Age Determination Unit

By
Kara Hilwig, Interim Lab Supervisor
Kevin McNeel
April Rebert
Rob Dinneford
Dion Oxman, MTALab Director
What is ADU?

- Alaska Dept. of Fish and Game
- Statewide groundfish and invertebrate age reading lab
- Operates under Headquarters in Juneau, AK
- A division of the Mark, Tag and Age Lab
  - Age Determination Unit
- Collaborate with other ADFG Age Readers
  - Based in Regions II and IV
Where is ADU?

Mark, Tag, Age Laboratory

10107 Bentwood Drive
Juneau, Alaska 99801

(907)465-3054
What does ADU do?

• Produce age data for fish and invertebrates
• Receives samples from commercial and sport fisheries, mariculture program, surveys and research projects
• Assist in port sampling and survey work
• Collaborate to standardize age reading criteria
• Age validation studies
• Age structure morphometrics

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Who is ADU?

Rob Dinneford
• Sample handling, receiving, and archiving
• Age Structure Measurement Specialist
• Data Entry Specialist
• Consumables Request Coordinator
• Inventory Specialist
• Age Reader in Training
Who is ADU?

April Rebert
• Production Age Reader
• Database Steward
• Invertebrate Specialist
• Ergonomics Specialist
Who is ADU?

Kevin McNeel
• Production Age Reader
• Database Steward
• Sablefish and Rockfish Specialist
• Imaging Specialist
• Biochronology Specialist
Who is ADU?

Kara Hilwig- (907)465-3054

(FB III Recruitment Pending)

• Interim Lab Supervisor
• Director of Operations
• Career Experience:
  • 18 yrs Fish Conservation and Invasive Species Management in Grand Canyon and Western US
  • 3 yrs Age Reading in AK
  • Production Age Reader
Who is ADU?

Biometrician II

(Biometrician II Recruitment Pending)
• Mark, Tag, and Age Lab Statistician
• Statistical liaison for age readers and end users
• Analysis support for age validations, biochronologies, etc

To Be Determined
Who is ADU?

Dr. Dion Oxman
- Mark, Tag, and Age Lab Director
- Research and Collaboration Coordinator
- Career Experience:
  - Salmon Ecology
  - Sclerochronology
  - Elemental Analysis
  - Quantitative Genetics
  - Stress Physiology

Please send correspondence to:
Dion.oxman@alaska.gov
(907)465-3499
ADFG Age Data Production Process

- Regions and Researchers give us a heads up on anticipated specimen numbers and species
  ~6 mo-1yr lead time please
- Samples collected, ADU staff assistance
- Regional samplers invoice to us online thru OASIS
- Data goes into Oracle Database
- Samples shipped, logged in, labeled
- Structures measured and aged
  – through custom designed application screens
- Data Distributed to User (due dates discussed)
- Samples Archived at ADU
The ADU Archive and Oracle Database

Riches within!

• 214,503 Specimens
• 39 species (fish, inverts)
• From 7,303 Samples taken across Alaska
• Earliest capture year: 1981
• Age Range = 0 – 205 years old
• Birth years = 1795 - 2012
• Age data released = 158,611 records
• Age Structure Measurements = 128,698

Mostly data for specimens aged at ADU, few data for specimens aged by Regional readers.
The ADU Archive

Bursts at the seams!
Whole otolith, clean and dry → Measured → Weighed → Broken
Burned → Oiled → Specimen ready to read!
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!
Committee of Age Reading Experts (CARE)

- International, state and federal agencies
  - PSMFC, NOAA-NMFS AFSC, CDFO, ODFW, ADFG, WDFW, CDFG, and IPHC
- Affiliated with the TSC (Technical Subcommittee of the Canada-U.S. Groundfish Committee)
- Standardize and improve age determination techniques and activities for Pacific Ocean fish species
  - Biennial meetings
  - Online forum
  - Age structure exchanges
ADFG Age data

• Other age readers: Regions II and IV

• Age Structure Exchanges
  – Compare are reading criteria

• Rap and Burn – Desire to make annual event!
  – Gathering at ADU -- Standardize criteria
  – Literature update -- Novel Species
  – Food and after hour fun!

Rougheye rockfish  Pacific cod  Yelloweye rockfish
Shortraker rockfish  Pollock  Quillback rockfish
Sablefish  Lingcod

18
Age Reader Training

• Mentorship from experienced reader
• Age reading criteria (CARE, training scope, image library, manuals)
• Training files to track APE and CV (Avg. % Error)

APE is a measure of the difference between two readers’ age estimates

• Species specific threshold values for APE

• Once achieved, new reader 2nd reads an experienced reader, then eventually becomes primary reader
Yelloweye rockfish
Age Reader Learning Curve
Comparison

DATA FROM TRAINING FILES
ADU’s Otolith Accretion Model applied to age reading

• Otolith growth fundamentally follows a VonBertalanffy growth equation
  – Fast early growth, transitional growth, maintenance

• Observed in otolith as growth increment spacing or annual accretion

Warning: Exceptionally easy specimen chosen to demonstrate
Life History applied to age reading

• Life history events expressed in common otolith growth patterns?

Seemingly abrupt reduction in volume of material added to the otolith (annual otolith accretion) noted as a skinny increment from age 4 to 5 (see previous slide too)

Could this be the onset of maturity in this individual?

Warning: Exceptionally easy specimen chosen to demonstrate
Life History applied to age reading

- Life history events expressed in common otolith growth patterns?

Yelloweye rockfish, age 82

Notice the reduction in increment widths from age 20 on.

Could this also represent the onset of maturity

Warning: Exceptionally easy specimen chosen to demonstrate
Transition at 5, which is the reported age of maturity.

Warning: Exceptionally easy specimen chosen to demonstrate Sablefish, age 42
Life History applied to age reading

A common feature on sablefish within the first year of growth. Visible feature, but lacks annual character. It is not as prominent as the first annulus. Could this be a feature that occurs with settlement?

“The Butterfly”
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 Structures

Have *so much more* to tell us

...than...

just an age estimate
Age Validation using Bomb Carbon

Atmospheric testing of nuclear weapons created a signal

Change in Atmospheric Bomb Carbon

Δ¹⁴C (‰)

Year

Northern Hemisphere – NH1 data
Age Validation using Bomb Carbon

- Signal appears in most anything containing carbon
- Bore out the center of the otolith to get $\Delta^{14}$C level for the first year of life.
- Gets at birth year validation

### Change in Atmospheric Bomb Carbon – Scaled and Smoothed

<table>
<thead>
<tr>
<th>Birth Year Estimate</th>
<th>$\Delta^{14}$C</th>
</tr>
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<tbody>
<tr>
<td>1956</td>
<td>-99.8</td>
</tr>
<tr>
<td>1960</td>
<td>-72.4</td>
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<tr>
<td>1962</td>
<td>-50.7</td>
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<tr>
<td>1964</td>
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<td>1972</td>
<td>43.1</td>
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<td>1975</td>
<td>40.8</td>
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<td>1976</td>
<td>39.9</td>
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<tr>
<td>1980</td>
<td>26.8</td>
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<tr>
<td>1982</td>
<td>-2.1</td>
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</table>
Bomb Carbon – LOESS curves

- Atmospheric scaled
- PWS Thornyhead
- Halibut
- SE AK Yelloweye
- POP
- Canary

Δ¹⁴C (‰)

Year


Post-Bomb

Bomb rise

Pre-Bomb
Biochronology – adapted from Dendro

- Age specimens
- Measure growth increments
- Identify ‘marker years’
- Correlate year specific increment values to environmental measures — e.g. SST, Chloro, Upwelling
- Overlap marker years from multiple specimens
- Extend chronology back in time with old specimens
- Historical environmental conditions

**Historic recruitment dynamics**

Good growth year, large whitish increment

Poor growth period, dark band, 6 consecutive skinny increments, 7 years after good growth year

1942

1962

Annotated for demonstration, not actual year
Geoduck chronology and the Pacific Decadal Oscillation

From CDFO Sclerochronology Group 2006
Alaska Dept. of Fish and Game’s Age Determination Unit has one of the largest collection of Age Structure Measurements within the age reading industry WORLD-WIDE

N = 128,698
Age Structure Measurements

GREAT POTENTIAL for discovering INSIGHTS into:

• life history, physiology?
• individual and population growth?
• unknowns and uncertainties?
• better modeling?
• better management?

See what you think!

Exploratory ASM data summaries presented to demonstrate concepts, error bars excluded for clarity of concepts.
Structure Measurement

- Otolith
  - Weight
  - Length
  - Height

- Valve
  - Weight
  - Length
  - Width
  - Hinge Thickness
Age Structure Measurements

Symmetry of Otoliths

n=43,081
Otolith Pairs

\[ y = 0.9471x + 0.4593 \]

Sablefish

\[ y = 0.9108x + 0.2695 \]
Age Structure Measurements

Symmetry of Otoliths

\[ y = 0.9828x + 0.0004 \]

n=43,082
Otolith Pairs

Sablefish

Munk 2012
Age Structure Measurements

Relationships between Otolith and Somatic measures

- Part of the variability of data is fast vs slow growth individuals
- Age readers can categorize fast and slow growth types
- Recommend developing measure of otolith density

Sablefish

n = 35,020

Age 27
Age 44
Age 79

0 0.025 0.05 0.075 0.1 0.125 0.15
Otolith Weight (g)

0 200 400 600 800 1000 1200
Somatic Length (mm)
Age Structure Measurements

Generalized Otolith and Somatic relationships with Age

Could otolith weight at age be an important variable for Age Structured Modeling?

n = 35,020  Differences in rate at which max growth potential reached?

n < 20 for age categories > 36
Age Structure Measurements

Perceivable (qualitative) patterns quantified

- 1st and 2nd year growth increments about equal
- Follows expected pattern

Index of annual growth

Sablefish

- Otolith Weight/Age
- Somatic Length/Age

n = 35,020

n < 20 for age categories > 36
Age Structure Measurements

Perceivable (qualitative) patterns quantified

Measurement resolution of otolith weight or density is likely much higher than fish length

- Otolith Weight/Age
- Somatic Length/Age

Think about this and age structured modeling again

n = 35,020

n < 20 for age categories > 36
Age Structure Measurements
Population Characters expressed in otoliths

All Lingcod

Live Fast, Die Young
Slow and Steady, wins the race
Age Structure Measurements
Population Characters expressed in otoliths

Region I Lingcod

Females tend to grow faster and live longer than Males
OR
Gear selectivity toward females
Age Structure Measurements
Population Characters expressed in otoliths

Region II Lingcod

RII Females tend to grow faster than RII Males but older males are captured in R II as compared to R I.

Or
Gear selectivity

Otolith Weight (g)

Age

RII Female
RII Male
Age Structure Measurements

Shortraker rockfish in the news!

All Shortraker rockfish

Somatic length (mm)

Estimated Age

Sitka’s International Media Celebrity Fish

Another not so famous Ketchikan fish

Commercial/Survey

Rod and Reel

Pelagic Trawl
Age Structure Measurements

Shortraker rockfish in the news!

All Shortraker rockfish

Otolith Weight (g)

Sitka’s International Media Celebrity Fish
Age 64

Age 120

Another not so famous Ketchikan fish

Estimated Age

Longline
Pelagic Trawl
Rod and Reel
Food for thought: Could otolith weight be a valuable surrogate for age data (binned in, say 10-20 yr age categories)?
Closing remarks

• Familiarize folks of services we provide
• Advertise ADU’s database and its wealth of info
• Generate critical thought among ADFG scientists:
  – Age structure measurements
  – Age data/modeling
  – Other uses of age structures
• Encourage collaboration and research
• Looking forward to future opportunities
  – Fish (marine and freshwater)
  – Inverts (mollusks, urchins, crab)
Discussion

Please send Data Requests to:

Dr. Dion Oxman
Dion.oxman@alaska.gov
(907)465-3499