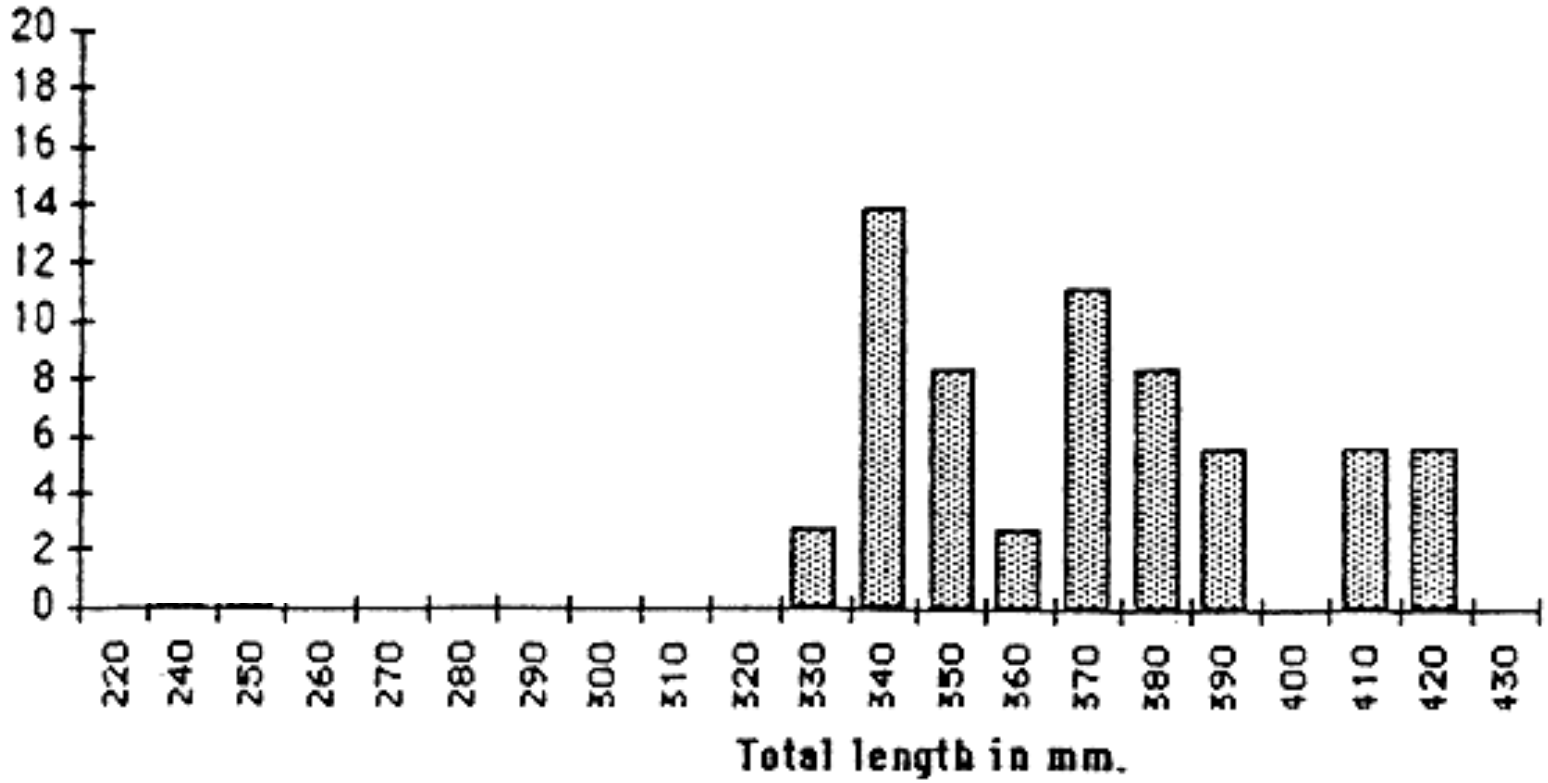
Length-Frequency Histograms

- Missing 260 – 320 mm individuals
  - Poor recruitment
  - Mortality event
    - Flooding
    - Freeze
    - Lots of predators
- Good 240 – 250 class



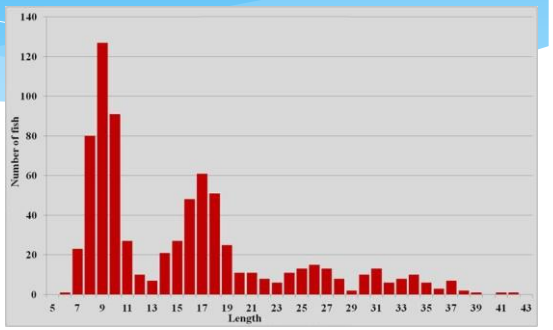
Length-Frequency Histograms

- Lack of Recruitment
  - Loss of spawning biomass
  - Poor recruitment
  - Mortality event
    - Flooding
    - Freeze
    - Lots of predato



Self Check

- How many ag4e classes would you guess are present in the above image
  - 2
  - 3
  - 4
  - 5 -7



- What can we tell about a fish population from looking at length frequency information
  - Reproduction
  - Recruitment
  - Growth
  - Mortality
  - Age
  - All of the above

Recap

- Importance of Length & Weight
- Length measurements
- Weight measurements
- Length vs weight
- Length Frequency