Fisheries Management Techniques FT 211

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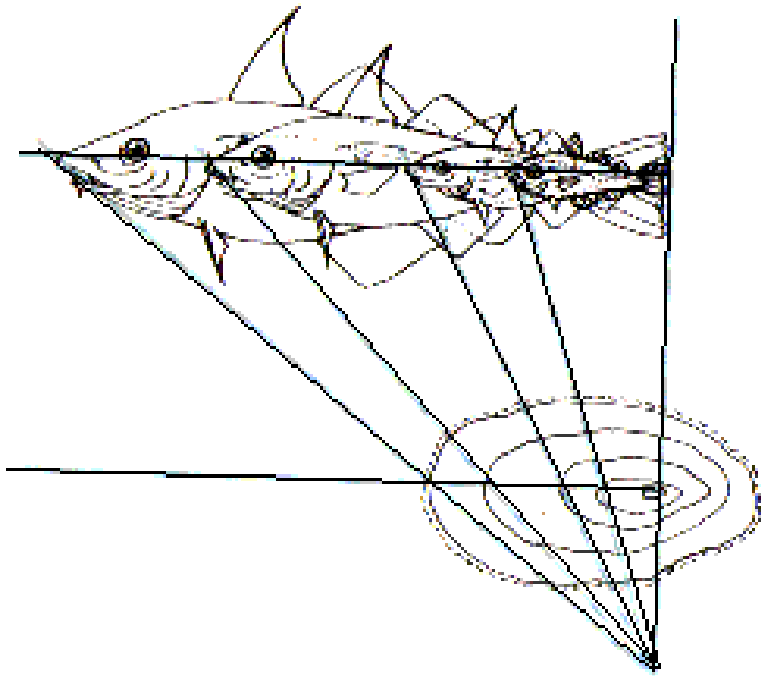
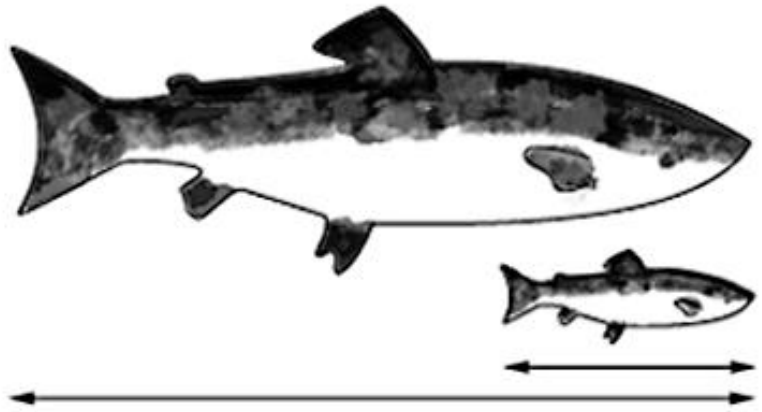
Chapter 15

Age and Growth





Outline

This Module will Contain 6 Main areas

Age & Growth in fish

Length Frequency Analysis

Recapture of marked Individuals

Scales

Otoliths

Other hard Structures

Student Learning Outcomes

Students will be able to:

- Describe age and Growth, how they differ, and their importance in fishery science
- Summarize length frequency analysis and how it can be used to determine age and growth in fish
- Describe recapture techniques and how they can be used to determine growth
- Describe how scales are processed for age determination and be able to identify annuali on salmon scales
- Describe how otolithsare processed for age determination and be able to identify annuali
- Summarize other hard structure analysis and how they can be used to determine age and growth in fish

Age and Growth

- **AGE** refers to a quantitative description of how long an organism has been alive
- Age refers to years
  - Used in determining maturity, used to describe growth

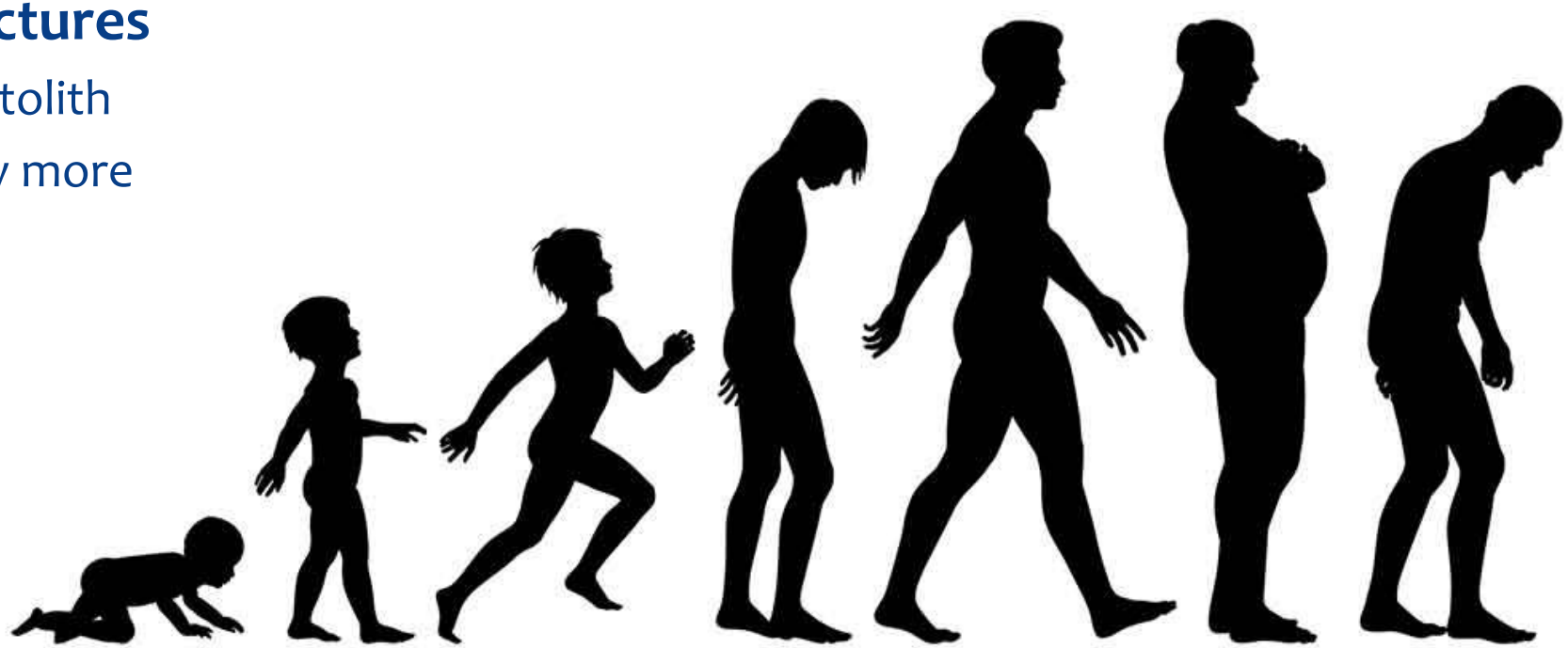
- **GROWTH** represents a change in size (e.g., length or weight)
- **GROWTH RATE** typically as a **function of time**
  - Growth is the change in length, wet weight, or dry weight over time

Age and Growth in Fish Biology

- Growth, recruitment, and mortality are the primary functions that regulate fish population
  - Important for managers to Know about these
    - Lots of fish – all old and ready to die
    - Only a few adult fish – but millions ready to recruit
    - Lots of fish – but not growing
- Growth integrates ecosystem properties
  - Water quality, food availability, predator density
  - Can be easier to measure than some of the other parameters

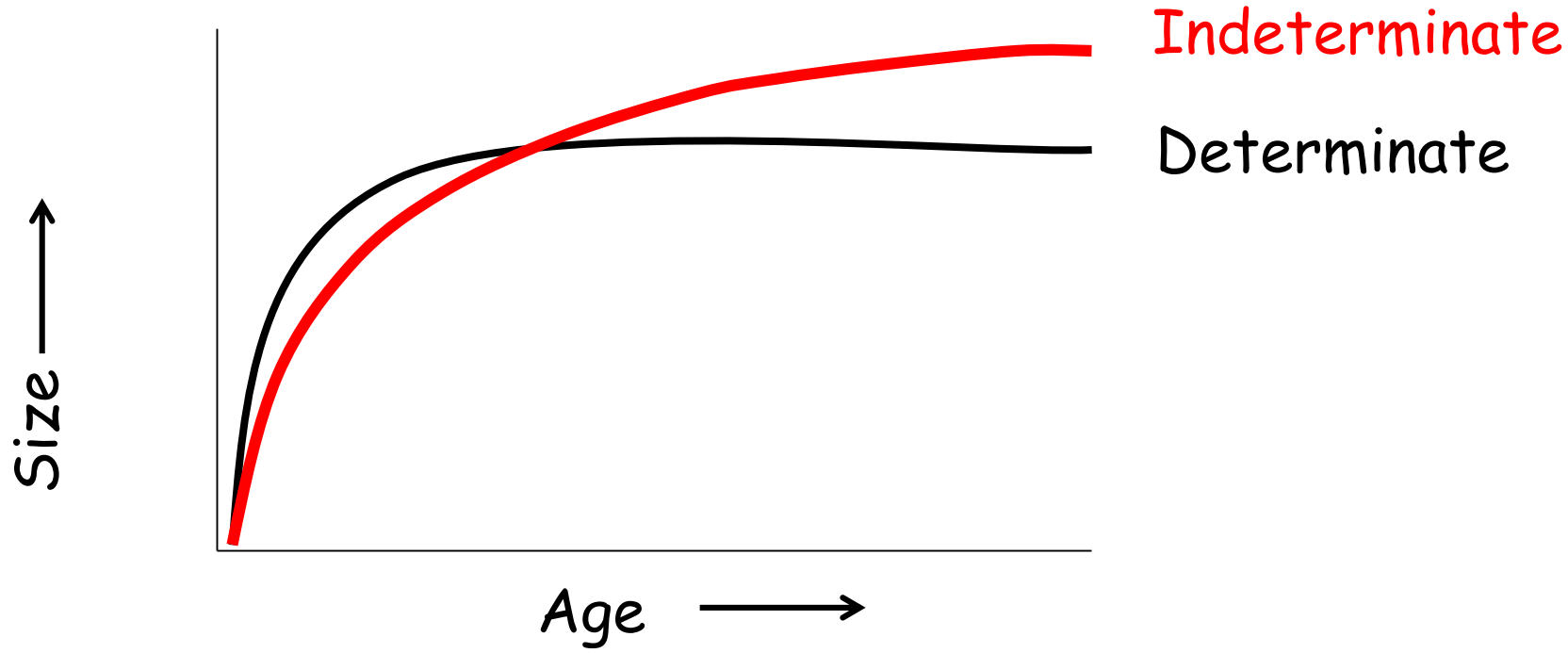
Measuring Age & Growth

- How do you estimate age and growth?
  - **Direct Observation** - Measuring & Recapturing fish
  - Looking at Fish **Length frequencies**
  - Using **Hard structures**
    - The powerful Otolith
    - And many many more

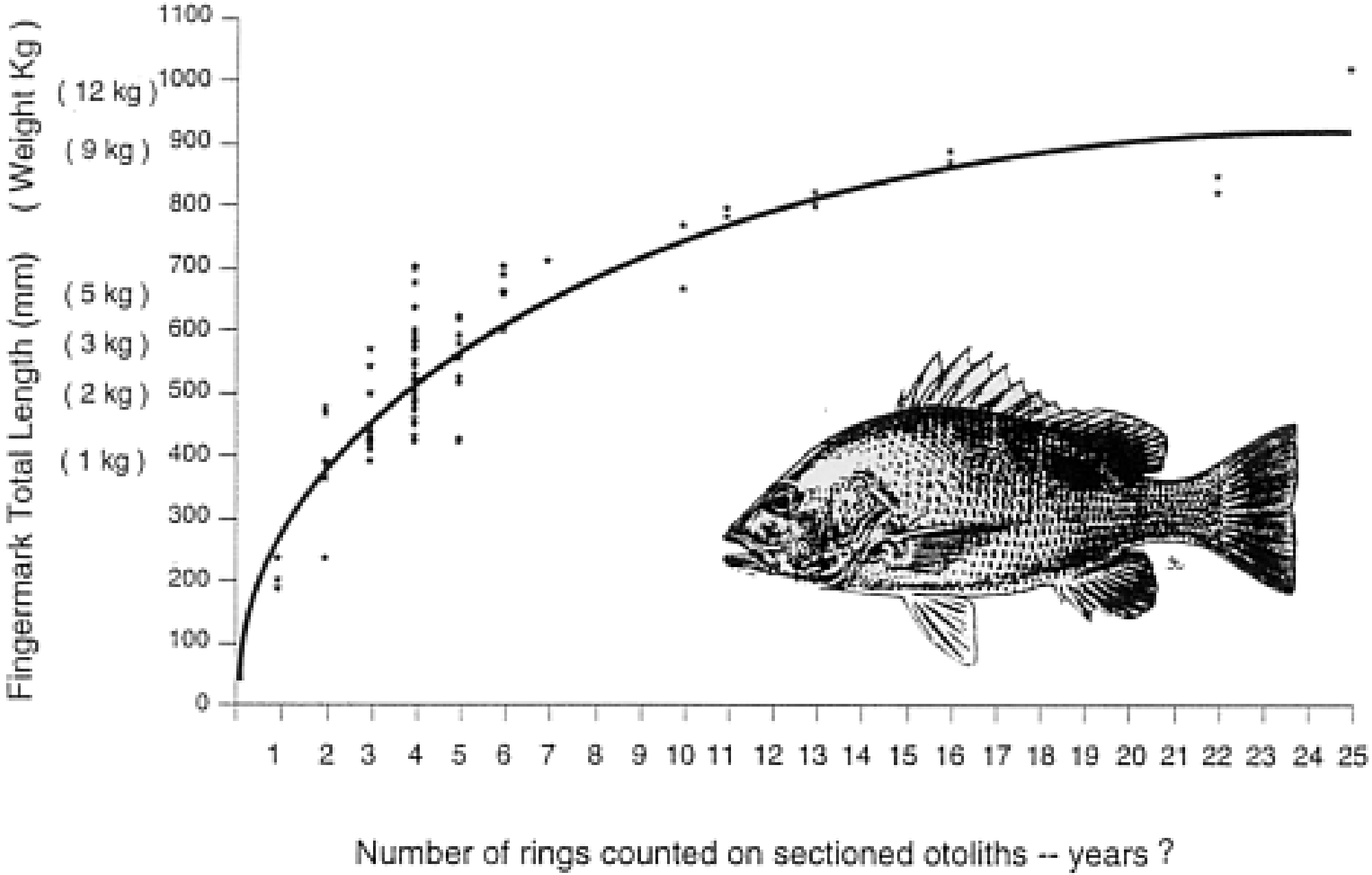


Growth patterns

- Determinate Growth
  - Mammals & birds
- Indeterminate Growth
  - Fishes, Reptiles, Mollusks



Fingermark Growth Curve

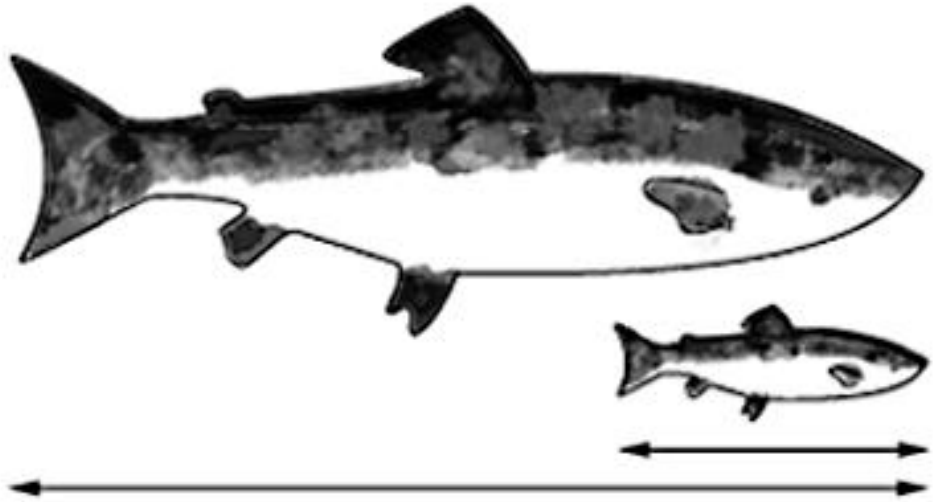


Different metrics of fish growth

- Length
  - Pros: easy, intuitive, history in angling, length rarely shrinks
  - Cons: lots of change in biomass not related in length
- Wet Weight
  - Pros: used in large calculations (ie population biomass)
  - Cons: can take more time in field (rocking boat or wind and scale don't mix)
- Dry Weight
  - Pros: accurate description of individual's current state
  - Cons: time intensive and must kill fish

Growth patterns

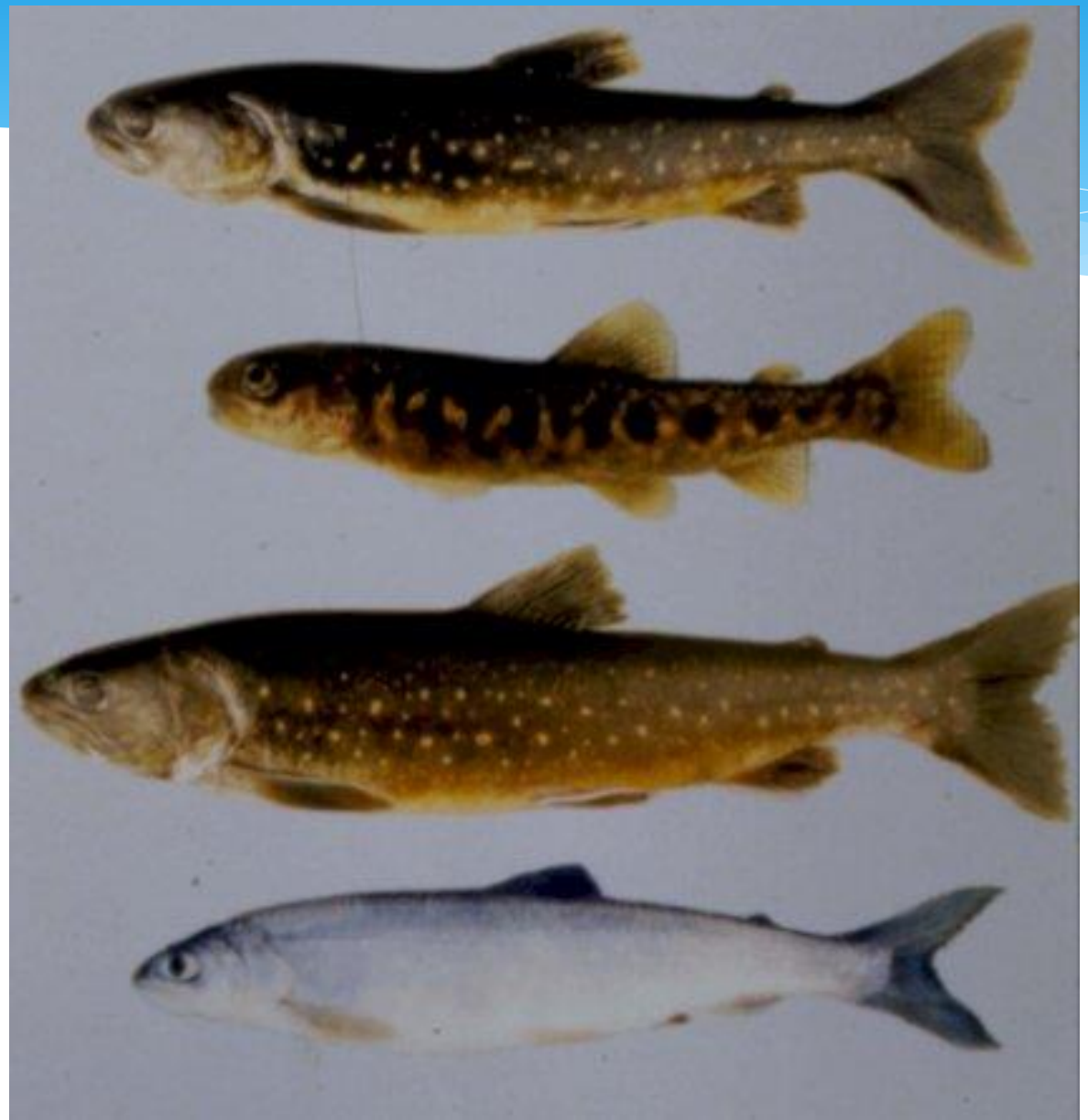
- Great variability in growth
- Size at age: High variability (L vs W ?)
  - Between species
  - Between populations
  - Between individuals
  - Between Habitats



Environmental factors influencing growth

- Temperature
- Food and Nutrient Availability
- Light Regime
- Oxygen Concentration
- Salinity
- Pollutants
- Predator Densities
- Intraspecific Social Interactions
- Genetics

Example: Species polymorphism



Large benthic feeder

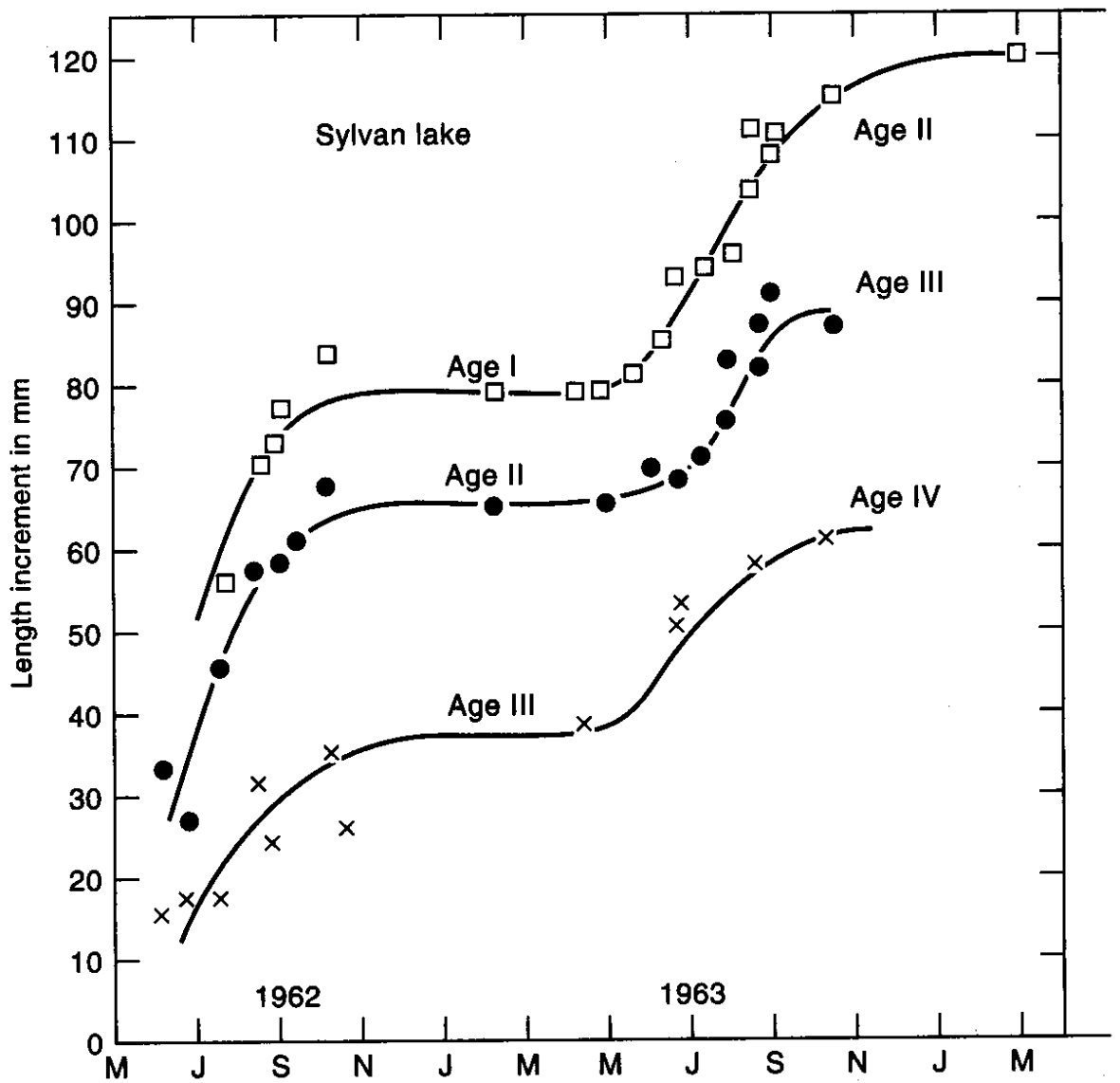
Small benthic feeder

Piscivorous feeder

Planktivorous feeder

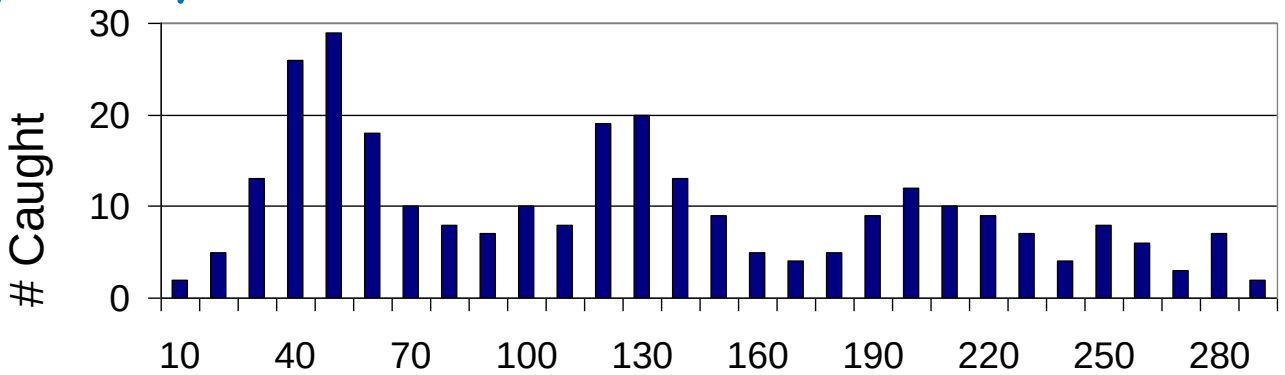
Salmonidae
Artic Charr
Salvelinus alpinus

Annual growth variation



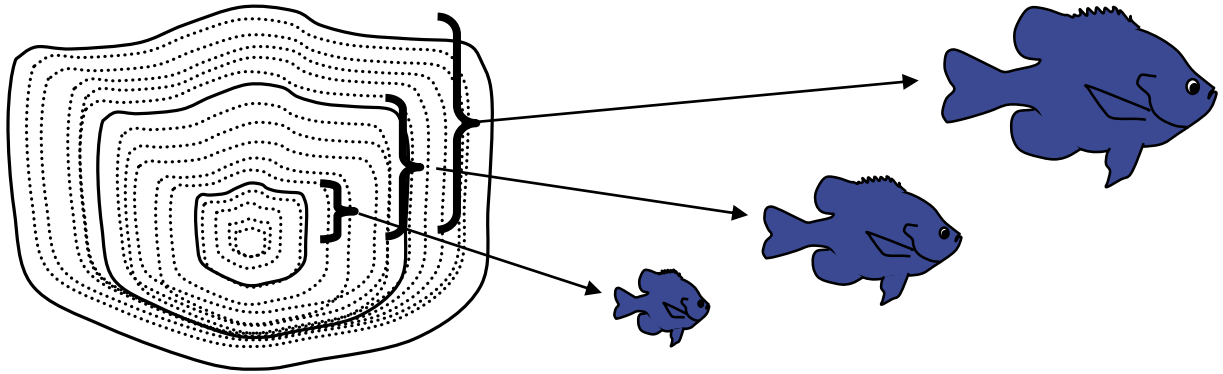
3 ways to estimate growth (Wild)

- Length Frequency Analysis



- Recaptures of individually marked fish (Observation)

- Back calculation from calcified structures (???)



What about in the laboratory?

- Not the same as wild
- Too many factors to control
- Sometimes our best guess

Self Check

- Fish grow the same way as mammals and birds and have what we call determinate growth
  - True
  - **False**

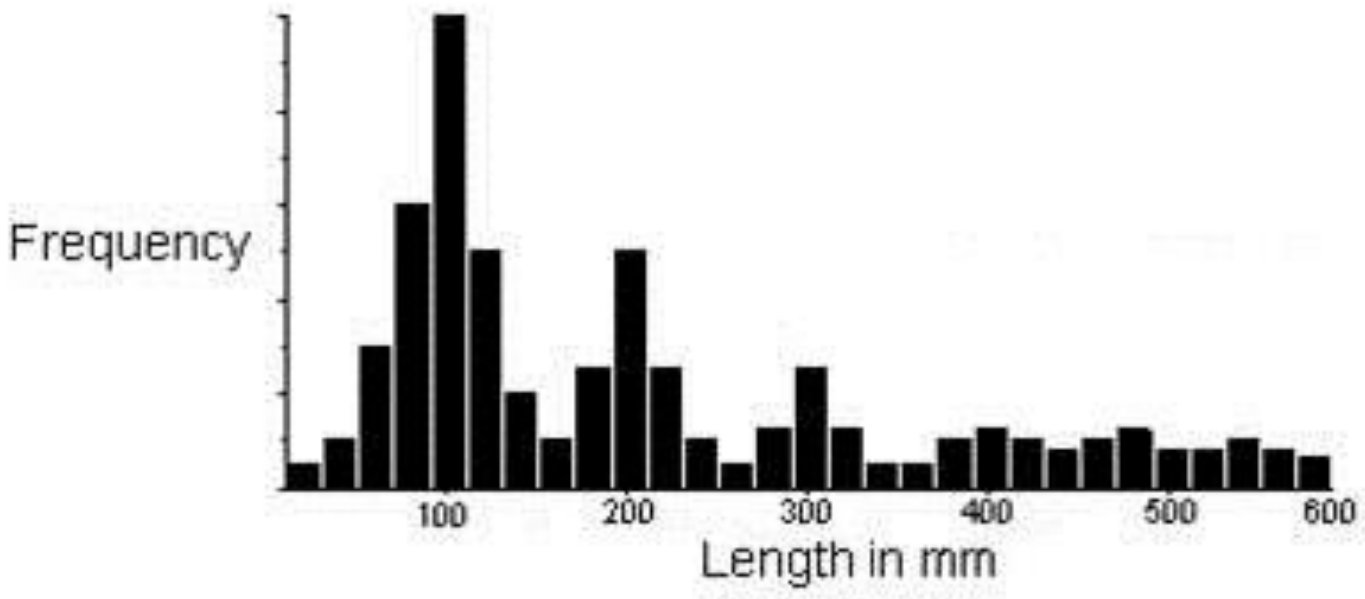
- A change in length or weight refers to
  - Age
  - **Growth**
  - Growth rate

Length Frequency Analysis

Examining length groups and modes then inferring age from them

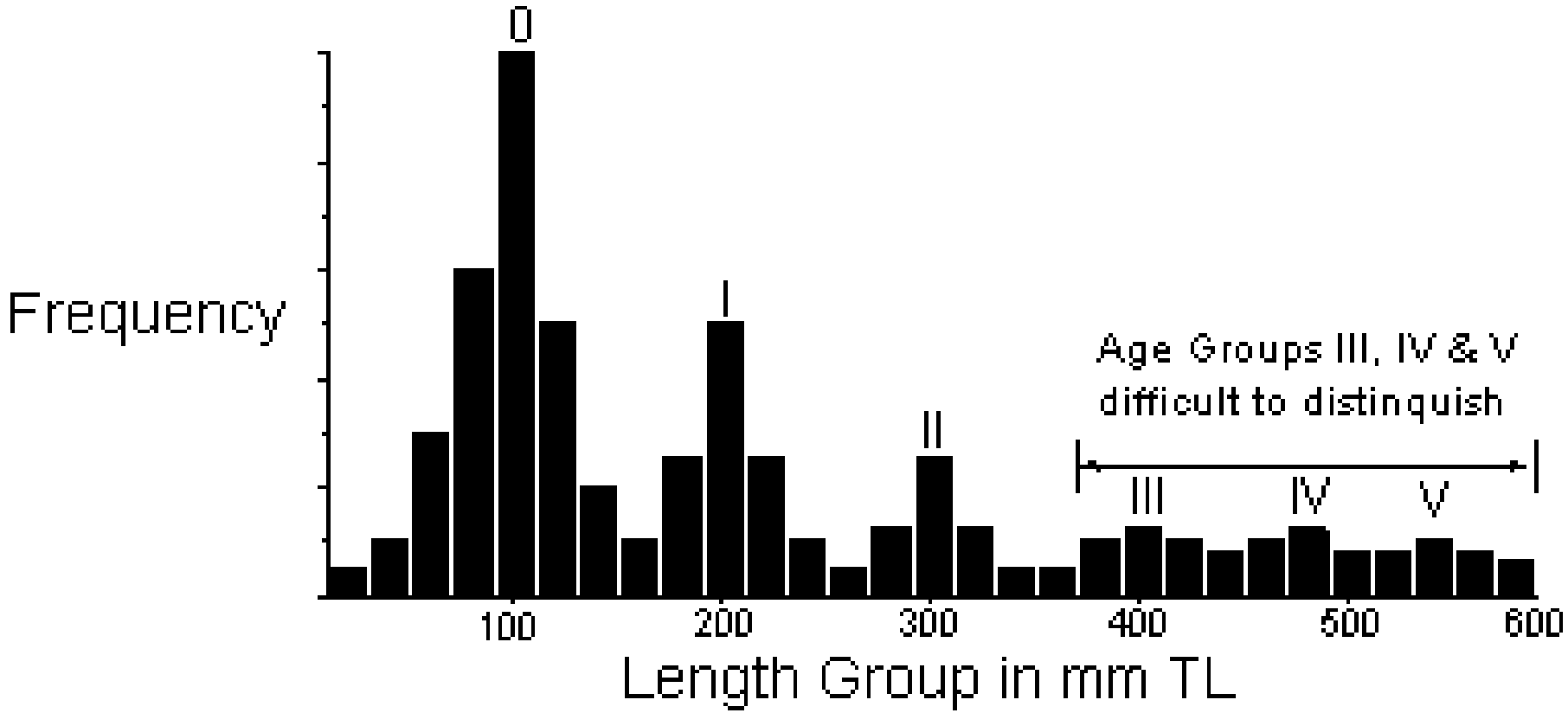
- Pros: non-destructive, can use archived lengths
- Cons: have to catch lots of fish, unknowns are high!, easy to bias sample with gear, time, or location

- ~6 age classes present
  - Appear to be strong

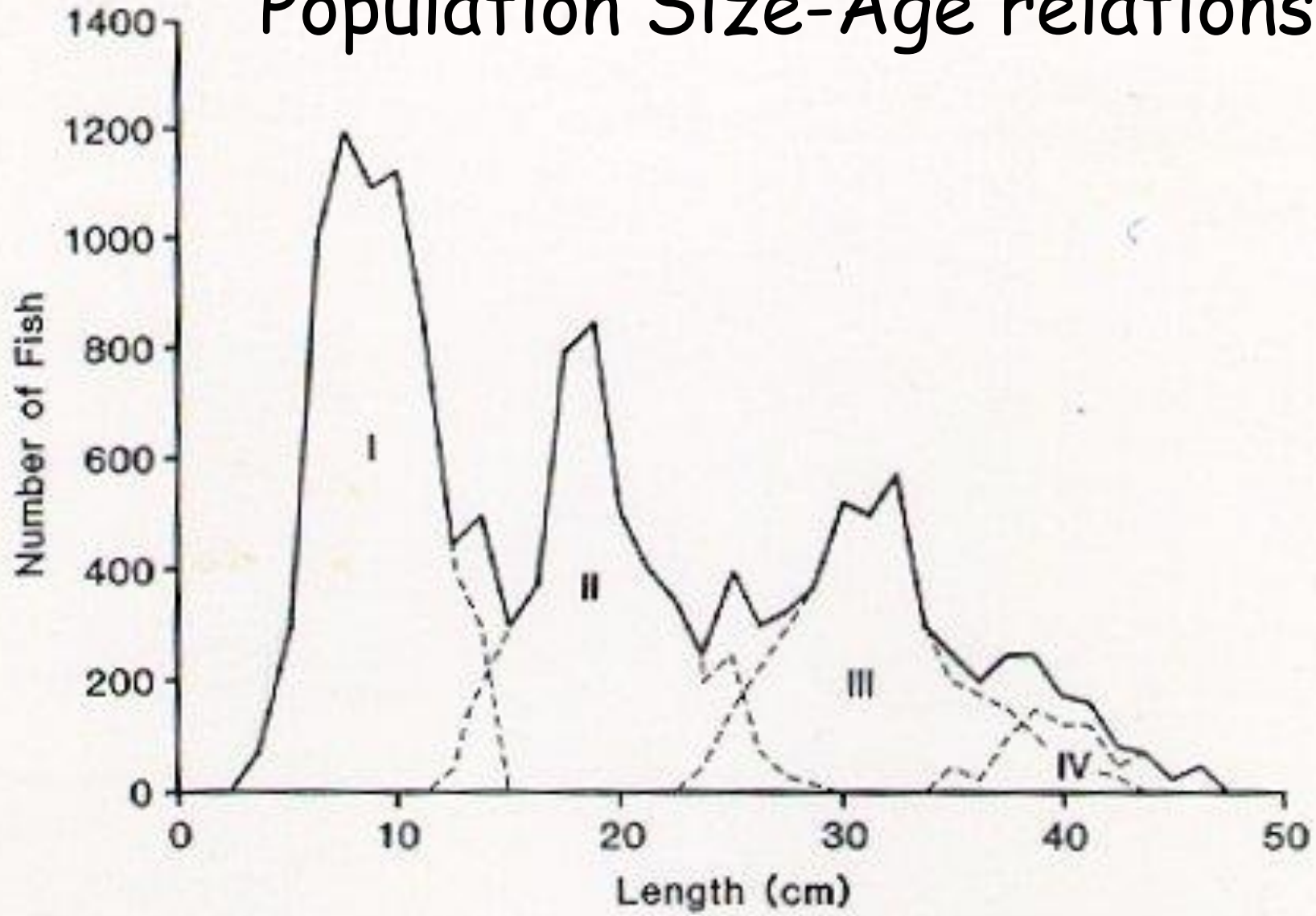


Population Age-Size structure

- Normal population



Population Size-Age relationship



Length frequency in use

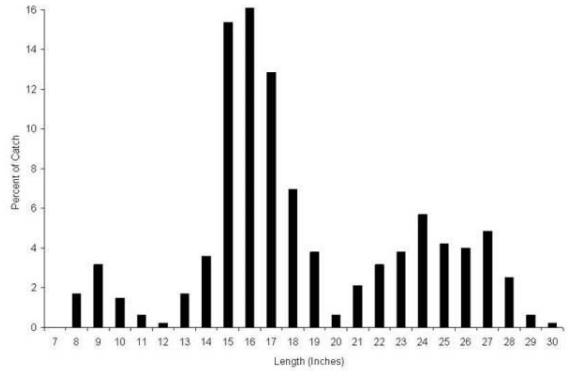
548 bluegill

- 4mm bins
  - 48 – 64 1 Year
  - 72 – 96 2 Year
  - 120 – 152 3 Year?
  - 160 – 200 4 Year ??

Self Check

- Length frequency information is useful and valuable for determining age of fish partly because you can use achieved fish length data and it is non lethal
  - **True**
  - False

- How many age classes appear to be present in the above length frequency histogram
  - 2
  - **3**
  - 4
  - 5
  - 6 or more



Recaptures of Marked Individuals

Measuring a fish (length, weight) tagging it, then measuring change or growth when recaptured

- Individual fish have to be marked (not groups)

- Pros: non-destructive, good individual data
- Cons: have to catch TONS of fish to see a recapture

  - Population is 10000 fish
  - You catch and tag 100 fish, good effort, but
  - You Come back a year later....
  - ...at best maybe 60 survived....
  - ...maybe only 10% lost their tags
  - .... so there are 54 tags in 10,000 fish

Estimating growth from tagging

- Pros: understand the variability in individual growth
- Cons:
  - tag loss,
  - tagging may influence growth, behavior, or mortality,
  - cant read tag

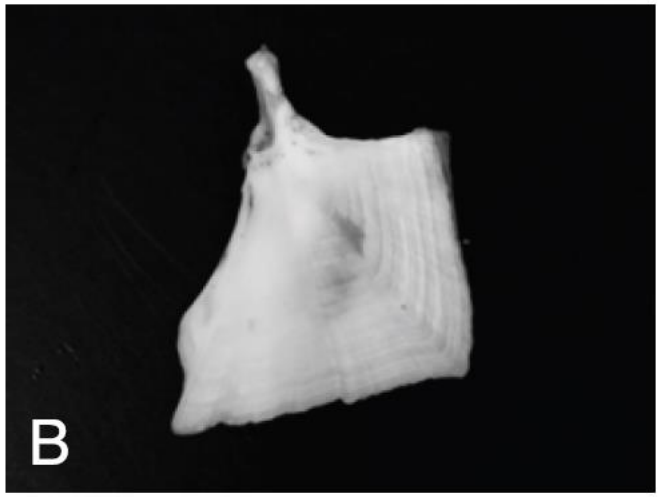
Lots of ways to mark fish

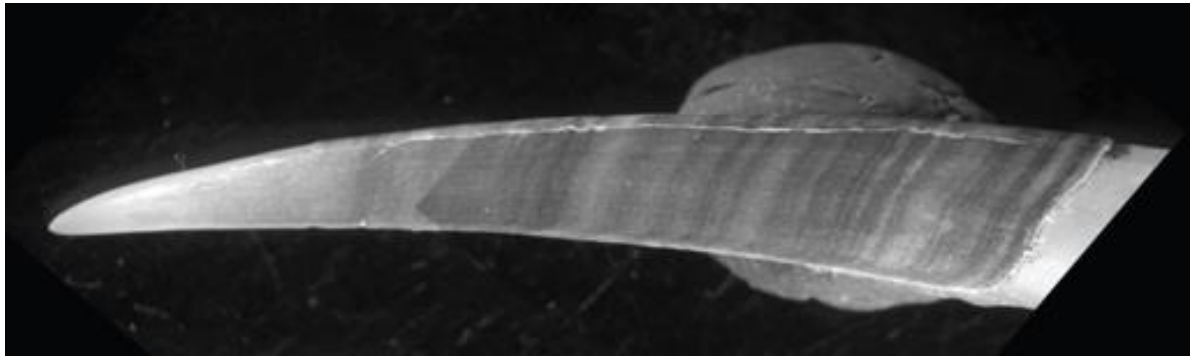
Type of mark	$ per Tag Tag Length	Advantages	Disadvantages
Fin clipping/V-notch - fish in a closed system (ex. trout) - lobster 	0 ~ 1 in.	- no cost - easy application - fast application	- no animal ID - limited time of mark (regrowth/ molting)
Polyethylene ribbon or disc - shellfish 	0.15 - 0.20 1/8 to 3/4 in.	- low cost - unique animal ID - easy application	- need hard surface - life of glue limits tag life
Visible implant elastomer (VIE) - turtles - salmon - hatchery releases 	(varies) ~ 1/4 in.	- easy detection - easy to tag large #s of fish quickly - inexpensive color	- no animal ID - very expensive injector
T-bar anchor tag - most fish - scup, shark... 	0.45 2+ in.	- low cost - unique animal ID - fast application - appropriate for many species	- requires tagging gun - training needed - tags are shed easily
Laminated disc - YT flounder - flat fishes 	0.50 3/4+ in.	- low cost - unique animal ID - nearly permanent	- minor injury to animal - some training necessary
Internal anchor tag - striped bass - bl. sea bass 	0.75 ~3 in.	- longer retention - more secure - unique animal ID	- specific training required - slow application - minor injury to animal
Passive integrated transponder (PIT) - turtles - salmon 	5-10 1/2 to 1 in.	- nearly permanent - unique animal ID - electronic tag detection	- not visible - scanner needed to read tag # - cost of scanners and tag injector
Archival tag (data storage) - various species - cod -YT flounder 	200+ 1 to 2 in.	- temperature and depth records - other options available	- limited battery life - tag must be retrieved to get data
Pop-up, satellite tag - tuna - shark - turtles - billfish 	2,000+ 2 to 6 in.	- real time data - location recorded - tags do not need to be recovered	- cost - limited battery life - satellite time is additional cost

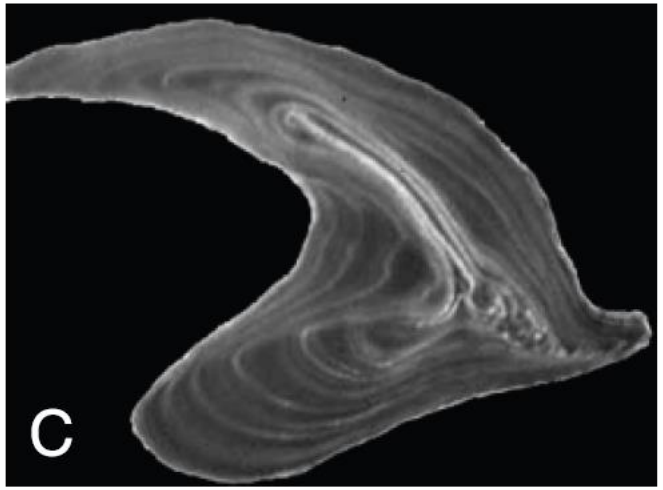
Self Check

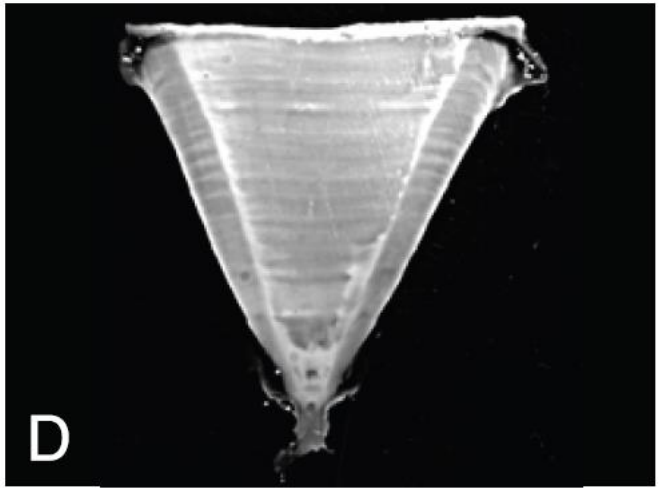
- What is the biggest downside of using recaptured fish to estimate growth
  - Tag loss
  - Have to capture lots of fish
  - Tag expense
  - Tags are harmful to fish

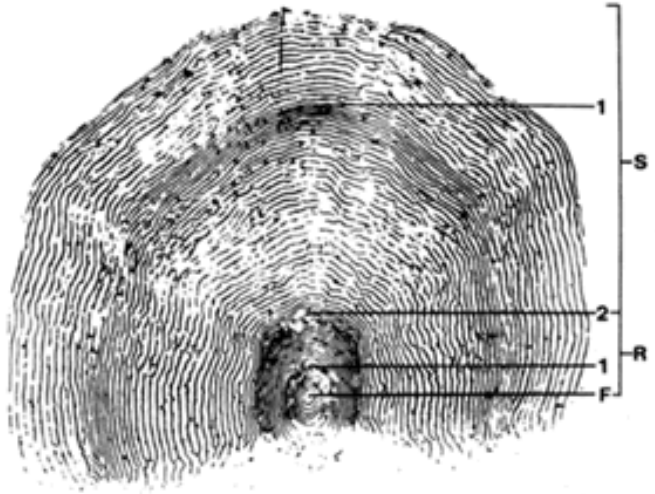
Aging Using Hard Structures









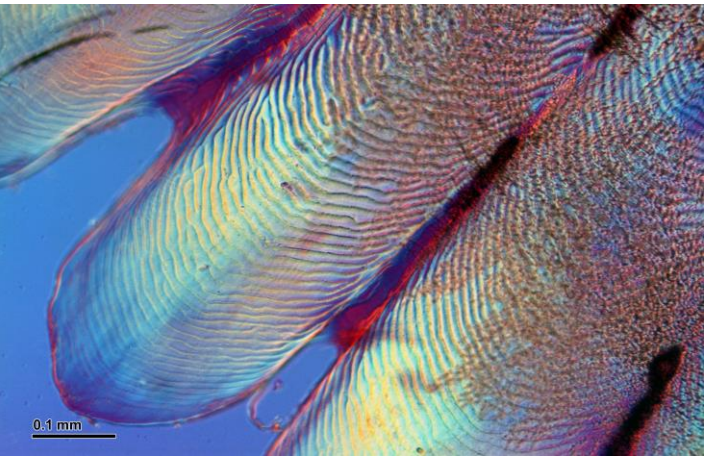


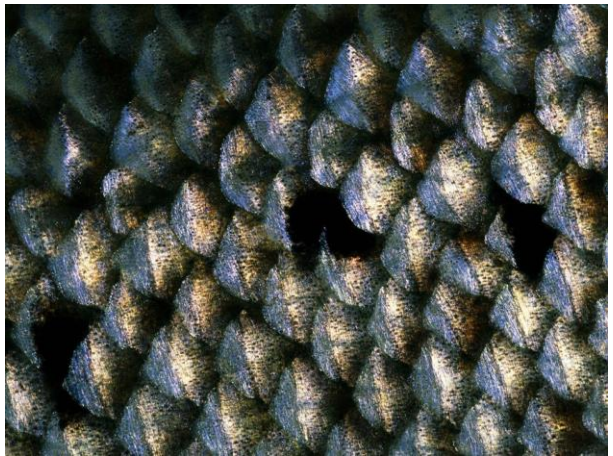
Structures used for aging

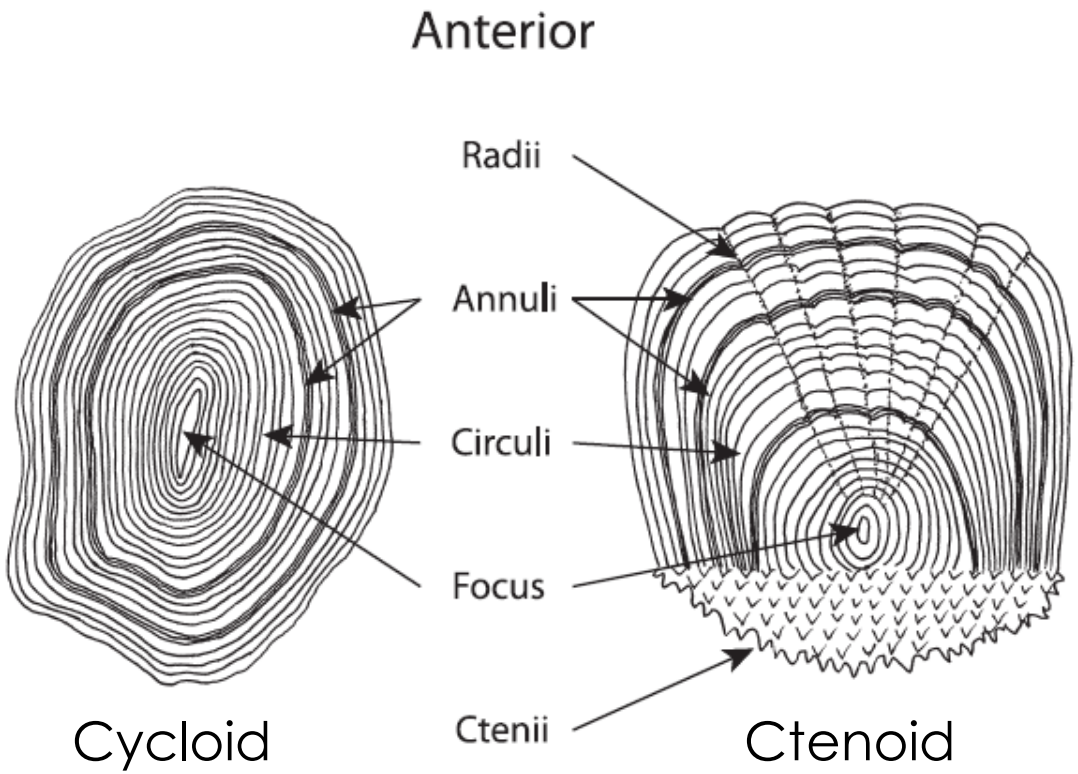
- Scales – Most common
- Otoliths (sacrifice) – 2nd most common
- Cleithra – Esocidae (sacrifice)
- Opercula (sacrifice)
- Vertebrae – Sharks (no spines, teeny otoliths)
- Fin Rays – anything where scales don't work and you don't want to kill the fish

Scales

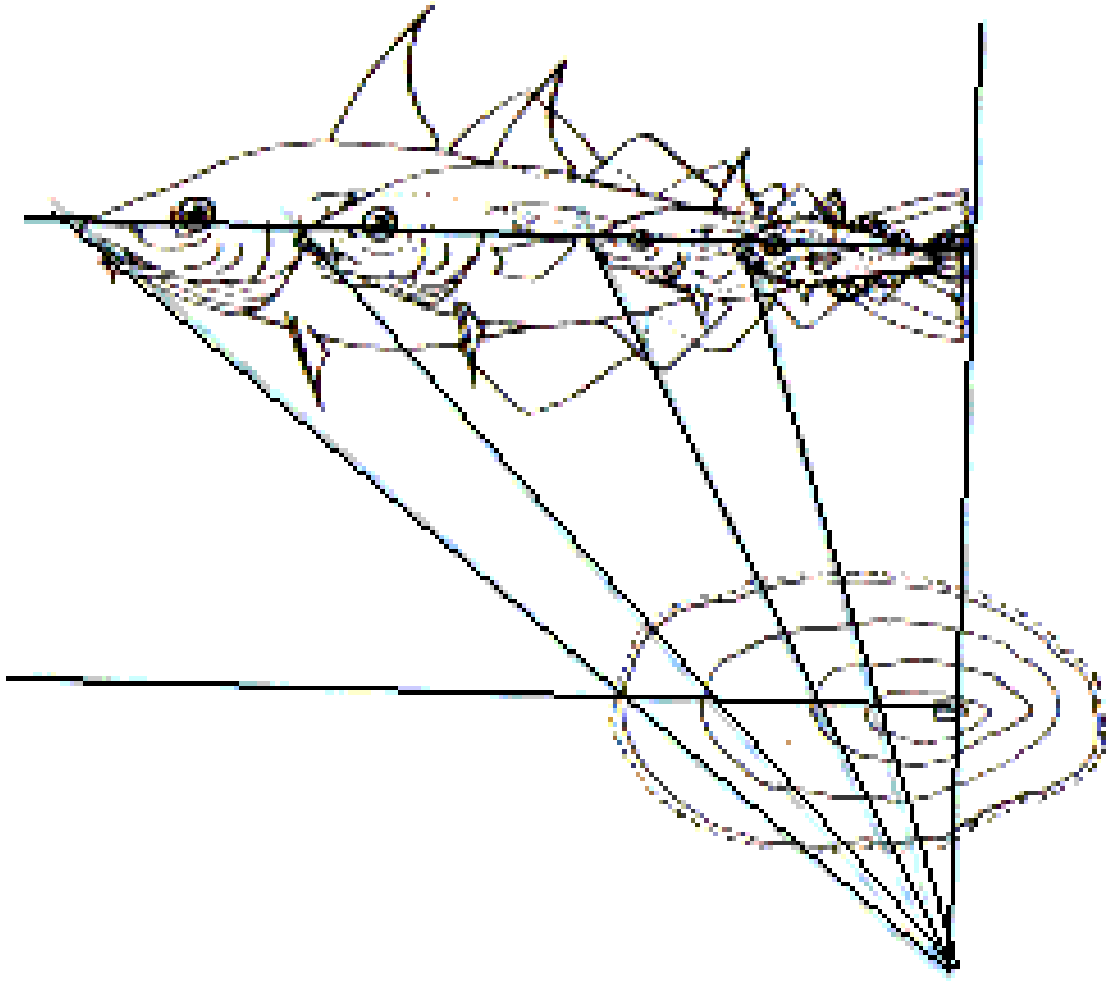
- Most widely used age method
  - Non lethal
- Count annual rings to get age
- Space between rings is proportional to growth
- Bias to underestimate older fish

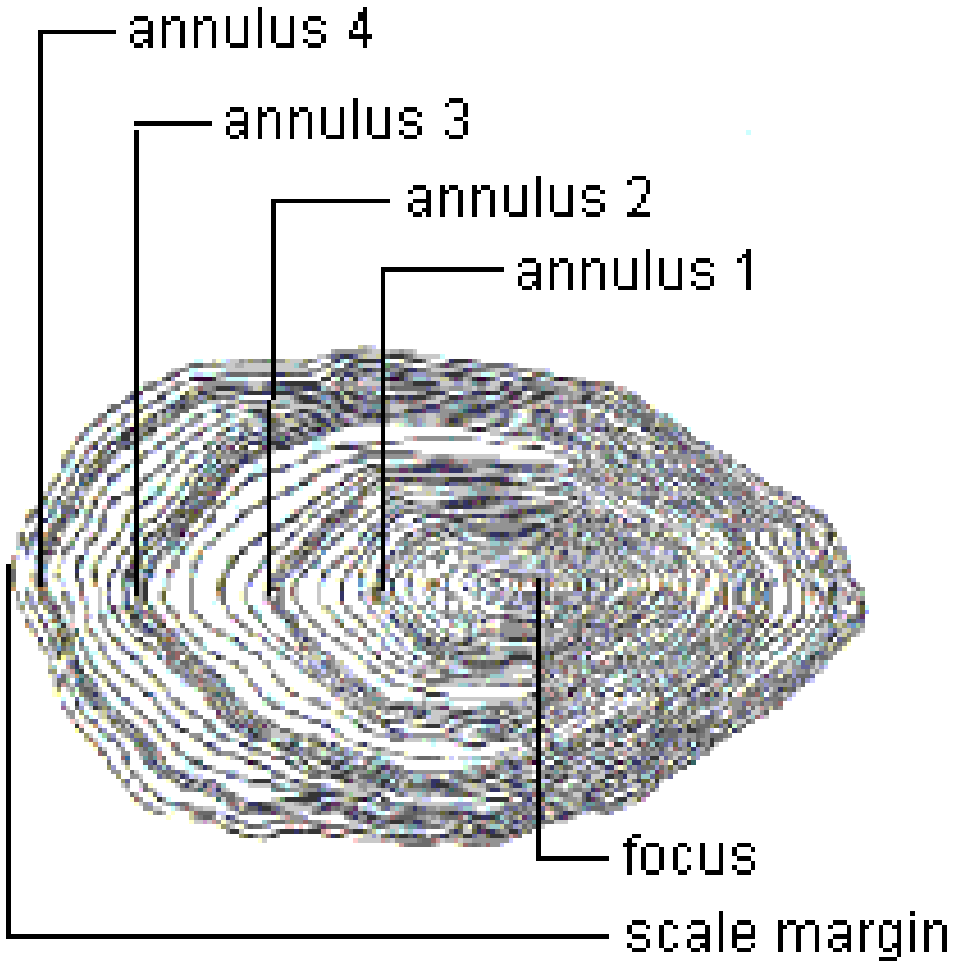






Age measurement through scales





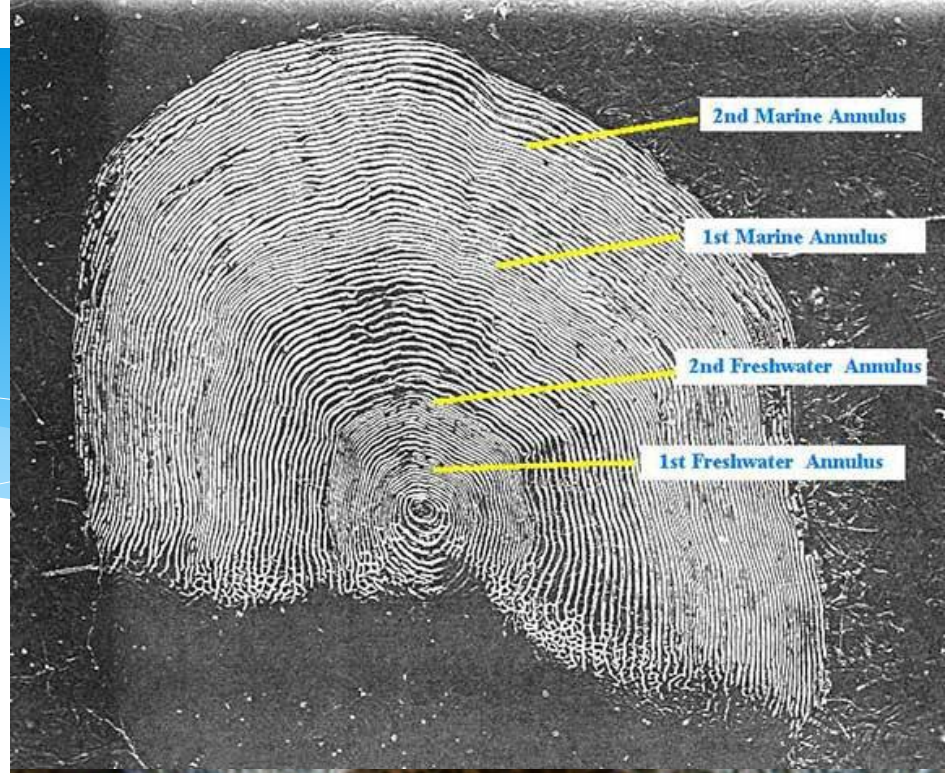
Scales

Scales are like rings on a tree

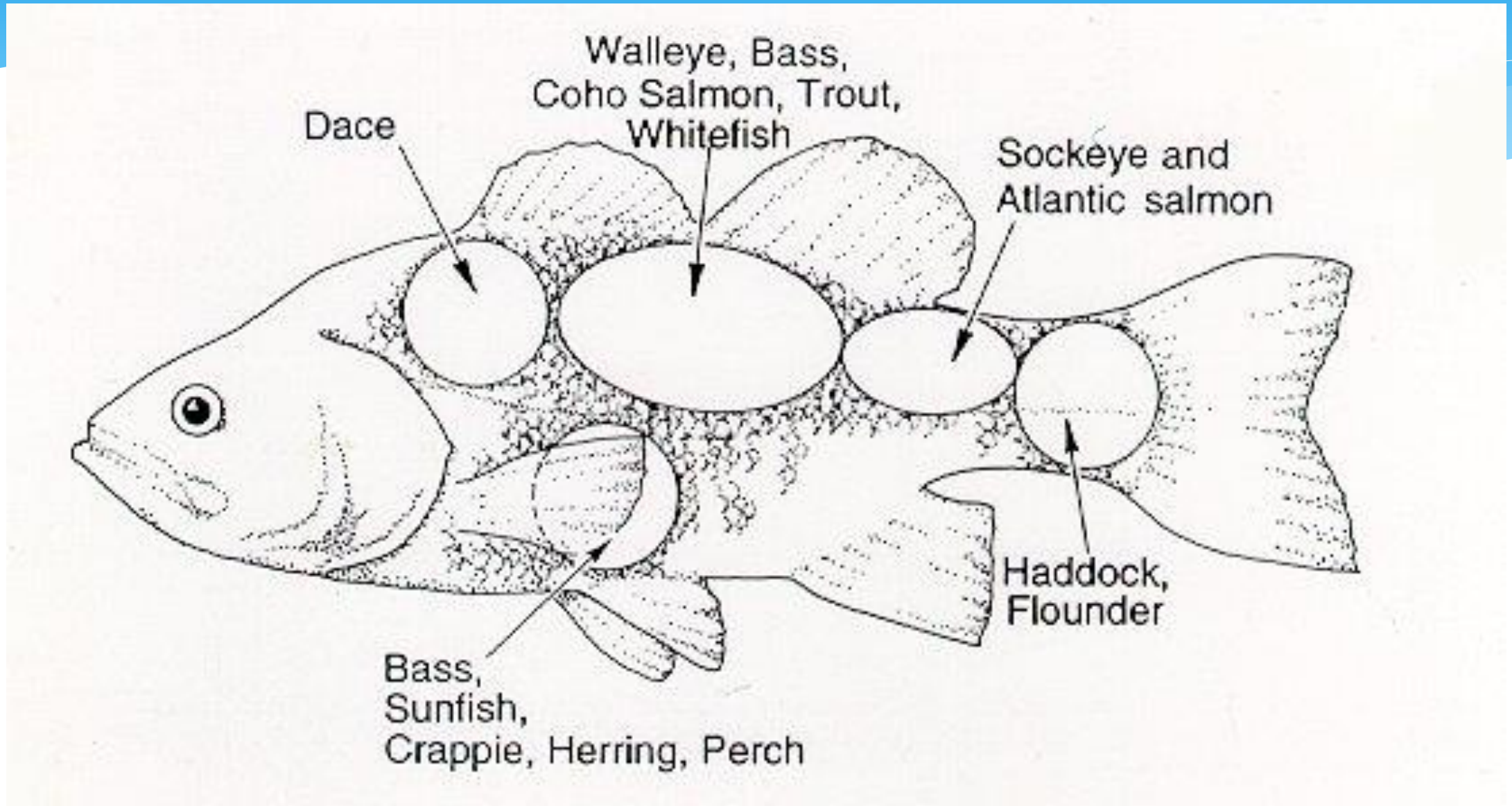
- Fish grow faster in summer than winter
  - Faster in Salt also

Scale Processing and Preparation

- Remove scales
- Scales go on scale cards (Gum Cards)
- Pressed and heated
- Use microfiche machine to read



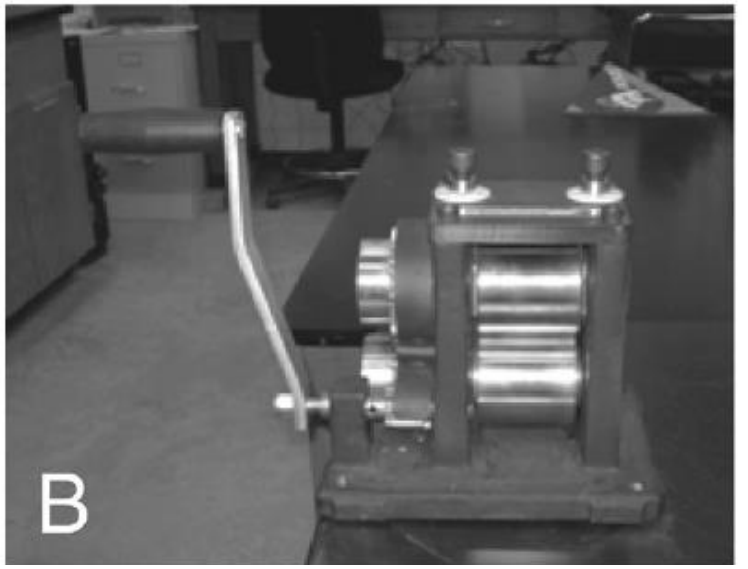
Fish Scale Location

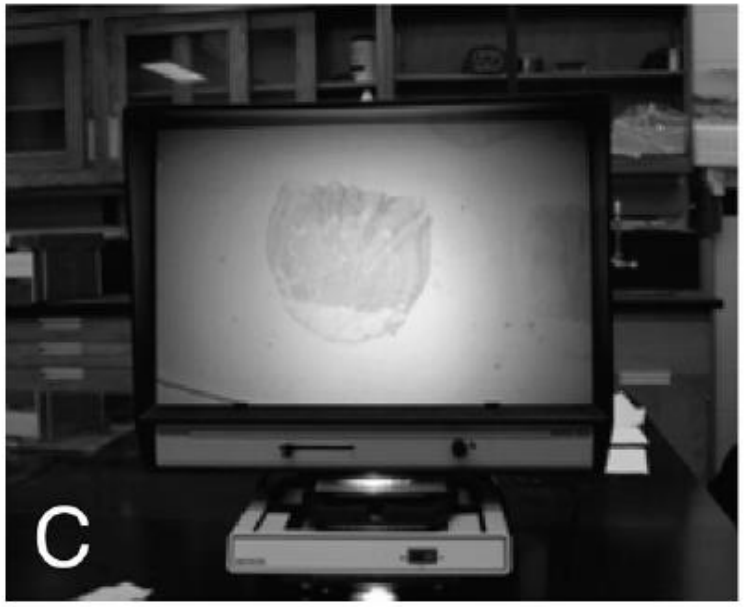


Mounting Scales

Mounting Scales

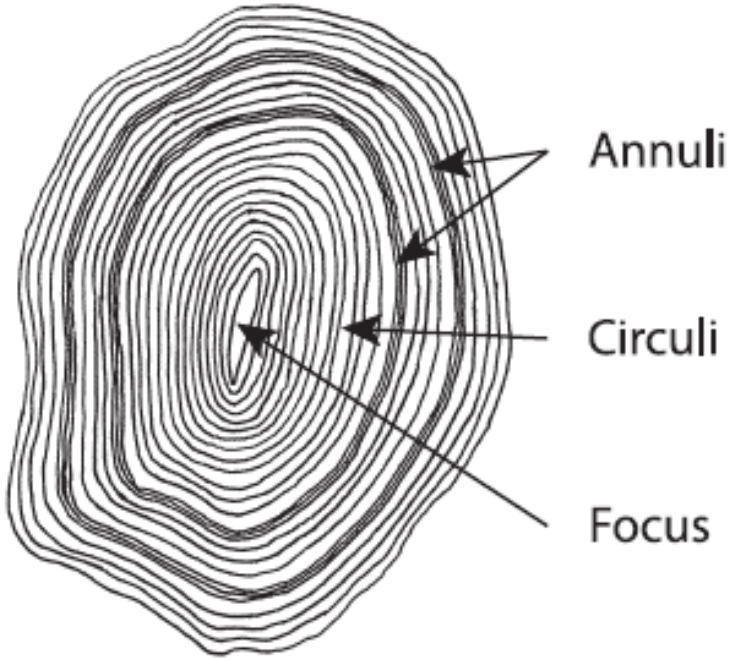
- A) Hydraulic Scale Press
  - Heated
- B) Manual Scale Roller
- C) Microfiche reader

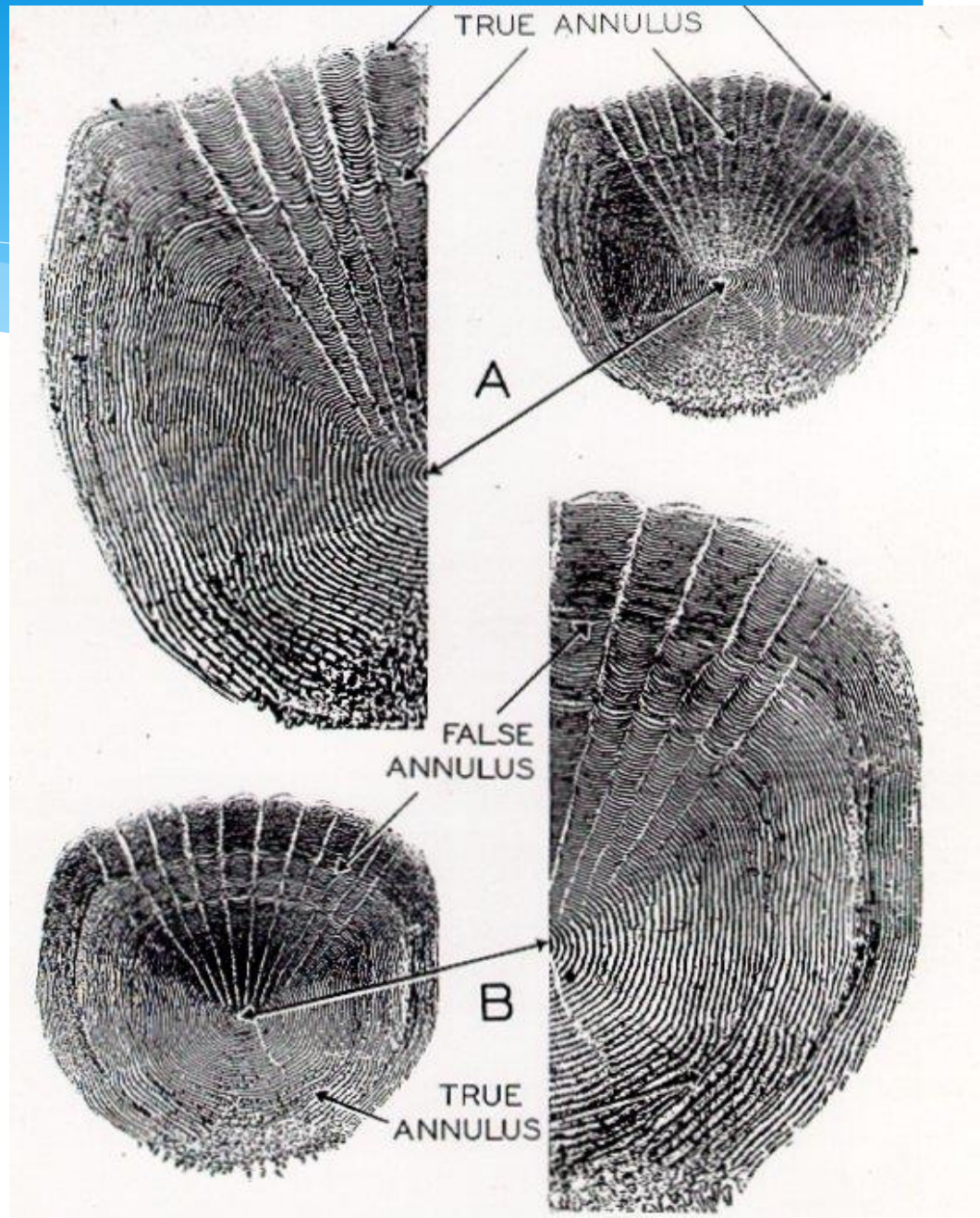




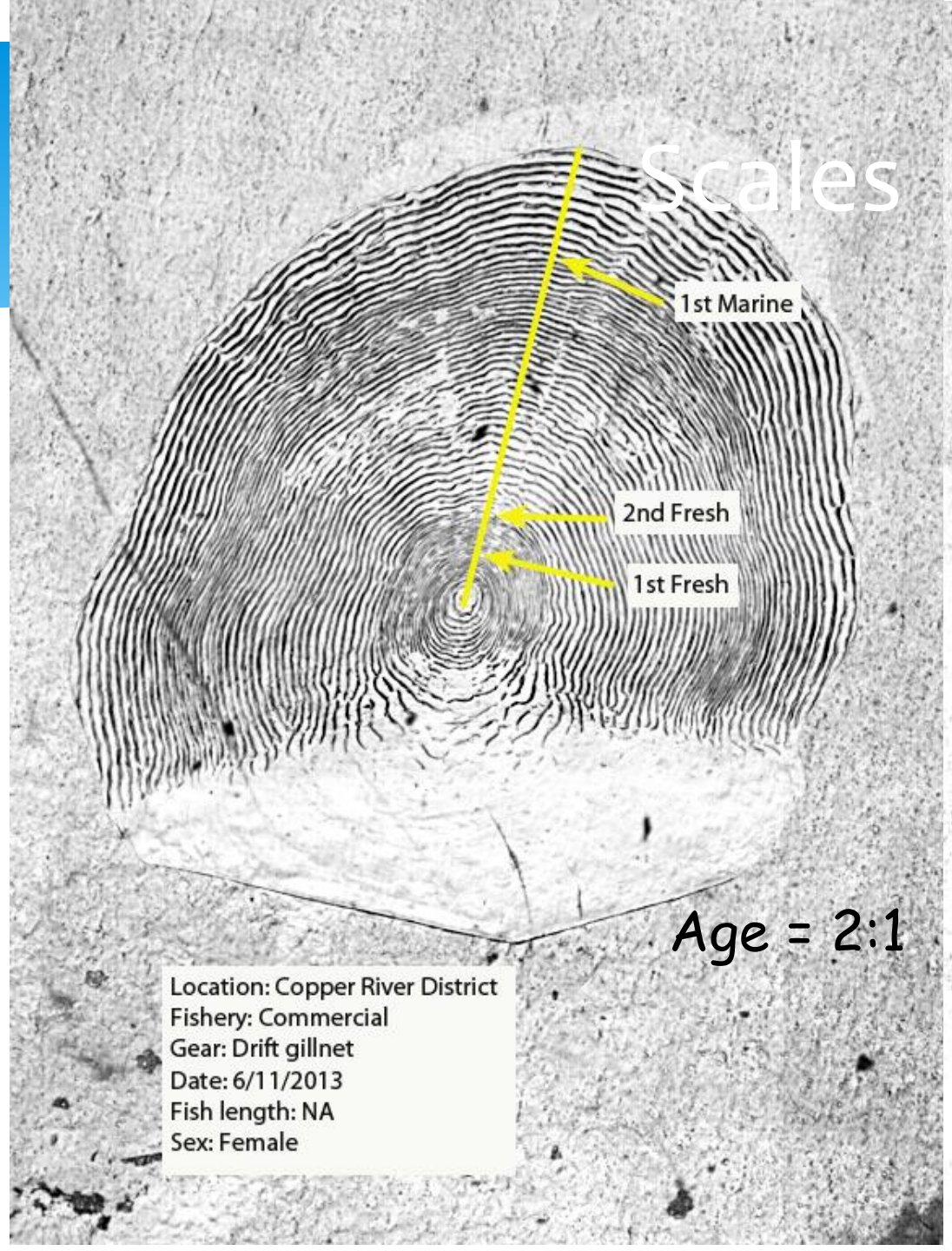
Scales

- **Annuli** – Dark annual bands laid down during winter slower growing periods
- **Focus** – or origin of scale
- **Circuli** – circular growth rings



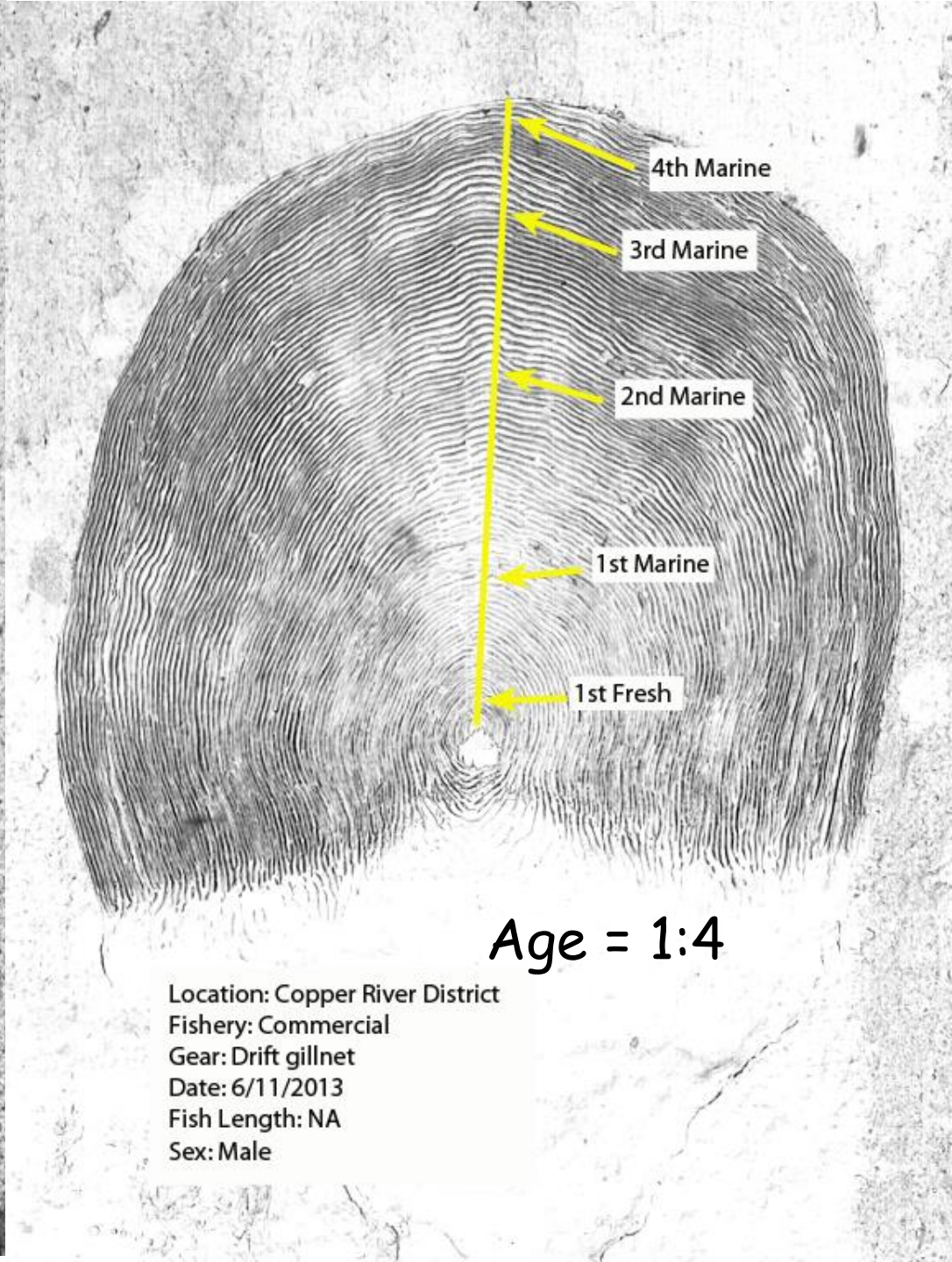


Scales



Age = 2:1

Location: Copper River District
Fishery: Commercial
Gear: Drift gillnet
Date: 6/11/2013
Fish length: NA
Sex: Female



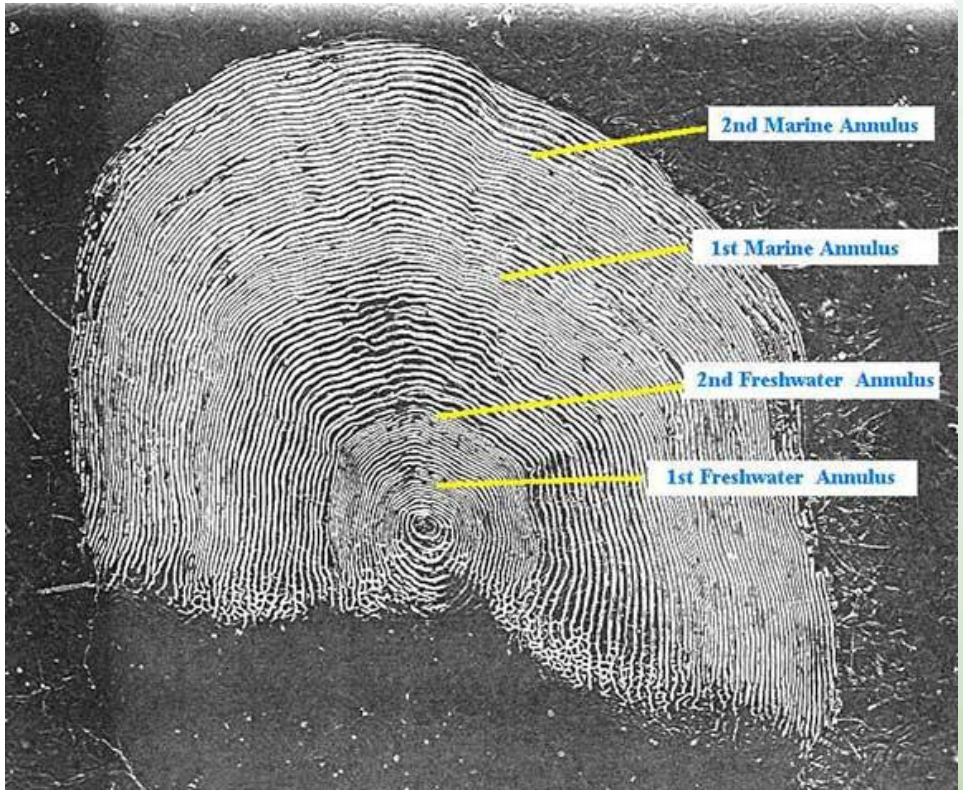
Age = 1:4

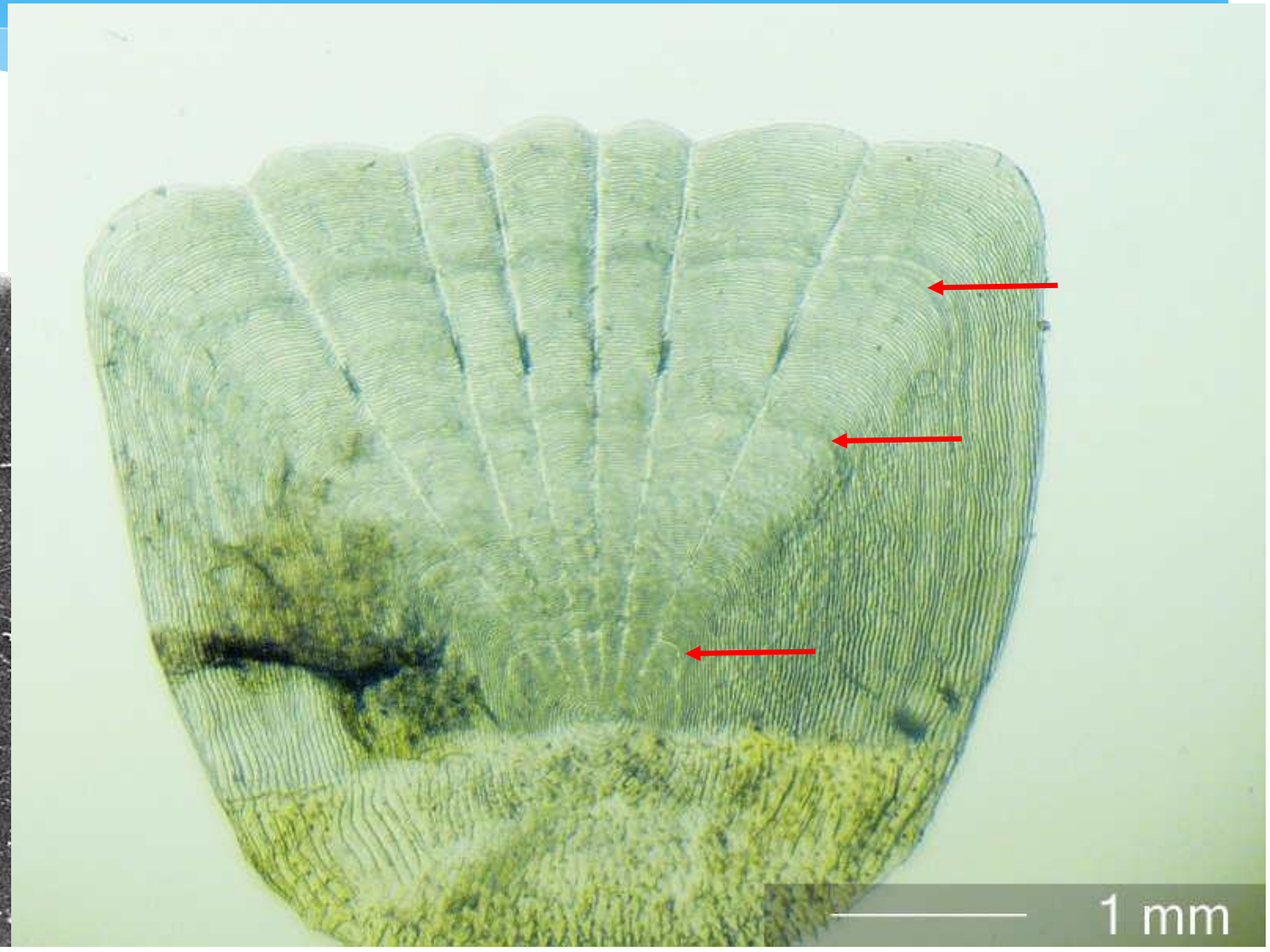
Location: Copper River District
Fishery: Commercial
Gear: Drift gillnet
Date: 6/11/2013
Fish Length: NA
Sex: Male

Age

2:2 Sockeye

0:3 largemouth bass 23cm





Self Check

- The dark bands laid down during the winter slower growing periods on a fish's scale are called
  - Annuli
  - Focus
  - Circuli
  - Loci

- Scales are the most widely used structures for aging fish
  - True
  - False

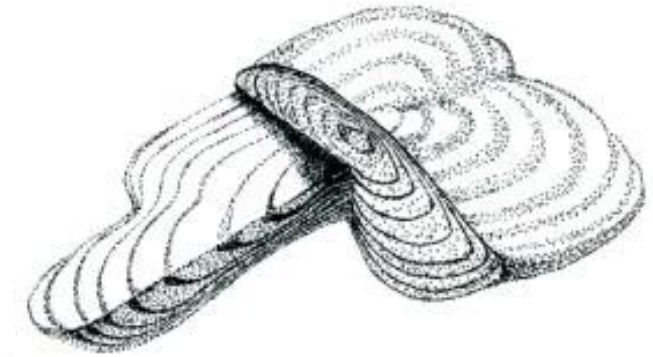
Otoliths

Otoliths are the earbones of bony fish

- They come in pairs (3 total)
- Size and Shape vary widely
- Must sacrifice to collect
- More accurate than scales

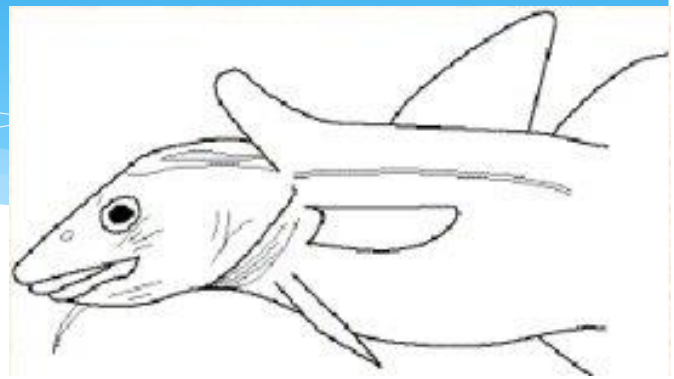
Otoliths and fisheries science

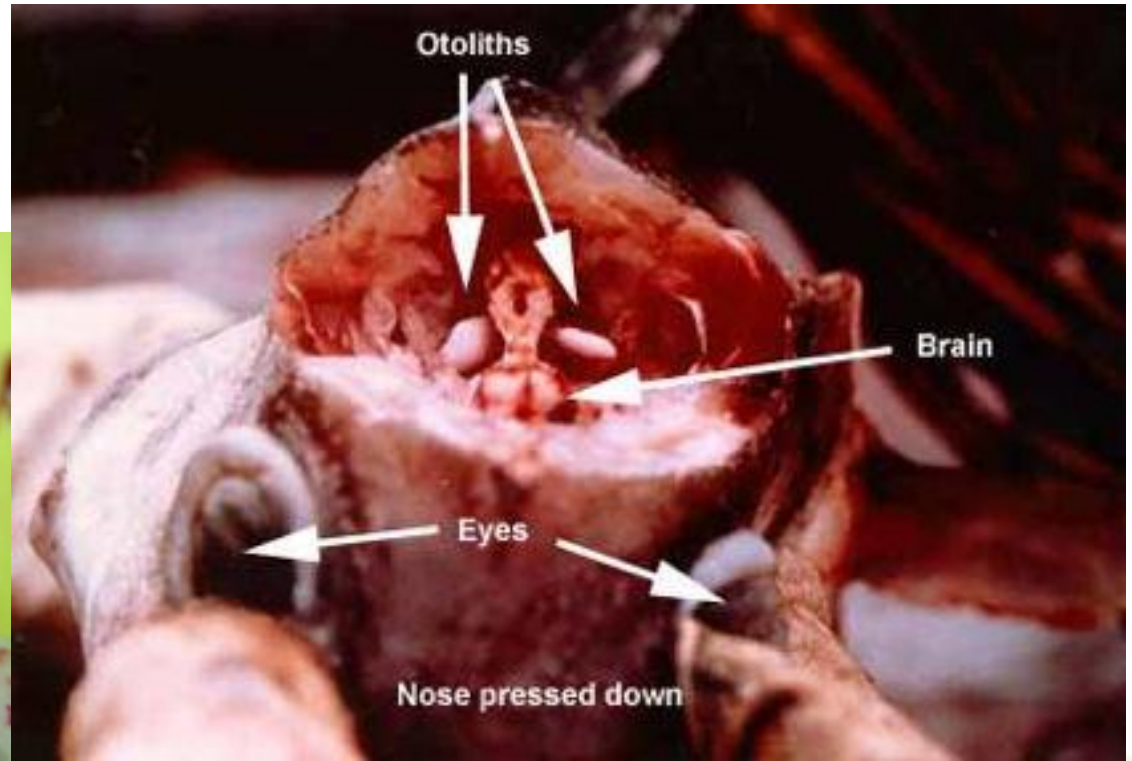
- Unique properties:
  - Otolith growth is continual
  - Lack of resorption
    - Complete growth and environmental record
  - Crystalline structure
    - Holds trace metals
- Allows scientist to:
  - Determine temperature (Sr:Ca)
  - Determine salinity throughout life history
    - Anadromous migrations

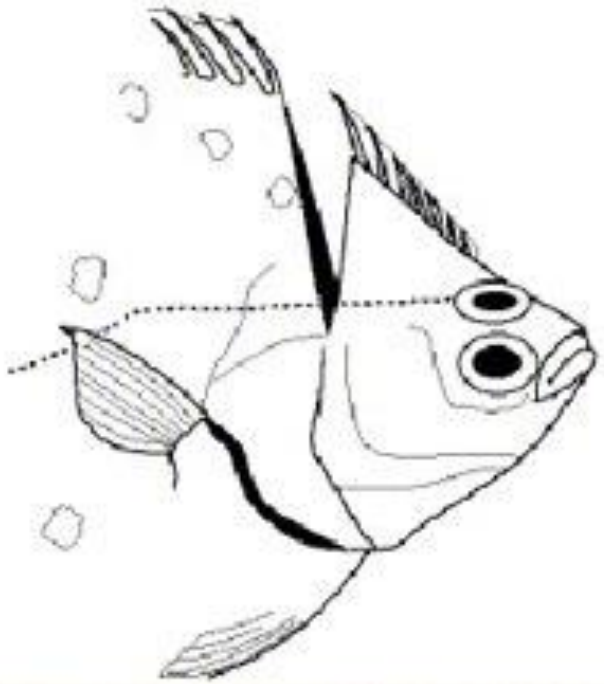


Where the F are they?

- Posterior and dorsal to the eyes
- Takes practice
- Port samplers 30 sec



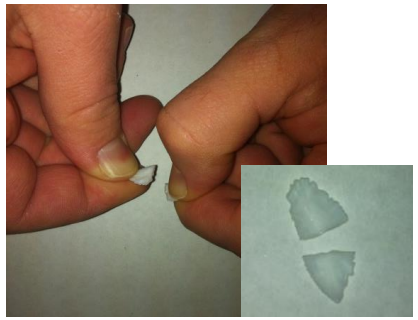


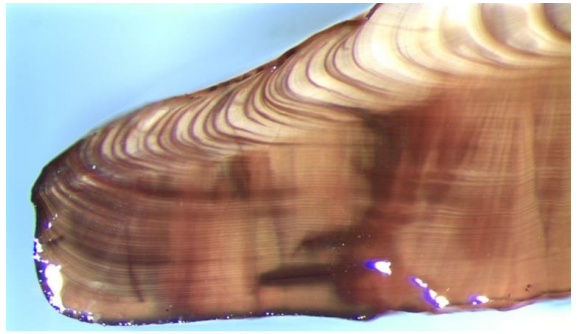


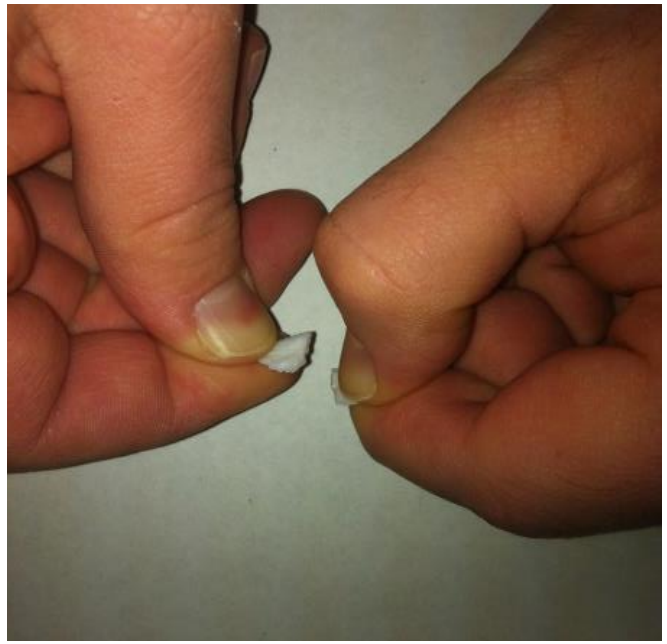
Otolith Process

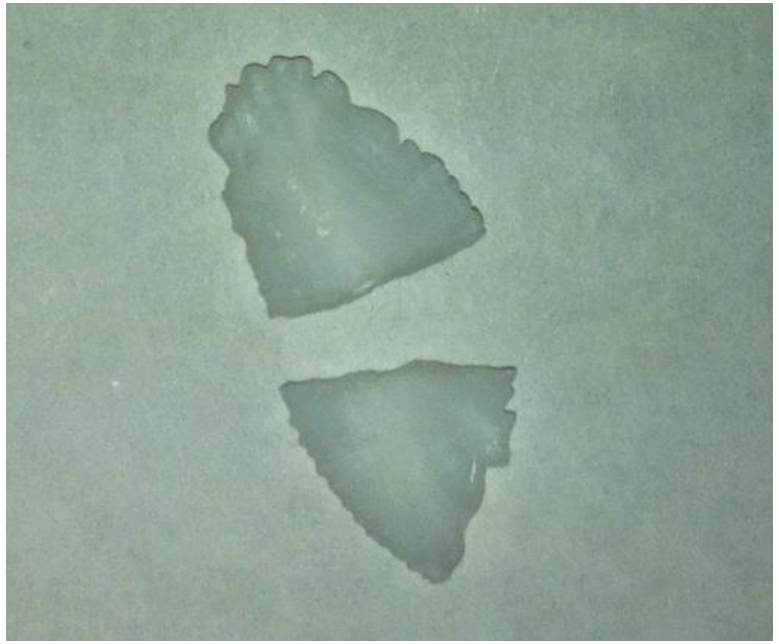
- Whole otolith, clean and dry
- Measured
- Weighed
- Broken
- Burned
- Oiled
- Specimen ready to read!



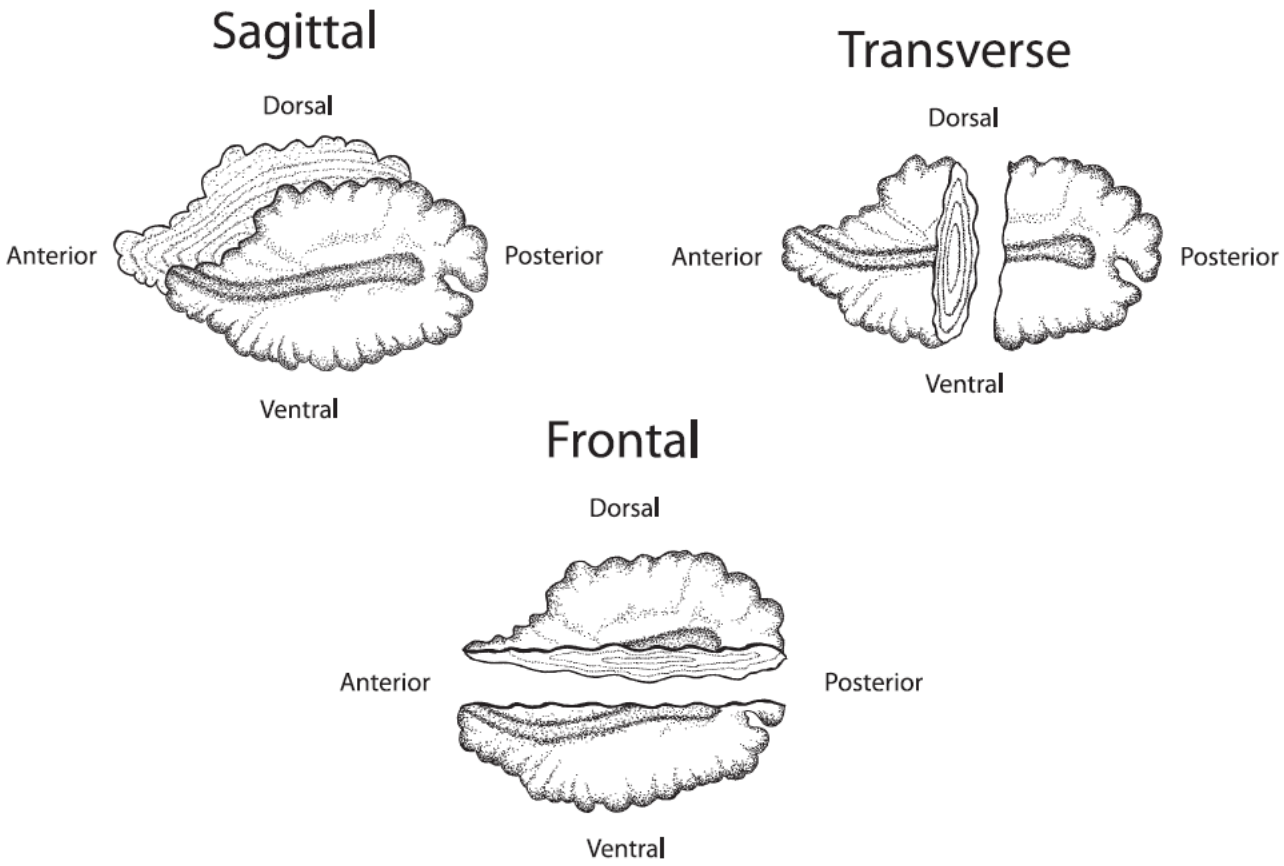






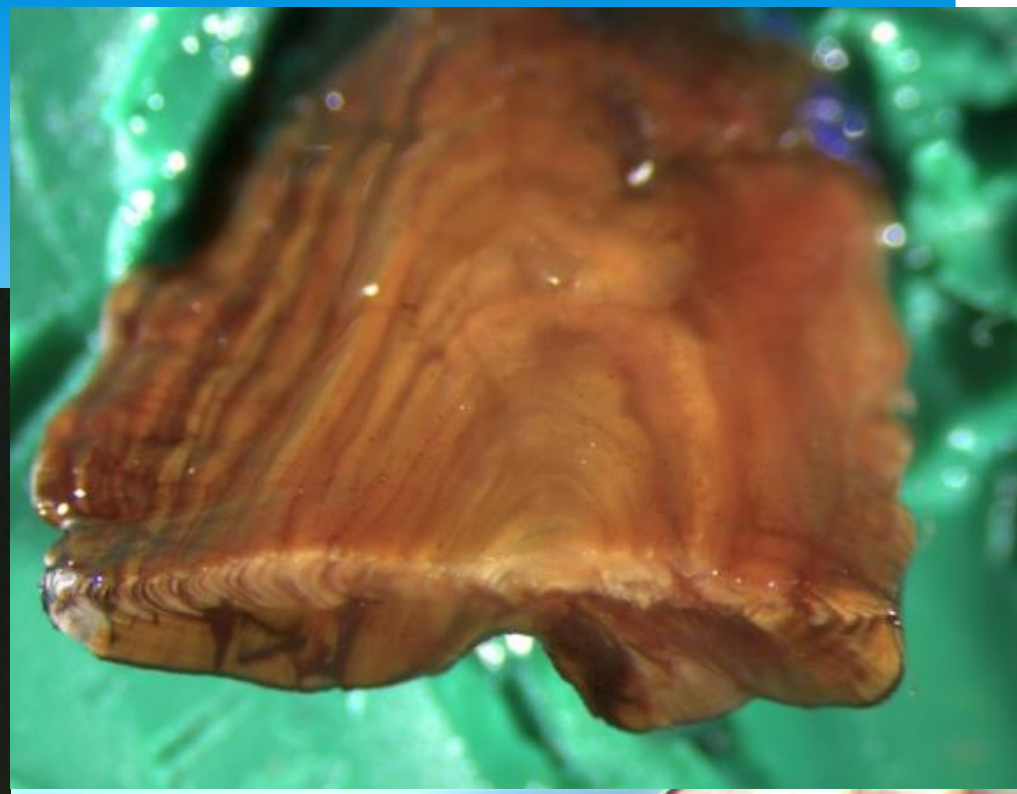
Various ways to fracture Otoliths

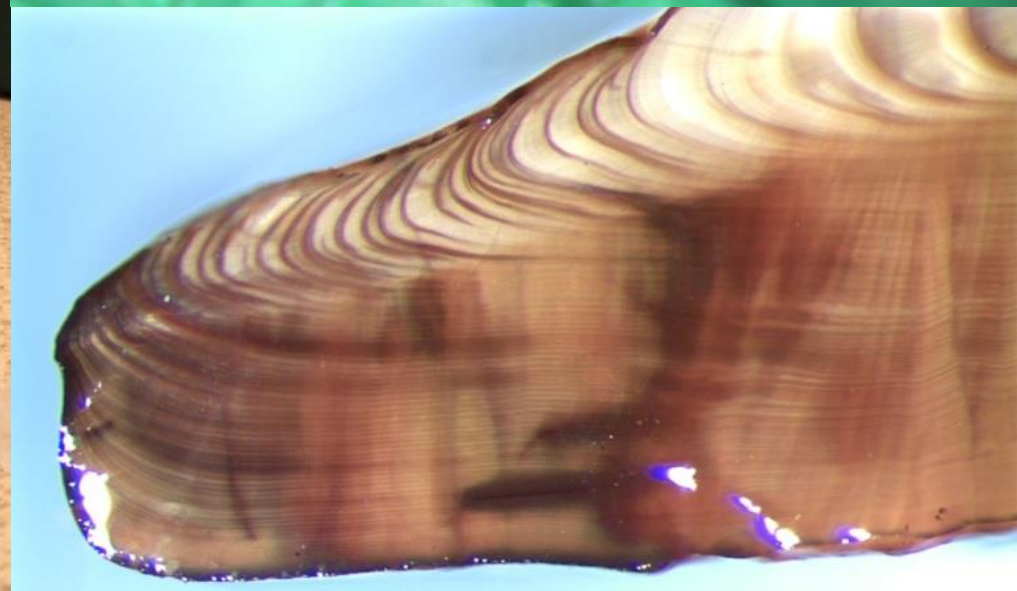
- Spp dependant



Otoliths

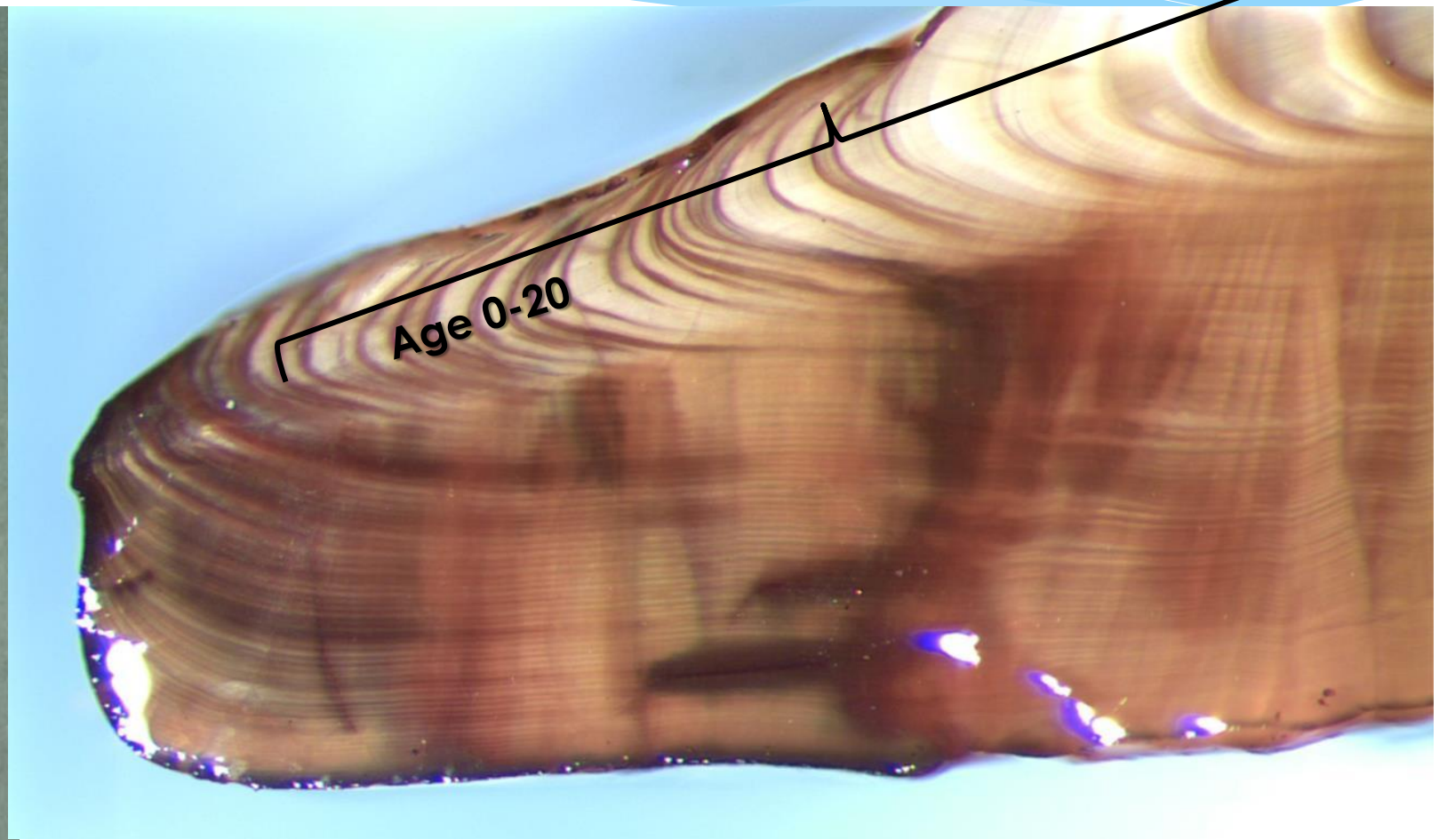
Break & Burn





Age measurement through otoliths

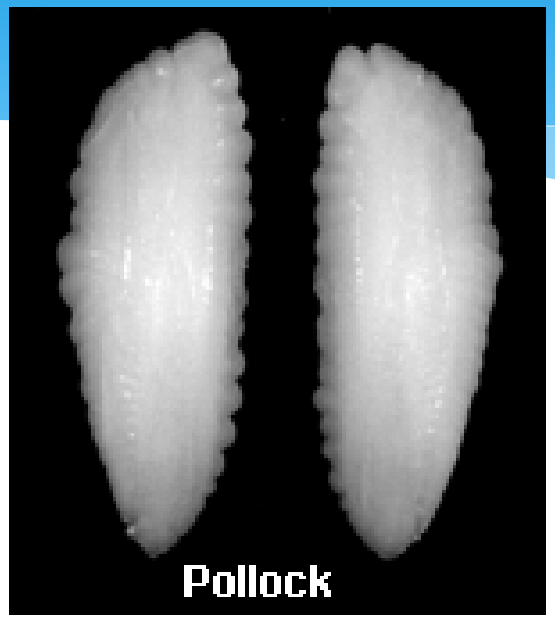
- Yelloweye rockfish, age 82

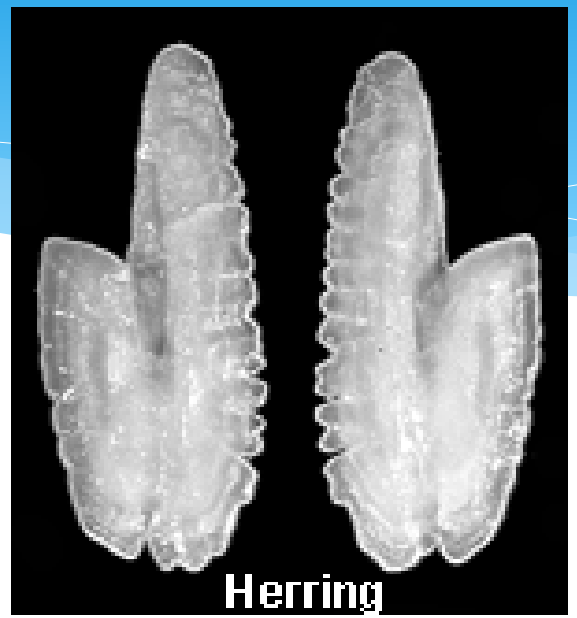


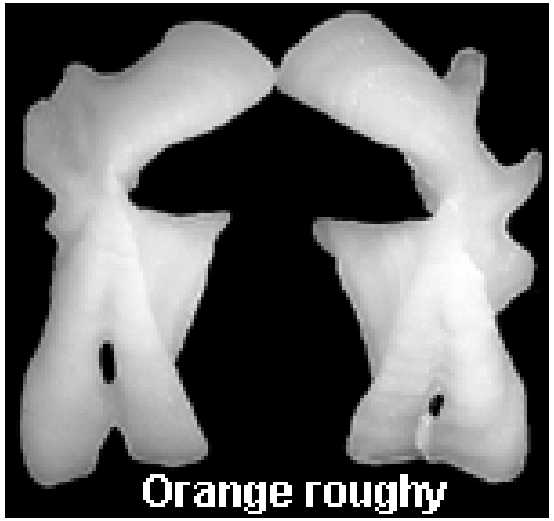
Otolith uses

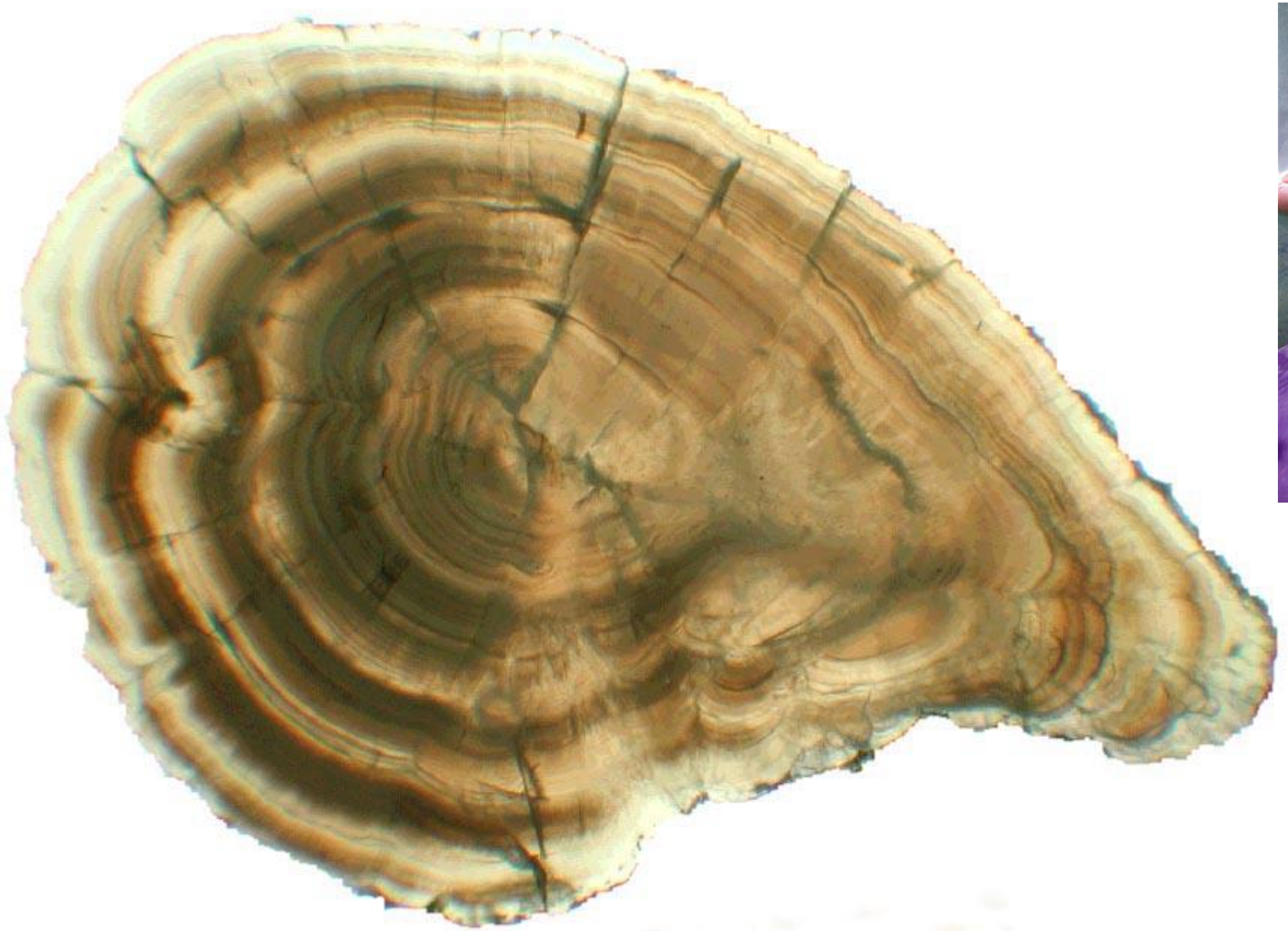
- Age determination
  - Daily ring counts
  - Annual ring counts
  - Radioactive isotopes
- Species identification
- Life history studies (elemental tracers)
- Paleoclimate studies (o_{18})

Species identification





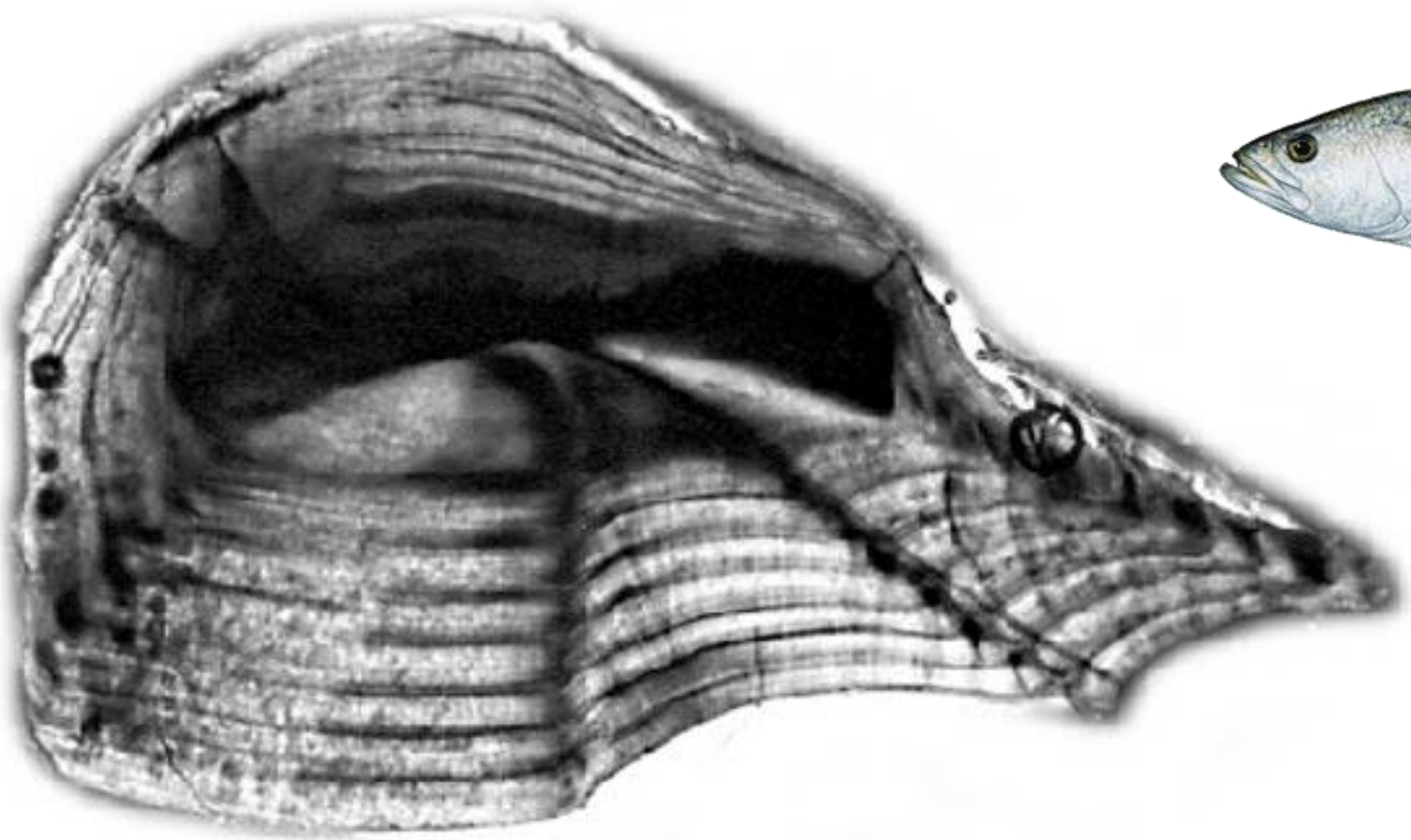


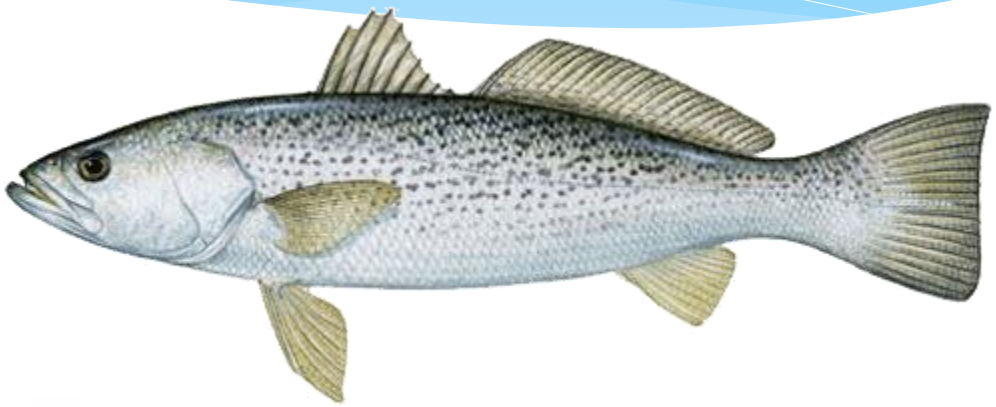


Westslope Cutthroat Trout

(Oncorhynchus clarkii)

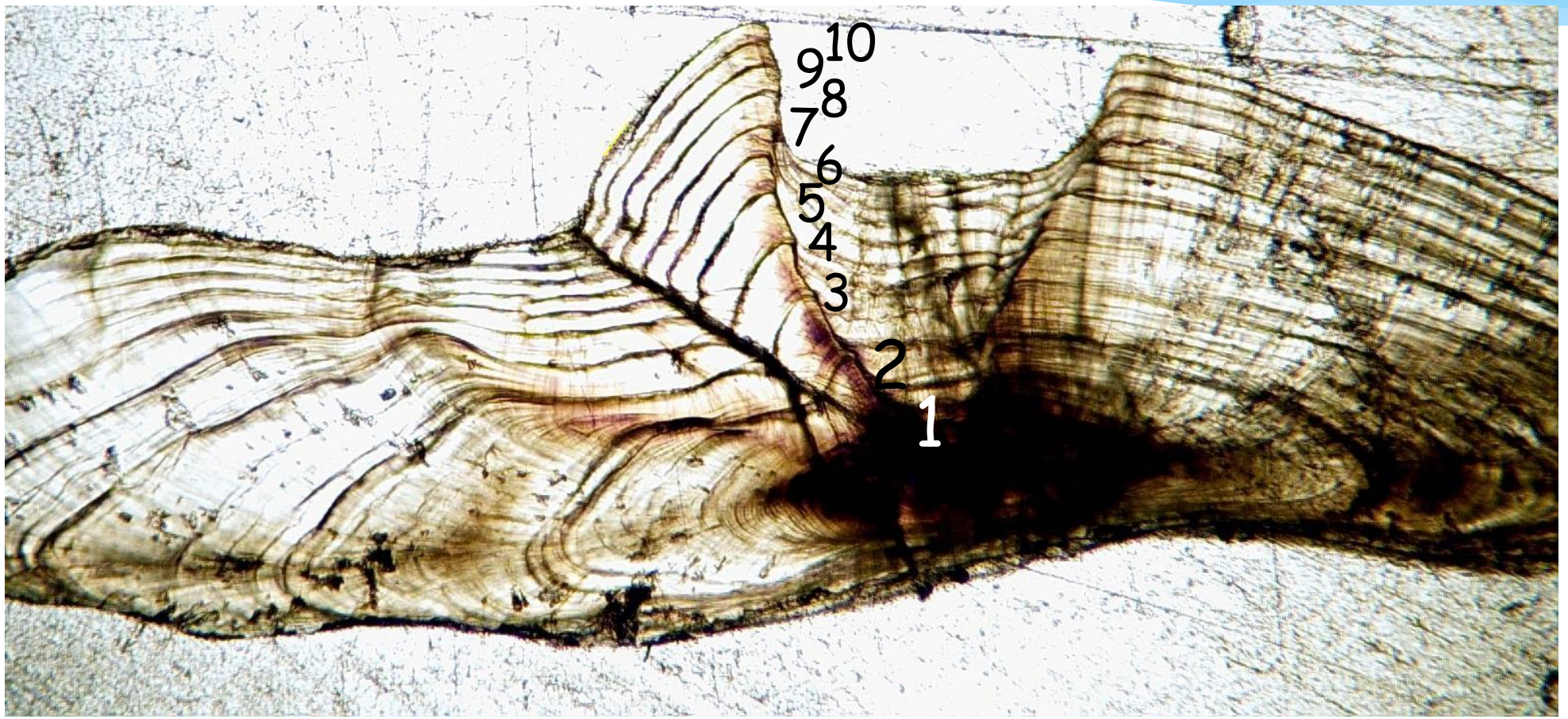
Weakfish (Cynoscion regalis)



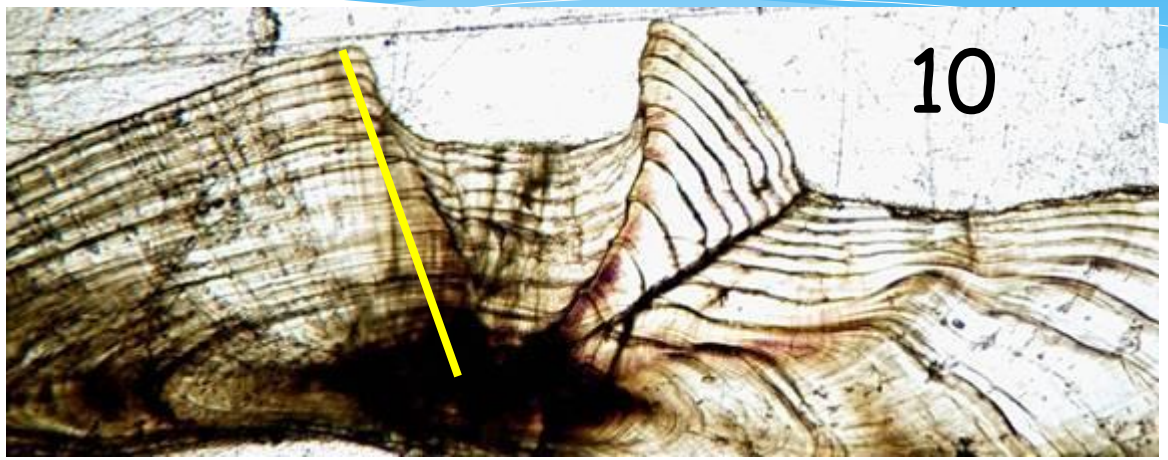


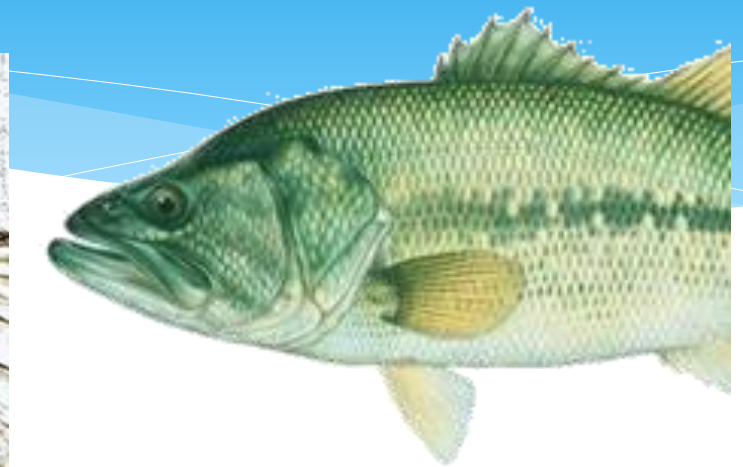
Back Calculate growth

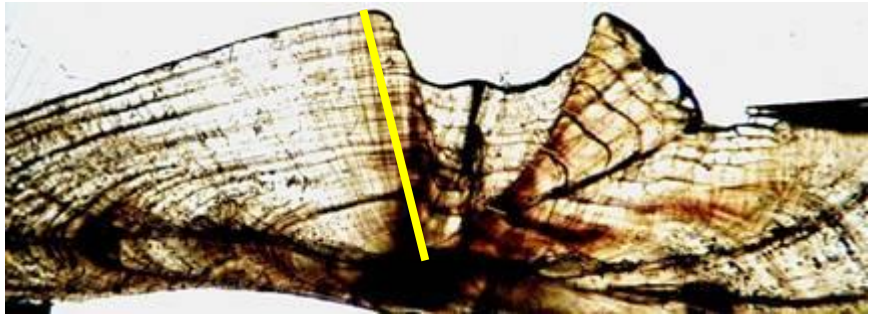
- Age = this 358 mm largemouth bass is 10 years old

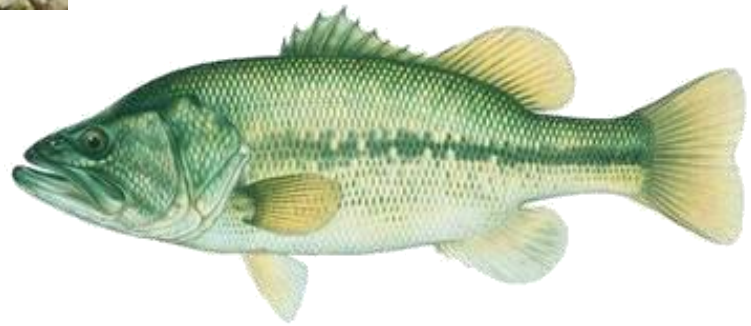


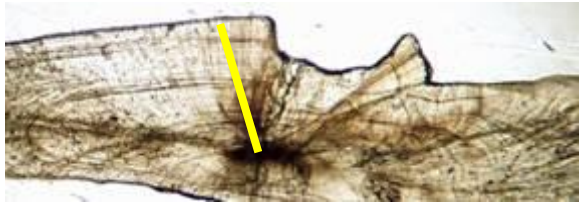
Back Calculate growth

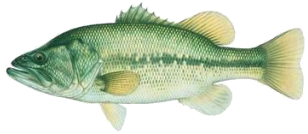






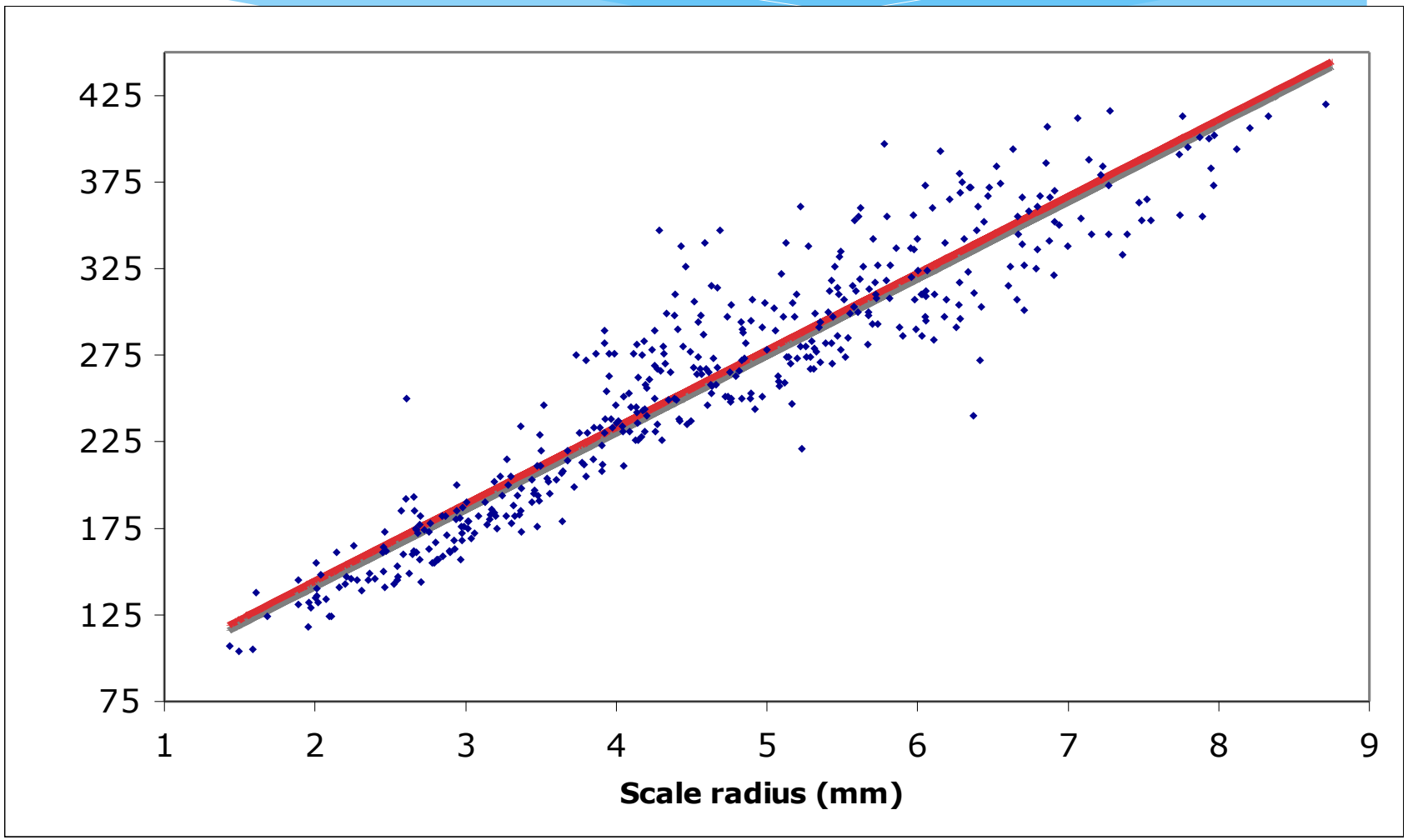






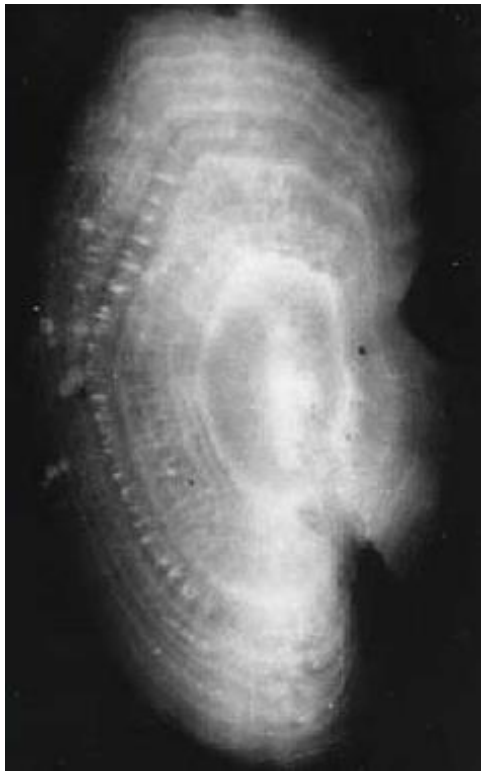
Back Calculation to get Weight

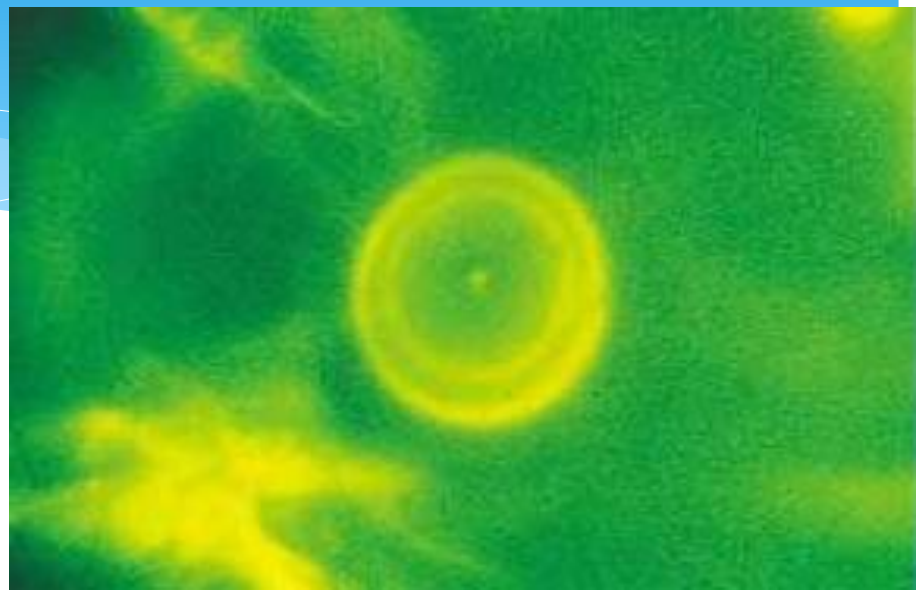
- Linear regression of scale radius and fish length
- 447 LMB from 15 lakes in Northern Wisconsin

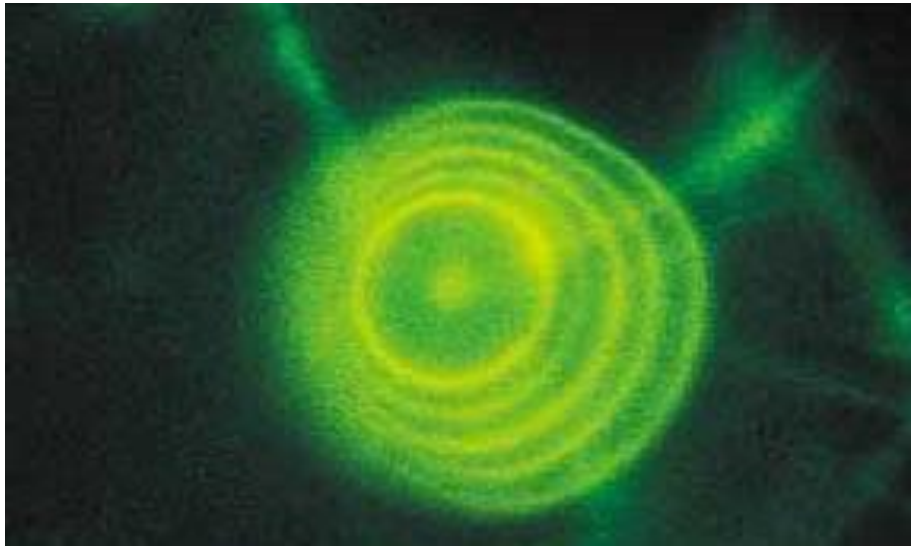


Otolith Age Verification

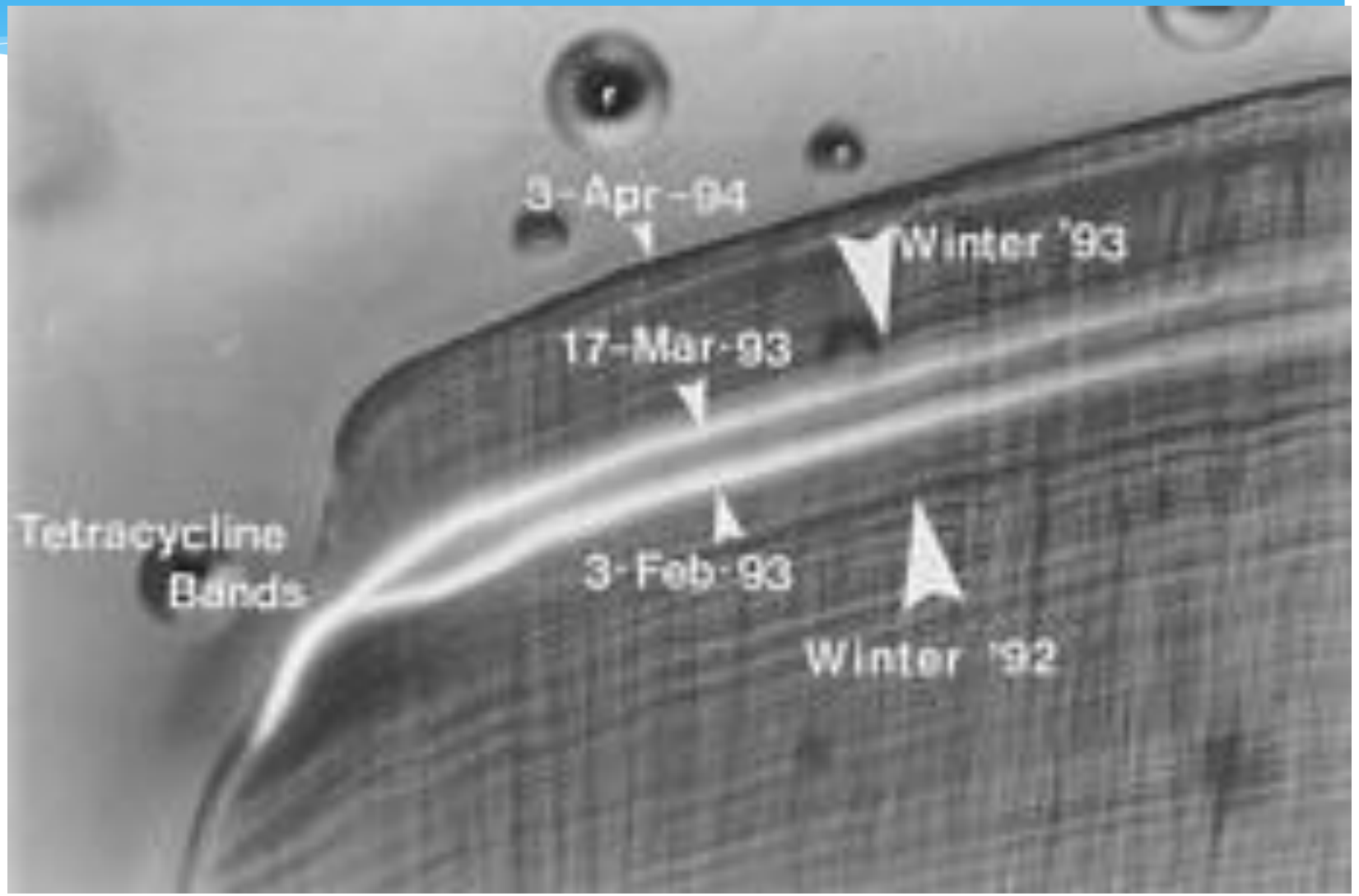
- Otolith under normal microscope light
- Marked otoliths under fluorescent light
  - Mark otoliths by exposing fish to fluorescent chemicals





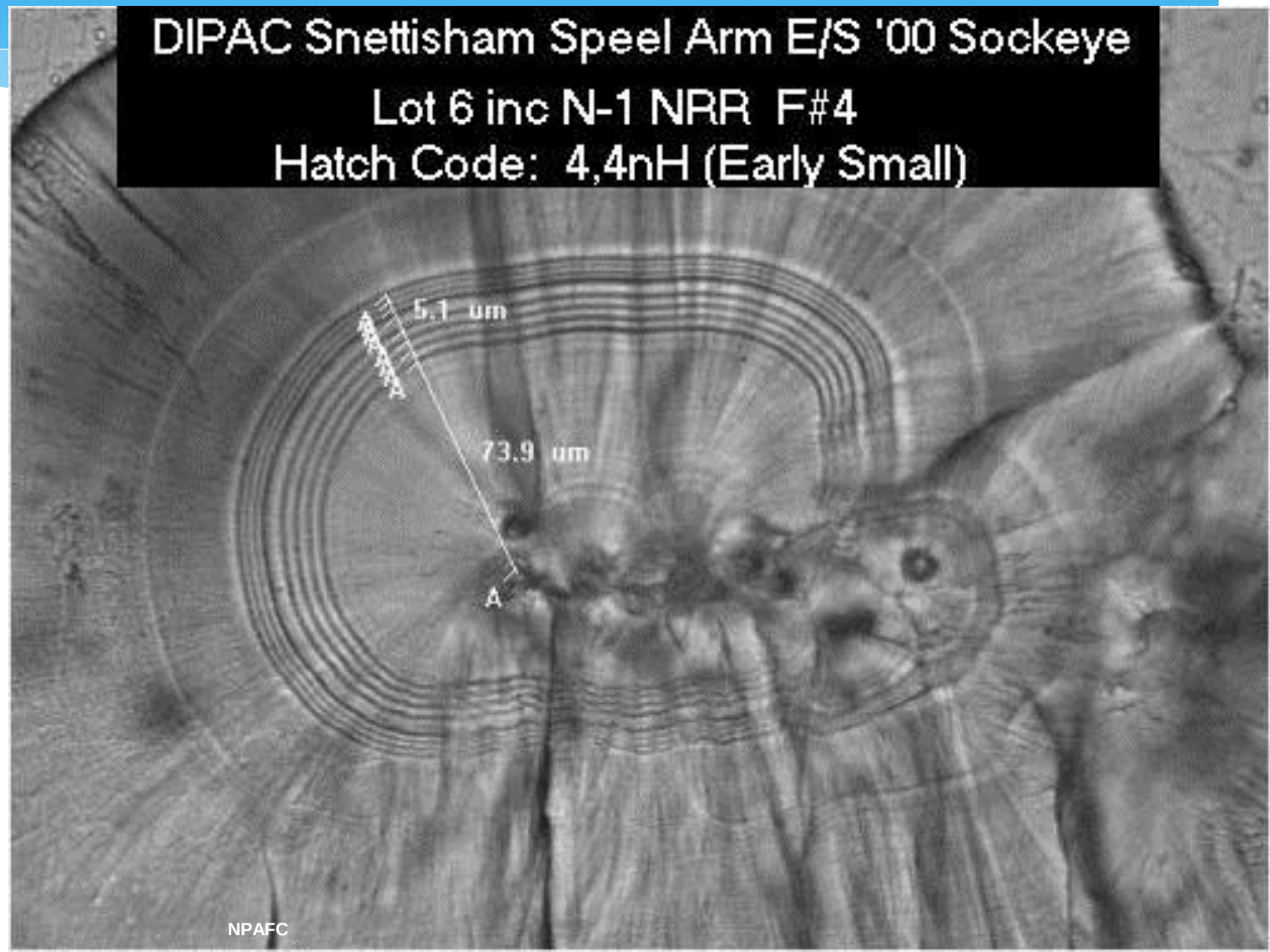


Otolith Age Verification



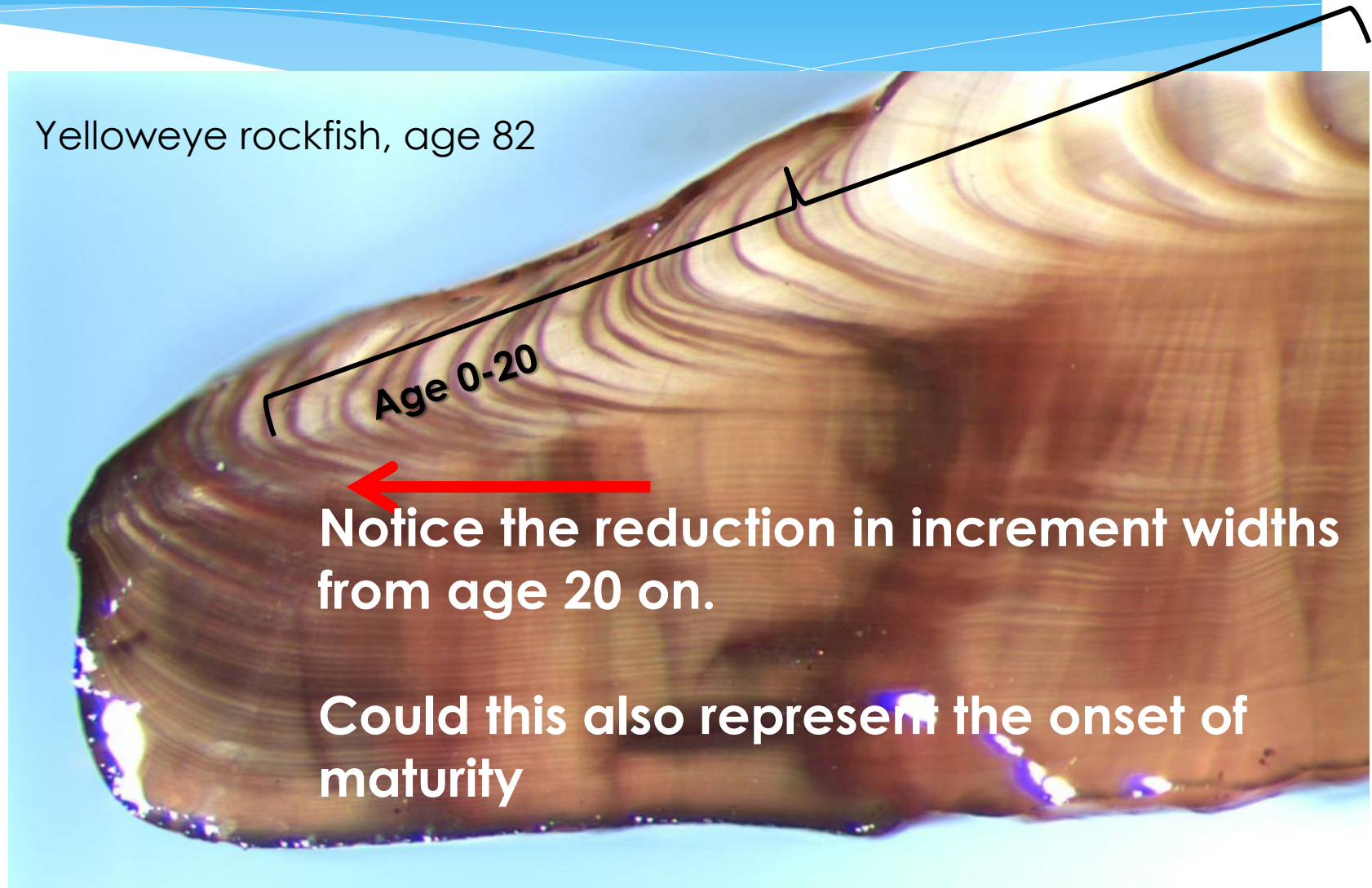
Thermal marking of Otoliths

- Change temp of water
  - Change growth rates
  - Lay down false anulit



Life History applied to age reading

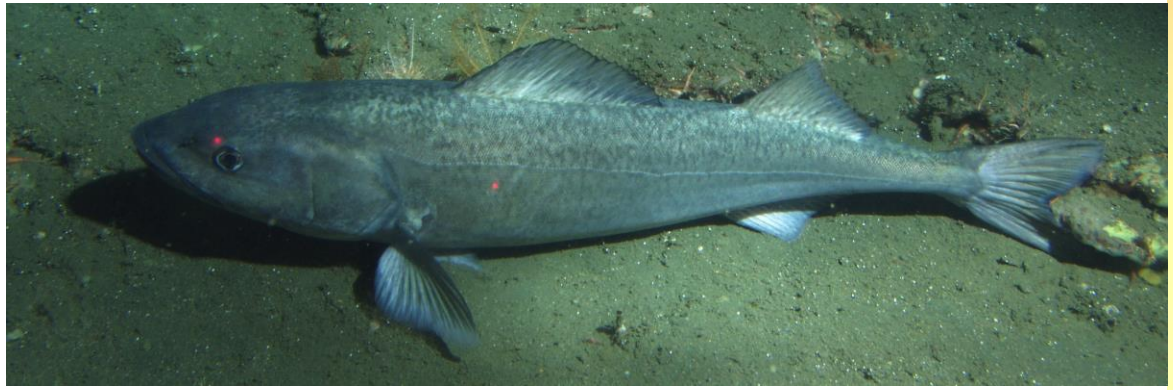
- Life history events expressed in common otolith growth patterns?

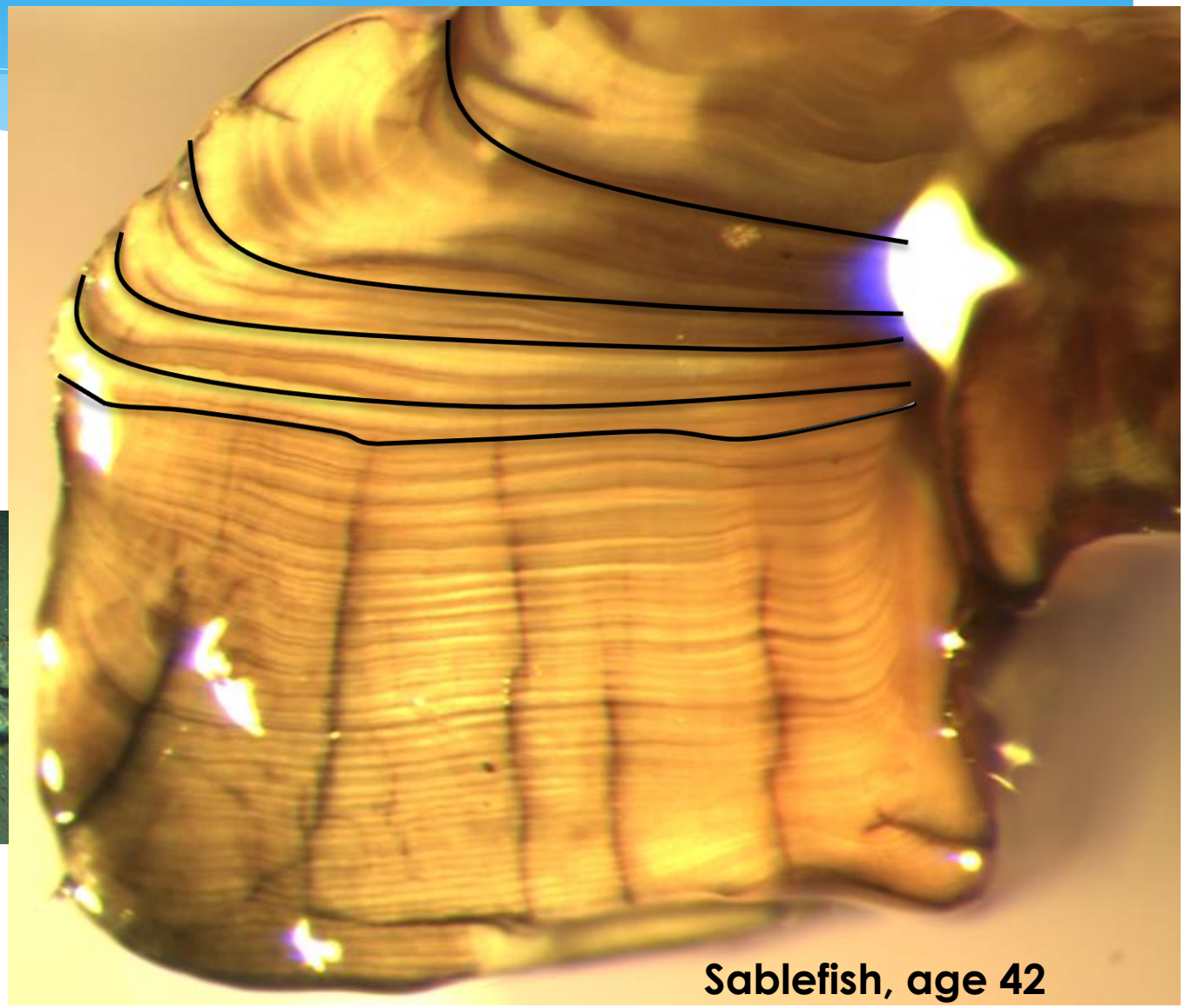


Life History applied to age reading

Transition at 5, which is the reported age of maturity

- Growth slows





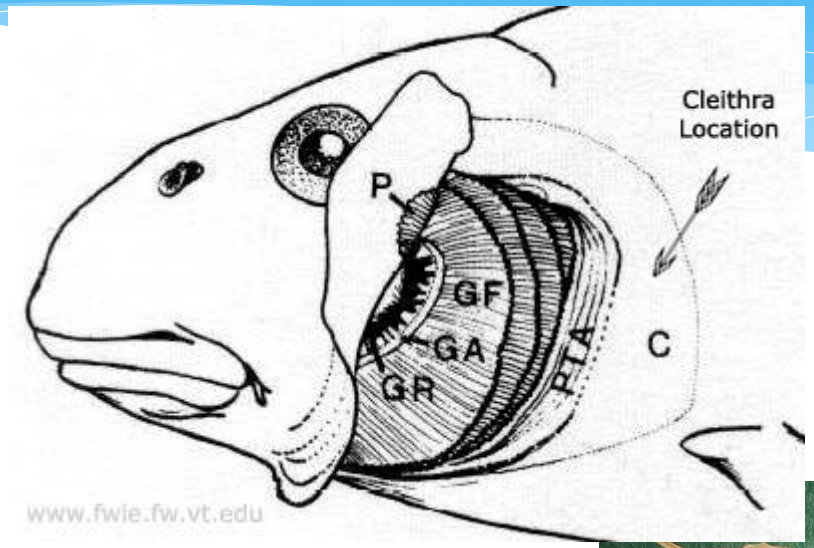
Sablefish, age 42

Self Check

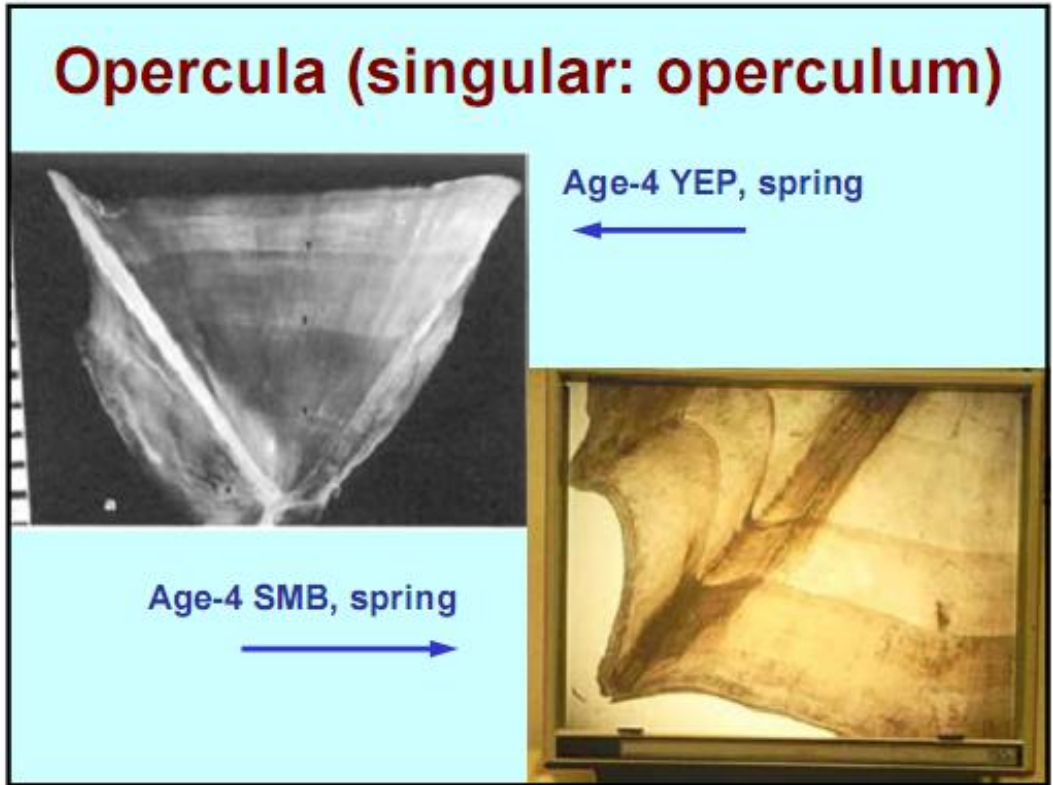
- Otoliths are typically only used for determining fish age
  - True
  - **False**

- What is the technique called that is used to prepare oroliths for age determination
  - Smash and grab
  - **Break and burn**
  - Slash and scope
  - Broke and poke

Cleithra - Esocidae (sacrifice)

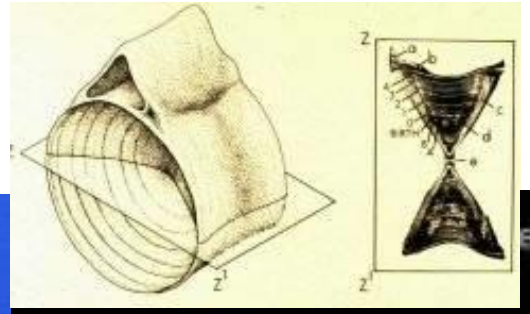


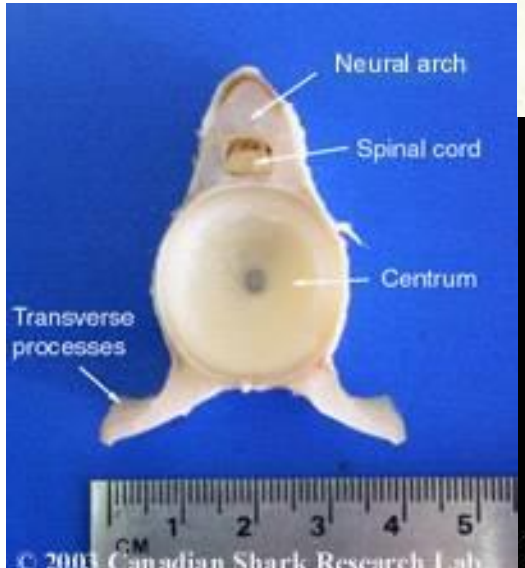
Opercula (sacrifice)

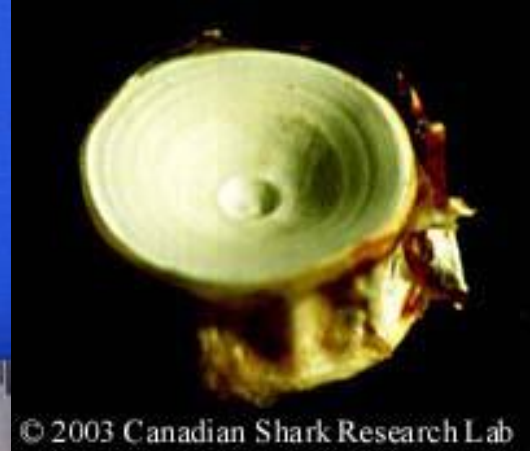


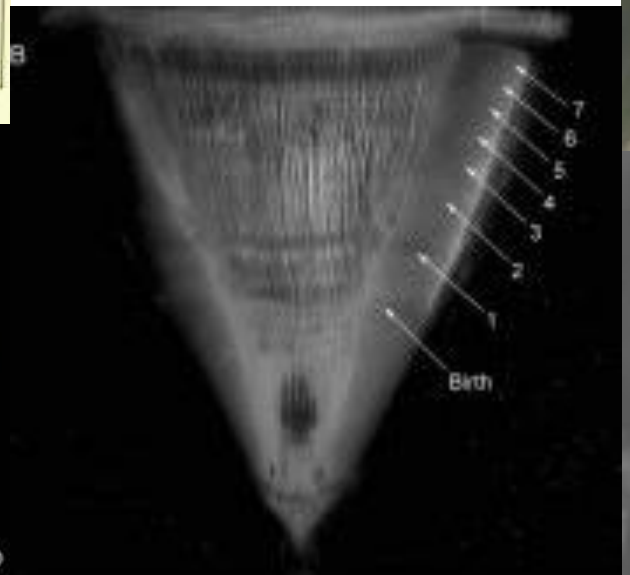
Other structures used for aging

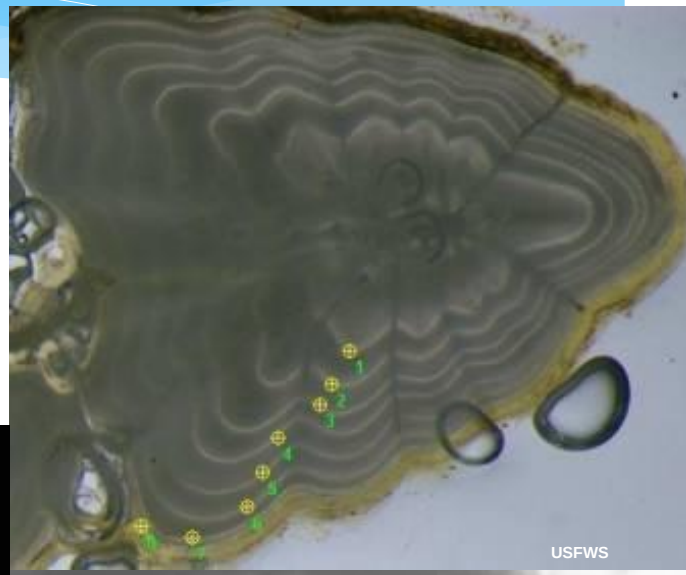
- Vertebrae – Sharks (no spines, teeny otoliths)
- Fin Rays – anything where scales don't work and you don't want to kill the fish
- Spines

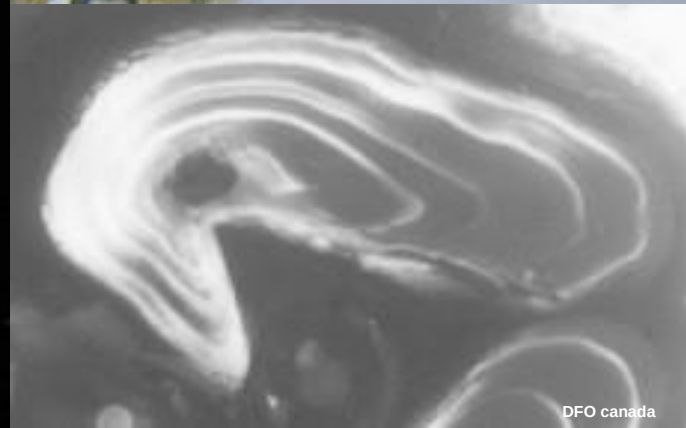










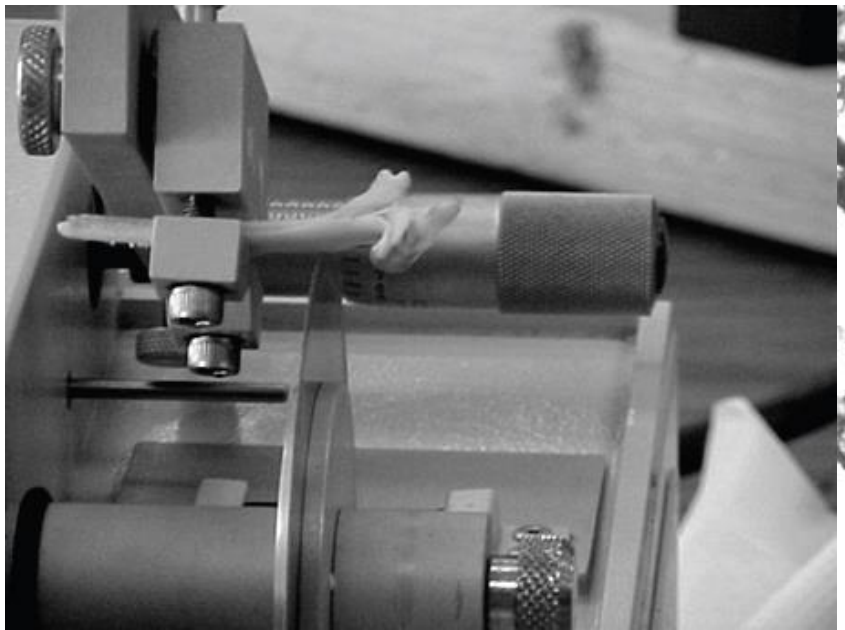


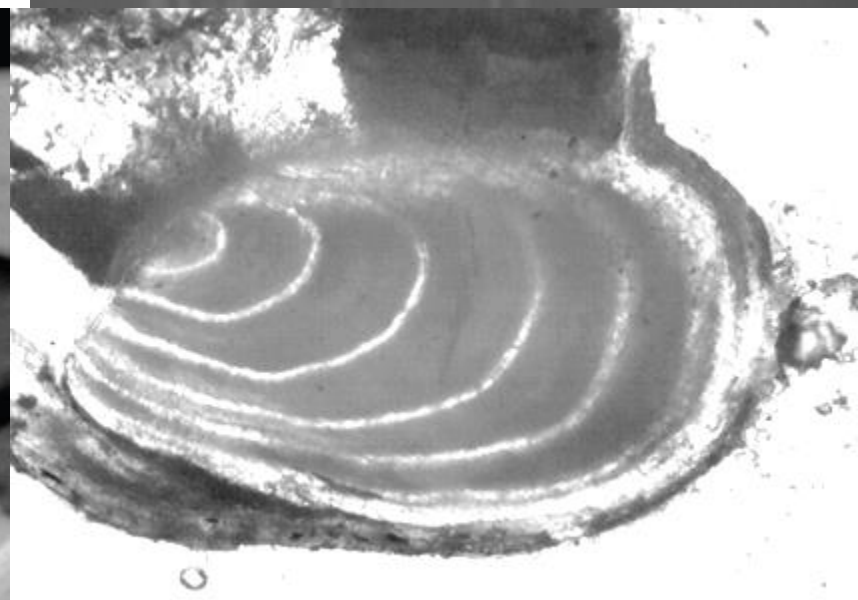
Fin Rays & Spines

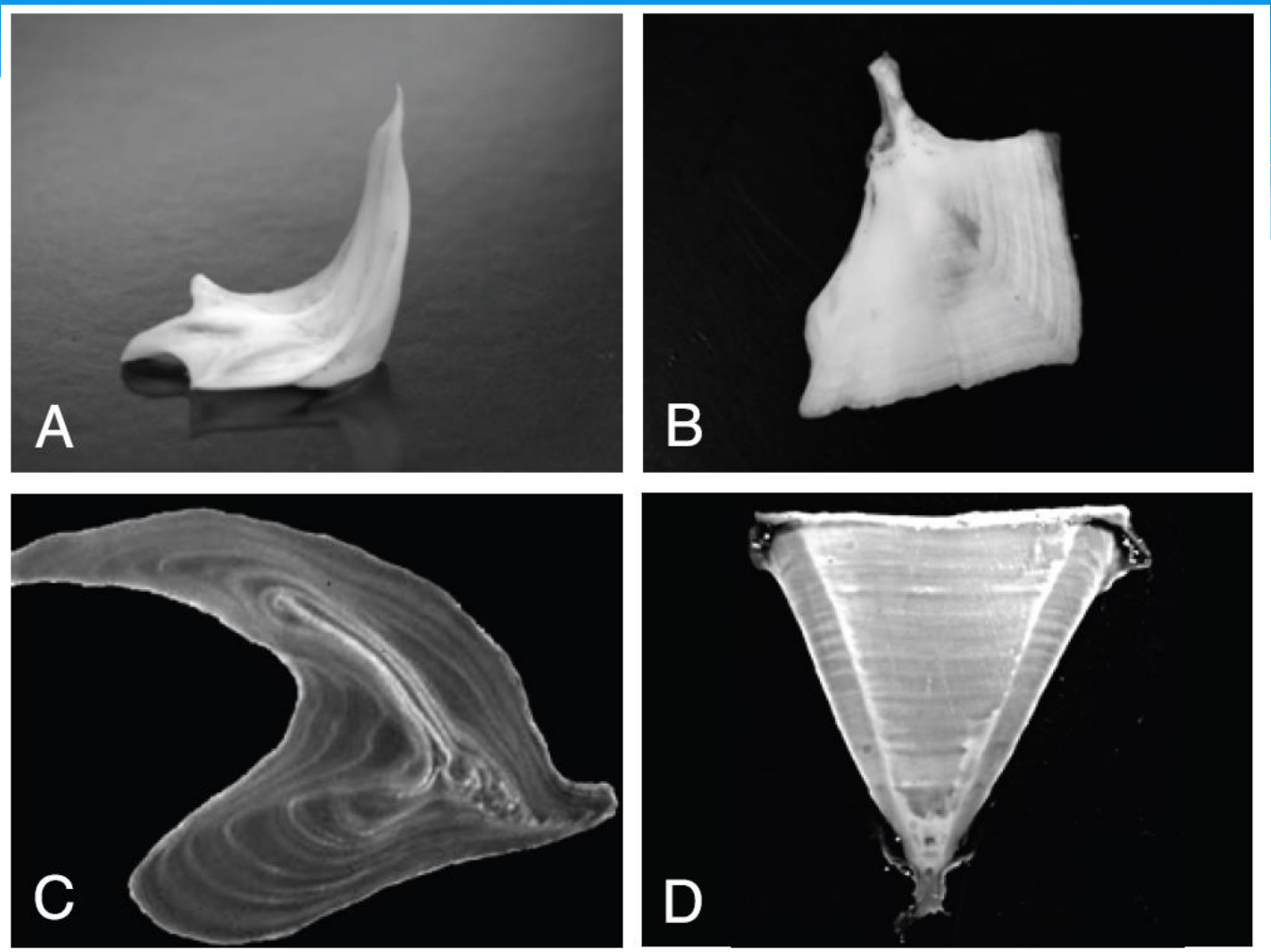
- Dorsal spine from a spiny dogfish

Fin Ray sectioning

- Fix in Epoxy
- Cut thin slice (section)
- Examine under magnifgication





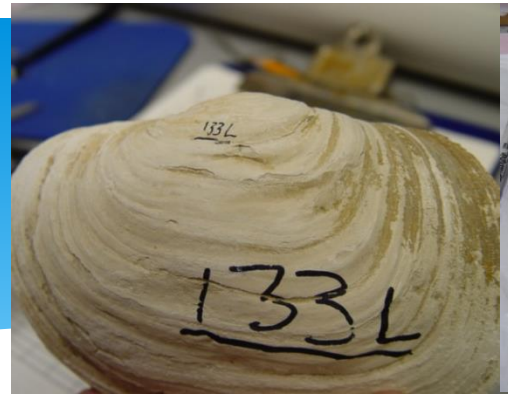


- A bluehead sucker - opercle bone
- B flannelmouth sucker - dentary bone
- C paddlefishand sectioned vertebra

Self Check

- Vertebrae are used to age sharks because they don't have scales and loose their teeth
  - **True**
  - False

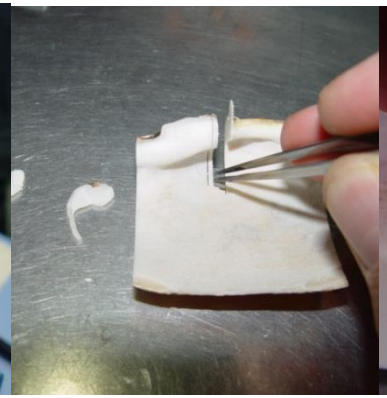
- Many of the other structures used to age fish are similar to scales and Otoliths, they are hard and deposit annual bands similar to a tree
  - **True**
  - False

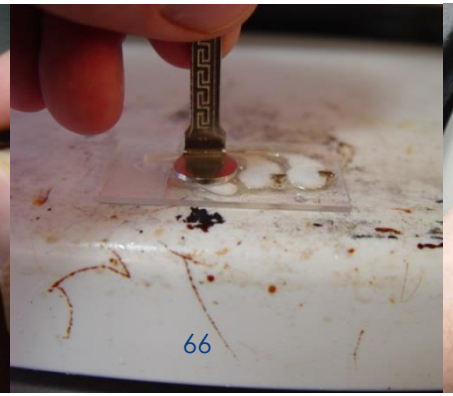


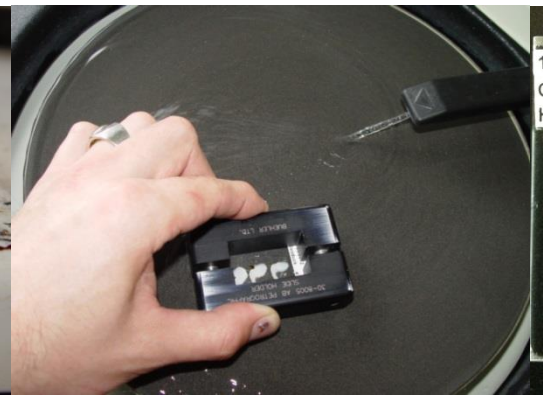
Whole valve, clean and dry → Weighed → Measured → Hinge piece removed

VALVE SPECIMEN PREP

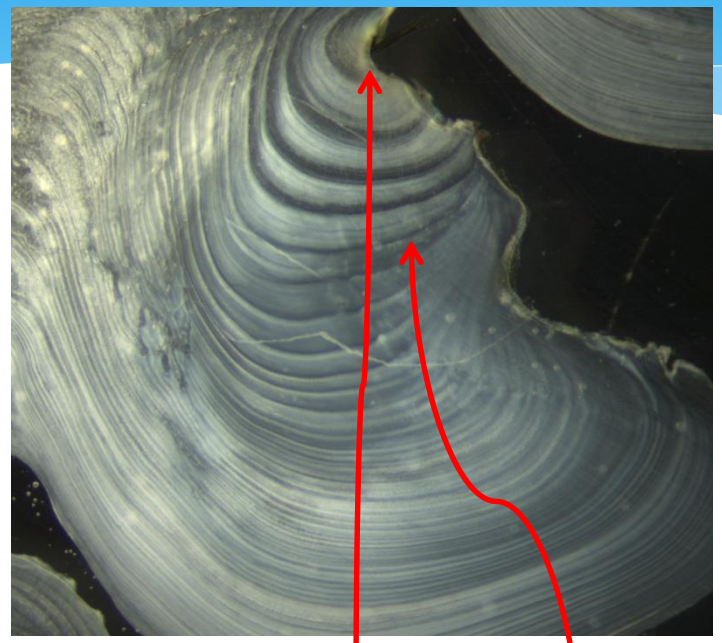
Thin sections of hinge plate cut at umbo → Serial thin sections removed → Thin sections mounted → Thin sections ground and polished → Specimen ready to read!







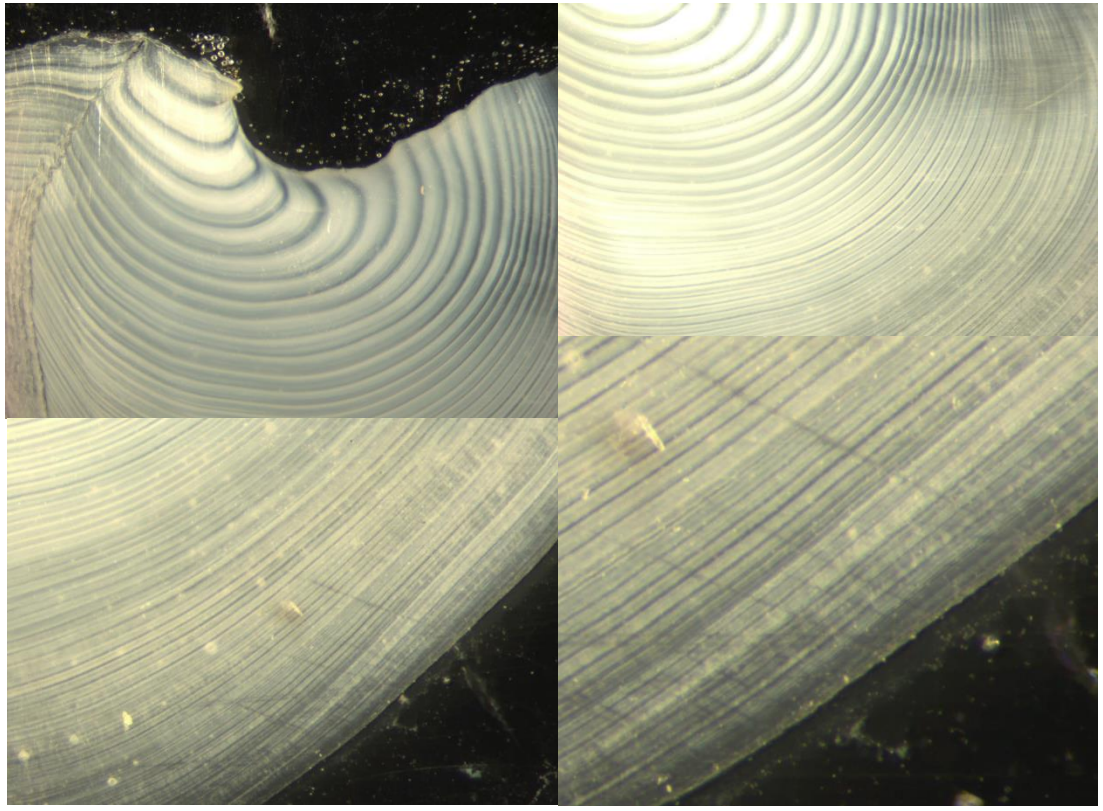
Life History applied to age reading



- Settle in 1st year
- Fast growth in first 5 years
- Mature at 5 years

Geoduck

17 years old; Born in 1995



74 years old; Born in 1938

Age measurement methods

- Scales
- Otoliths
- Vertebrae
- Rays/Spines
- Non Fish spp. ???
  - Clams
  - Urchins
  - Crabs
  - Shrimp
  - Octopuses
  - Sea Cucumbers

Recap

- Age & Growth in fish
- Length Frequency Analysis
- Recapture of marked Individuals
- Hard structures
  - Scales
  - Otoliths
  - Other hard Structures