Committee of Age Reading Experts

2022 Committee Report

Prepared for the Sixty-second Annual Meeting of the

Technical Subcommittee of the Canada-USA Groundfish Committee

April 19 – 20, 2022

Prepared by
Delsa Anderl
2019-2022 CARE Chair

National Oceanic Atmospheric Administration
National Marine Fisheries Service
Resource Ecology and Fisheries Management
Alaska Fisheries Science Center
Age and Growth Program
7600 Sand Point Way NE
Seattle, Washington
98115

A. CARE Overview

1. History

The Committee of Age-Reading Experts (CARE) is a subcommittee of the Canada-USA Groundfish Committee's Technical Subcommittee (TSC) charged with the task to develop and apply standardized age determination criteria and techniques and operate within the Terms of Reference, approved by the TSC in 1986, and the CARE Charter, developed in 2000 and approved by the CARE in 2004.

2. Report Period

This report covers the work period of April 7, 2021 – April 8, 2022. This interim reporting period was prepared by current CARE Chair Delsa Anderl. Current officers through June 30, 2022 (elected at April CARE 2019 Meeting) are:

- Chair – Delsa Anderl (AFSC-Seattle)
- Vice-Chair – Andrew Claiborne (WDFW-Olympia)
- Secretary – Nikki Atkins (NWFSC-Newport)

3. CARE Conference

CARE meets biennially for a conference that usually lasts three days. However, due to COVID-19 pandemic restrictions, the CARE biennial meeting that was supposed to take place in April 2021 was postponed to November 2022 or until all members are allowed to travel and meet inside government buildings. Conferences typically consist of one and a half "business" days and one and a half days for a hands-on calibration workshop at microscopes to review and standardize age reading criteria with any extra time scheduled for a specific focus group or workshop.

i. CARE Check-in

A virtual CARE member check-in similar to the spring 2021 virtual meeting was not held in spring 2022, in anticipation of the full meeting scheduled for November 2022.

The list of recommendations outlined by the TSC to CARE, CARE to CARE, and CARE to TSC were not addressed at the 2021 check-in but will be addressed at the November 2022 meeting.

ii. Agency Reports:

A. Alaska Department of Fish & Game (ADF&G)

There are four main groundfish age programs within the Alaska Department of Fish and Game that operate autonomously: the Kodiak ADF&G Age Lab, the Homer Commercial and Homer Sport Age Labs, and the Age Determination Unit (ADU, based in Juneau).

***ADF&G - Kodiak*– (Sonya El Mejiati)**

The Kodiak ADF&G otolith age laboratory and port sampling programs are both overseen by the same project leader. The Kodiak port sampling program is responsible for collecting biological samples and catch information from state managed commercial fisheries of shellfish and groundfish species harvested in the Kodiak, Chignik, and South Alaska Peninsula management areas. Shellfish species include Tanner crab, Dungeness crab, red sea cucumbers, and occasionally BSAI king and snow crab (for the Dutch Harbor ADF&G office). The main groundfish species include black rockfish, dark rockfish, and Pacific cod. Prince William Sound (PWS)

walleye pollock and Pacific cod landed in Kodiak are also sampled on occasion to assist the Homer ADF&G office. All otolith samples collected by the Kodiak sampling crew are aged in the Kodiak age lab, except for the PWS samples that are sent to the Homer office. Each year a total of about 2,000 Pacific cod from all management areas, 1,000 black rockfish and 500 dark rockfish mainly from the Kodiak Area, some lingcod (opportunistic sampling), and a few miscellaneous rockfish species are collected and aged in Kodiak.

Age readers are employed for 3-4 months between January and April. In 2022 there were two age readers: Sonya El Mejjati (project leader) and Jessica Horn. Mike Knutson moved on to pursue an education in data programming but also remains in his seasonal position with the ADF&G Tanner crab trawl survey program in Kodiak. Since the start of the COVID-19 pandemic, the Kodiak ADF&G building remained open with the option to telework. In 2020, more than half of the building employees chose to telework. Most staff are now back in their offices and labs, and in the absence of direction from the State, our mask policy follows the CDC guidelines, leaving mask use optional. In the age lab, we like to be mindful of coworkers' preferences, we try to follow risk level in the community, and we choose to wear masks when fighting or getting over a cold.

Precision testing is done on 40% of all samples and on 100% of samples that are aged by new readers. All differences between readers are resolved. The lab uses the standard break-and-burn method for rockfish. For Pacific cod, one otolith is broken, and the other is cut with an Isomet saw; halves of each otolith are baked rather than burned for 12 min at 400ºF using a standard toaster oven to prevent otoliths from bursting or cracking. The baking process is time consuming but makes growth patterns easier to interpret. Starting in 2017, morphometric measurements have been collected for all species (otolith length, width, and weight, excluding crystalized or broken otoliths). This information is plotted against age and has helped find some data outliers, species identification errors, and typographical errors that occurred during sampling. In the last few years, Joan Brodie, Sonya El Mejjati, and Carrie Worton (research division) have spent countless hours looking at potential data outliers for black and dark rockfish sampled over the years to determine species identification mistakes. Some otolith samples from the ADU lab and Homer sportfish lab that stood out as outliers were also sent to the Kodiak age lab for species identification checks and re-ageing and are part of our 2022 CARE exchanges.

ADF&G – Sportfish – (Martin Schuster)

Martin Schuster supervises the Homer Sport Age Lab that includes two other groundfish age readers: Marian Ford (primary production reader), and Tim Blackmon (aging technician). The port sampling program collects biological samples including age structures (otoliths and fin rays) from groundfish species harvested by the sport fishery in Cook Inlet and Prince William Sound management areas. Samples are collected by field technicians in the ports of Homer, Anchor Point, Ninilchik, Seward, Kodiak, Whittier, and Valdez. The lab also receives black rockfish otoliths to age from the Sitka port sampling program.

In 2021, the Homer lab prioritized the aging of black and yelloweye rockfish in response to an ADF&G Statewide Rockfish Initiative, but also aged dark, dusky, quillback, and other rockfish species as time allowed. A total of 2,636 otoliths were aged for this season. The project also started weighing all of the black rockfish otoliths that have been collected to detect species misidentification. Lingcod fin rays are cross-

sectioned and mounted on slides for aging. A total of 531 fin ray slides were aged for the 2021 season. The Homer lab participated in a lingcod otolith/fin ray exchange with the ADU lab with the hope of transitioning to using otoliths for lingcod ages.

During the past year, Marian continued to do most of the age reading from home, while Martin and Tim worked in the office and lab while wearing masks and social distancing.

***ADF&G- Age Determination Unit (ADU, Juneau)* – (Kevin McNeel)**

Kevin McNeel supervises the ADU with three other groundfish age readers: Chris Hinds, Cathy Mattson, and Juliet Harrison. The ADU also accessed technicians and biologists from other Mark Tag and Age Lab programs to process samples and estimate age. During the past year, personnel continued teleworking and estimated ages and processed structures remotely and at home, and age resolutions and training were done remotely through screensharing apps (Microsoft Teams) and microscope cameras. During the last year, the lab focused on four groundfish species: sablefish, lingcod, Pacific cod, yelloweye rockfish, black rockfish, and weathervane scallops but continued to process slope rockfish as time allowed. The ADU also participated in a lingcod otolith/fin ray exchange with ADFG-Homer-Sport, a rougheye rockfish exchange with AFSC, and a couple of black rockfish exchanges with ADF&G-Kodiak and ADFG-Homer-Sport.

For age-related research, the ADU is continuing work on rockfish chronologies for Prince William Sound, is wrapping up a North Pacific Research Board funded project reconstructing reproductive histories of individual fish through bone hormone profiles, is collaborating with other labs to compare age criteria for lingcod fin rays and otoliths, and is collaborating with other ADF&G labs to develop procedures to identify black rockfish misidentification using otolith measurements. The ADU is also collaborating with the Alaska Fisheries Science Center to investigate gadid life history through a long-term rearing study in Little Port Walter, AK.

***ADF&G- Commercial* – (Elisa Russ)**

In 2021, the Homer ADF&G commercial groundfish age lab had three age readers: Elisa Russ (project leader), Andrew Pollak (primary production reader), and Aaron Slater (black rockfish; hired in September 2021). The port sampling program collects biological samples including age structures (primarily otoliths) from state-managed groundfish and shellfish species harvested in Cook Inlet and Prince William Sound management areas (Central Region). Sampling goals are 550 otoliths collected from primary groundfish species – Pacific cod, sablefish, lingcod, walleye pollock, and rockfish. Groundfish sampling occurs in the ports of Homer, Seward, Whittier, Cordova, Kenai, and Kodiak.

Groundfish species aged in Homer include demersal shelf rockfish (primarily yelloweye and quillback rockfish), pelagic shelf rockfish (primarily black rockfish), and walleye pollock. In 2021, the Homer age lab continued to prioritize black and yelloweye rockfish age work in response to an ADF&G Statewide Rockfish Initiative (SRI) focusing on black and yelloweye rockfish assessment as the keystone species. A total of 2,060 ages were produced in 2021 with age data now current through 2021 for black rockfish and 2020 for yelloweye rockfish. Due to losing Kerri Foote in spring of

2020 to a new career in California and not hiring a new age reader until fall of 2021 (who also serves as a port sampler), production age reading was down from the previous year.

Precision testing is done on 20% of all samples and on 100% of samples that are aged by new readers. All differences beyond 1 year are resolved, unless there is bias, in which case all differences are resolved. Otoliths are stored dry, cut using an Isomet saw, and baked; burning is used to refresh otoliths during precision testing. Morphometric measurements have been collected for all species (otolith length, width, and weight, excluding crystalized or broken otoliths) since 2018. This information is analyzed to help identify outliers and errors in age, species identification, or data entry.

The continuation of the COVID-19 pandemic in Alaska continued to present challenges for the ADF&G project, as it did for everyone. Travel to other ports (primarily Seward and Whittier) resumed in 2021, with staff driving in separate vehicles when two samplers were needed to minimize close contact. All port sampling and age reading staff voluntarily submitted to regular testing and any exposure was handled using State of Alaska protocols similar to CDC guidelines for quarantining. Safety vests stating to keep a distance of 6 feet and masks were worn by port sampling staff. Much of the staff at the ADF&G Homer office continued teleworking, and for those who continued to work in the office, masks, frequent hand sanitizing, and social distancing were required in all public areas.

Primary age reading staff returned to the Homer lab with their microscopes in September 2021; Elisa Russ and Andrew Pollak began training Aaron Slater in person in October 2021 wearing masks and after getting negative COVID-19 test results – necessary because of working in close contact at the teaching scope. Time spent in the lab continued to be scheduled with only one person working there at a time, except during training when masks were worn. We realized that age reading efficiency actually improved when staff were working from home, likely because time was dedicated solely to age reading without office distractions and also because port sampling had been curtailed until safer conditions were present. Some staff returned to working in the office in the fall, including Andrew Pollak who worked closely with Aaron Slater reviewing results of precision testing as Aaron's aptitude increased. Aaron was able to begin production age reading of black rockfish in early December, which resulted in completion of ageing of all black rockfish sampled through 2021.

B. Sclerochronology Lab (SCL) – (Stephen Wischniowski)
Pacific Biological Station (PBS), Fisheries and Oceans Canada (CDFO), Nanaimo BC

The SCL was onsite over the last reporting period as it is considered an essential service. However, lab capacity under COVID-19 restrictions was reduced to 50% to allow compliance with CDFO Health and Safety measures in regard to social distancing. This has severely hampered the age estimation of groundfish species that require the "break-and-burn" methodology. There are only two lab spaces at PBS with suitable environments that CDFO Health and Safety has allowed us to operate with an open flame. Coupled to this were increased absences for sick leave for "flu-like" symptoms. Confusing guidelines, poor communications and a lack of COVID-19 antigen tests kits early in the pandemic resulted in many staff remaining in isolation for 14 days before being allowed to return to work.

SCL staff dynamics

- Nine staff
- Two senior staff to retire 2023 and 2024 – this will be the last of the senior staff with 25 or more years' experience

Species of focus during March 2021 to March 2022

- *Clupea pallasi* – Pacific Herring
- *Sebastes maliger* – Quillback Rockfish
- *S. flavidus* – Yellowtail Rockfish
- *S. pinniger* – Canary Rockfish
- *S. alutus* – Pacific Ocean Perch
- *Anoplopoma fimbria* - Sablefish
- *Merluccius productus*- Pacific Hake
- *Oncorhynchus tschawytscha* – Chinook Salmon
- *O. keta* – Chum Salmon
- *O. nerka* – Sockeye Salmon
- *O. kisutch* – Coho Salmon

The SCL Direct Data Entry application for groundfish moved from beta testing into full production mode. Direct Data Entry (DDE) has been a long-term priority for the SCL that dates back to the previous program manager Shayne MacLellan. Prior efforts towards implementation of DDE over the last ~20 years have been unsuccessful because of the lack of technology historically and due to recent funding limitations. The vision of DDE has changed since its original conception, where the main objectives were to

- increase work throughput and efficiencies
- eliminate paper usage
- eliminate/reduce transcriptional errors
- eliminate client key punching
- add real time statistical analysis for increased QA/QC
- provide immediate access to historical data

These attributes are foundational in the implementation of DDE and will continue to be important. However the hidden advantage of computerized workstations is the increased capacity to record data that historically was too cumbersome and time consuming to collect. Computerized age workstations will provide the ability to record otolith weight and imaging information, supplemental data that will facilitate real-time quality control measures within the daily routine of producing age estimates.

There is a direct and often linear relationship between otolith weight and age. The utility of otolith weight facilitates the real-time evaluation of outliers during the age determination process, providing the ability to re-examine outliers that do not fit the weight-age relationship before data is released to the client.

The utility of Otolith Shape Analysis (OSA) from otolith images has in recent years become a powerful tool for the identification of species based on morphometric measurements of the otolith. A recent SCL/GF pilot study has had great success in identifying the species within the *S. aleutianus/melanostictus* complex based on OSA, otolith weight, fish length, and age. More recently, its utility has been implemented in the identification of populations within species that reveal no genetic disparity.

Climate change is certain to increase the difficulty of estimating fish age. The SCL has observed in several species an increasingly "noisier" pattern; based on the timing of these occurrences, this change can potentially be attributed to the onset of a changing climate. To reduce ageing error and provide more certainty in the data produced will require the SCL to move away from a "single" determinant of age. Otolith weight and shape can be considered analogues to age and when used synergistically will deliver a more robust, higher quality set of data.

C. International Pacific Halibut Commission (IPHC) – (Joan Forsberg)

The number of IPHC age readers was reduced from four to three in 2021. Together, readers age an average of 25,000 to 30,000 otoliths per year. In 2021, a total of 26,282 otoliths were aged.

Pandemic issues:
The IPHC office gradually began opening to onsite work for fully-vaccinated staff in the summer of 2021; however, most of the age reading has continued offsite.

The IPHC expects to collect a similar number of otoliths in 2022. We also plan to provide a video showing Pacific halibut age reading techniques as requested by the TSC.

D. Washington Department of Fish and Wildlife (WDFW) – (Andrew Claiborne)

WDFW's Fish Ageing Lab

- Andrew Claiborne—Age Lab Team Lead and Age Reader (salmon and trout)
- Christina Jump—Age Reader (freshwater), salmon data entry
- Austin Anderson—Age Reader (salmon and trout), research projects
- Jenny Topping—Age Reader (groundfish lead)
- Vacant—Age Reader (groundfish), groundfish data entry

Staff Changes
WDFW currently has two age reader positions that focus on groundfish. In January of 2022, Sandy Rosenfield retired as our senior groundfish age reader. Sandy first joined the department as an age reader 50 years ago and was one of the first female scientists at WDFW. We are sad to lose such a vital part of our team and CARE but wish Sandy the best in retirement. WDFW promoted Jenny Topping into our senior groundfish age reader position in February 2022. Jenny Topping has over 20 years' experience ageing groundfish and working alongside Sandy. WDFW is currently hiring the groundfish age reader position vacated by Jenny Topping.

Species and Numbers Aged Since 2020 CARE to TSC Report

Species Name	n
Black Rockfish	4,425
Copper Rockfish	1,077
Lingcod	7,547
Northern Anchovy	2,023
Pacific Sardine	109
Quillback Rockfish	2,411
Vermilion Rockfish	808
Yelloweye Rockfish	214
Yellowtail Rockfish	3,416
Atlantic Spiny Dogfish	2,000
Total	*24,030*
Salmon, Trout, Freshwater	~75,000

Research Work and Special Projects

- Assisted NOAA NEFSC Atlantic spiny dogfish assessment by providing age determinations and training to NEFSC staff on spine processing. We processed ~2,000 spines for the project and calibrated age readers using known-age samples.

- Completed scale analysis age validation study and report for chum and sockeye salmon per research work funded by the Pacific Salmon Commission. Manuscript is in preparation.

- Collected ~370 paired lingcod otoliths and fin rays in 2019 for a structure comparison that is being initiated through CARE. We have aged all fin rays during the last assessment cycle and have started ageing the otoliths using a combination of break-and-burn and surface reads.

E. Alaska Fisheries Science Center (AFSC) – (Delsa Anderl & Thomas Helser)

AFSC includes 19 staff members, of which 3 are affiliates. The program is divided into two sub-programs that includes the traditional age reading group of six age readers led by Delsa Anderl and a research group of seven FTEs led by program manager, Thomas Helser. Managing the flow and collection of large amounts of data generated by the entire program is a data manager, Jon Short.

Due to the COVID-19 pandemic, AFSC continues to be on mandatory telework since March 23, 2020. Access to campus is still restricted, so all age readers continue to work at home and have adapted well to the situation. Some age readers have even found themselves to be more productive in the home environment. The biggest challenge to

age readers is to continue to exercise quality control practices, which entail sample exchanges between two readers, discrepancy resolution, and discussion of ageing criteria application so as to achieve acceptable precision. The pandemic has necessitated doing much of the quality control process virtually.

In the last year, the age reading group lost a long-time age reader, Charles Hutchinson, to retirement and gained a new reader, Andrew Chin. Andrew and the experienced readers were trained to age species new to them by other readers who have extensive experience in those species. Progress on the program's otolith reference collections expanded to include more species, and in some cases, completed a collection. Plans to produce several instructional PowerPoint slides with embedded video on the ageing of select species are being developed.

Production ages for the AFSC 2021 assessment cycle totaled 25,755 ages. The total number of otoliths aged was below previous years due to lack of survey collections. Survey cruises did not happen in 2020 due to pandemic restrictions. The breakdown of species includes:

Common_Name	Number Aged
Alaska Plaice	2
Arrowtooth Flounder	1,986
Atka Mackerel	2,170
Blackspotted Rockfish	212
Dusky Rockfish	440
Harlequin Rockfish	227
Northern Rock Sole	528
Northern Rockfish	1,344
Pacific Cod	2,569
Pacific Ocean Perch	1,640
Rex Sole	1,760
Rougheye Rockfish	1,201
Sablefish	2,377
Walleye Pollock	8,639
Yellowfin Sole	660

As part of a NOAA-funded 5-year strategic initiative (SI), scientists at the AFSC are investigating the use of Fourier transform near infrared spectroscopy (FT-NIRS). The strategic initiative entitled, "A revolutionary approach for improving age determination efficiency in fish using Fourier transform near infrared spectroscopy" led by Dr. Thomas Helser is a nationwide effort that involves seven biological labs focused on operationalizing this technology within the NOAA Fisheries ageing estimation enterprise. Fourier transform near infrared spectroscopy is a non-destructive, vibrational spectroscopy technique that has been used in agriculture, pharmaceuticals, and medicine for several decades, but with more recent novel applications to ageing fish. FT-NIRS functions by exciting covalent bonds in a sample with NIR electromagnetic energy (4,000 to 12,500 cm^{-1}), resulting in measurable vibrational frequencies that are unique

to the molecular bonds in the material being analyzed (O-H, C=O, C-H, C-N, and N-H), and serve as a "fingerprint" associated with the target property such as fish age. Fish age estimation uses a calibration set of otoliths with associated traditionally estimated ages to "train" a predictive model using multivariate partial least squares (PLS) regression or other structural equations by simultaneously reducing spectral signatures and maximizing the correlation with age. This process produces a linear correlation model to predict the age of a fish based on a rapid scan (usually < 60 seconds) of a whole otolith.

Since we last reported, we have expanded the application of FT-NIRS to estimate age of a number of fish species in multiple large marine ecosystems, and we have made advances using the same technology to rapidly estimate reproductive status and energy density (% lipid) from scans of ovary and body tissues, respectively. Moreover, several new areas of research at AFSC involve: *i*) coupling FT-NIRS technologies with machine learning, specifically deep neural networks, to substantially improve age predictions, *ii*) elucidating the molecular constituents within fish otoliths and other structures responsible for information content in spectra using proteomics, metabolomics, and lipidomics research, and *iii*) conducting "ground-truthing" studies by rearing known-age gadids at the Little Port Walter Field Station in Alaska. Together, these studies will underpin the science needed to advance the application of this technology toward greater acceptance from stakeholders (e.g., fishery management councils, fishers, public, etc.), the scientific community and toward operational readiness within NOAA Fisheries.

Achievements of the strategic initiative team related to groundfish include:

- Scanning over 26,000 walleye pollock and 16,000 Pacific cod otoliths with FT-NIRS instrumentation from 2014-2018 and integrating FT-NIRS age predictions into stock assessments to evaluate model outcome differences between FT-NIRS and traditional age estimates.
- Development of a simulation framework to: 1) assess impacts of ageing uncertainty in reference data on FT-NIRS age model predictions, and 2) develop standards and best practices regarding quality controls, reporting requirements, and predictive model updating procedures.
- Using known-age data from tagged sablefish to improve ageing model predictions for that species.
- Exploring the use of FT-NIRS spectral and biological data fusion using machine-learning models to improve age prediction.
- Rapid estimation of reproductive status from ovaries and energy density from muscle or liver.
- Using Raman spectroscopy as complementary to FT-NIRS data analysis.
- Ground-truthing spectral data with target life history properties such as fish age, reproductive status, and condition using lab-based and captive rearing studies.

F. Oregon Department of Fish & Wildlife (ODFW) – (Mark Terwilliger)

Aging Activities:

Production Aging: Early in 2021, emphasis was placed on finishing ageing of vermilion rockfish in preparation for a full assessment. Break-and-burn ages were produced for the remaining 573 fish captured by the sport fleet (captured from 2009-2020). Double reads were performed on a 20% subsample that included fish aged in 2020 (236 test reads on 1,196 total sport vermilion rockfish). Within-reader average percent agreement was 55.93% and average percent error (APE) was 2.12%. ODFW also participated in a CARE exchange with PSMFC, SWFSC, and WDFW, resulting in an additional 170 exchange ages.

Effects of COVID-19 on sport lingcod ageing continued into 2021. In 2020, ODFW developed a new technique for mounting fin rays that did not require the use of a fume hood, and 260 samples each from 2009, 2010, 2011, 2013, 2017, 2018, and 2019 were sent to Laurel Lam at the NWFSC for aging. Laurel was able to age all but those from 2009-2011. ODFW performed a re-read of 208 of Laurel's ages (split approximately 50% by sex) and obtained an average percent agreement of 54.81% and an APE of 4.91%. Fin rays from 2009-2011 were subsequently aged by ODFW (780 total with 156 double reads). Within-reader average percent agreement (and APE) were 61.54% (3.40%), 73.08% (2.73%), and 60.78% (3.39%) for 2009, 2010, and 2011, respectively.

The remainder of production aging in 2021 centered around black rockfish in preparation for the 2023 assessment:

Year Captured	Commercial ages	Commercial 2nd reads	Avg. % agreement (% APE)	Sport ages	Sport 2nd reads	Avg. % agreement (% APE)
2017	1011	202	61.00% (2.74%)	0	0	NA
2018	1048	207	63.77% (2.27%)	1203	241	69.29% (2.08%)
2019	0	0	NA	1159	232	70.26% (2.07%)

Lingcod aging structure comparison: In 2021, ODFW began collecting sagittal otoliths and fin rays from lingcod captured by commercial and sport fleets coastwide for a study to determine the potential of discontinuing using fin rays to age lingcod. Our goal was to obtain 360 fish (180 of each sex) from four coastal areas (north coast: Astoria/Garibaldi, south coast: Bandon/Port Orford/Gold Beach/Brookings, Charleston, and Depoe Bay/Newport). To date, we have collected 156 paired structures from the north coast, 66 from the south coast, 49 from Charleston, and 141 from Depoe Bay/Newport. Overall, the sex ratio was approximately 2:1 female to male, and we have collected few very small (<350 mm) or large (>1000 mm) fish. A meeting with other West Coast aging labs is planned for March 2022 to discuss plans moving forward.

Oregon Statewide Black Rockfish Survey: In anticipation for the 2023 assessment, ODFW conducted a survey of Oregon's nearshore environment with the purpose of providing an abundance estimate for black rockfish. The survey incorporated acoustics, CTD casts, video camera drops, and hook-and-line drift sampling. All fish caught by hook-and-line were measured, sexed, and subsequently aged. Of 825 fish caught, 116 black rockfish and 122 deacon rockfish were aged in 2021 (no double reads). Aging and further analyses will continue in 2022.

Age Validation: The 2015 stock assessment for California, Oregon, and Washington stocks of black rockfish identified the need for validation and verification of annuli as a recommended avenue for research in order to improve upon future assessments. In May 2020, we began a collaborative study with the Canadian Centre for Isotopic Analysis at the University of Alberta to validate annuli on otoliths of black rockfish (a semi-pelagic

rockfish), cabezon (a difficult-to-age sculpin), and copper rockfish (a demersal rockfish) using secondary ion mass spectroscopy (SIMS) to measure oxygen isotope ratios ($\delta^{18}O$) in otoliths over the lifespan of the fish. Because an otolith is acellular, metabolically inert, and grows throughout the life of the fish, any elements or compounds accreted onto its surface are permanently retained. Otoliths therefore contain a complete record of the temperature and chemical composition of the ambient water a fish experienced over its lifespan. A known inverse relationship exists between water temperature and $\delta^{18}O$, so our goal was to relate seasonal peaks in the $\delta^{18}O$ signal (corresponding to cold water temperatures) to annual growth marks on the otolith.

Lab work was completed in early 2021, and study results indicate that otolith $\delta^{18}O$ values obtained via SIMS is an effective tool for validating the periodicity of annual increments in these nearshore species. SIMS analyses showed strong seasonal temperature cycles across the probe transects for all three species, with peaks in the $\delta^{18}O$ signal occurring close to locations of identified growth marks on the otoliths and generally one strong signal peak and trough between marks (Figure 1). Production aging of otoliths from these species has shown that annulus formation typically occurs in mid- to late-spring each year and the fish examined in this study followed that trend. Timing of annulus formation corresponded to an increase in the seasonal upwelling index off Oregon and resulting colder water temperatures.

Although growth marks were associated with peaks in $\delta^{18}O$, the signal could be highly variable and irregular between the core and the first annulus; therefore, it was necessary to determine where the first annulus occurred along each transect before a peak and trough could be assigned to a calendar year and an age could be validated. The variability in $\delta^{18}O$ values prior to age-1 may be due to the life history strategies of these species, which includes an extended pelagic larval and juvenile stage as well as recruitment into shallow habitats with dynamic temperature regimes.

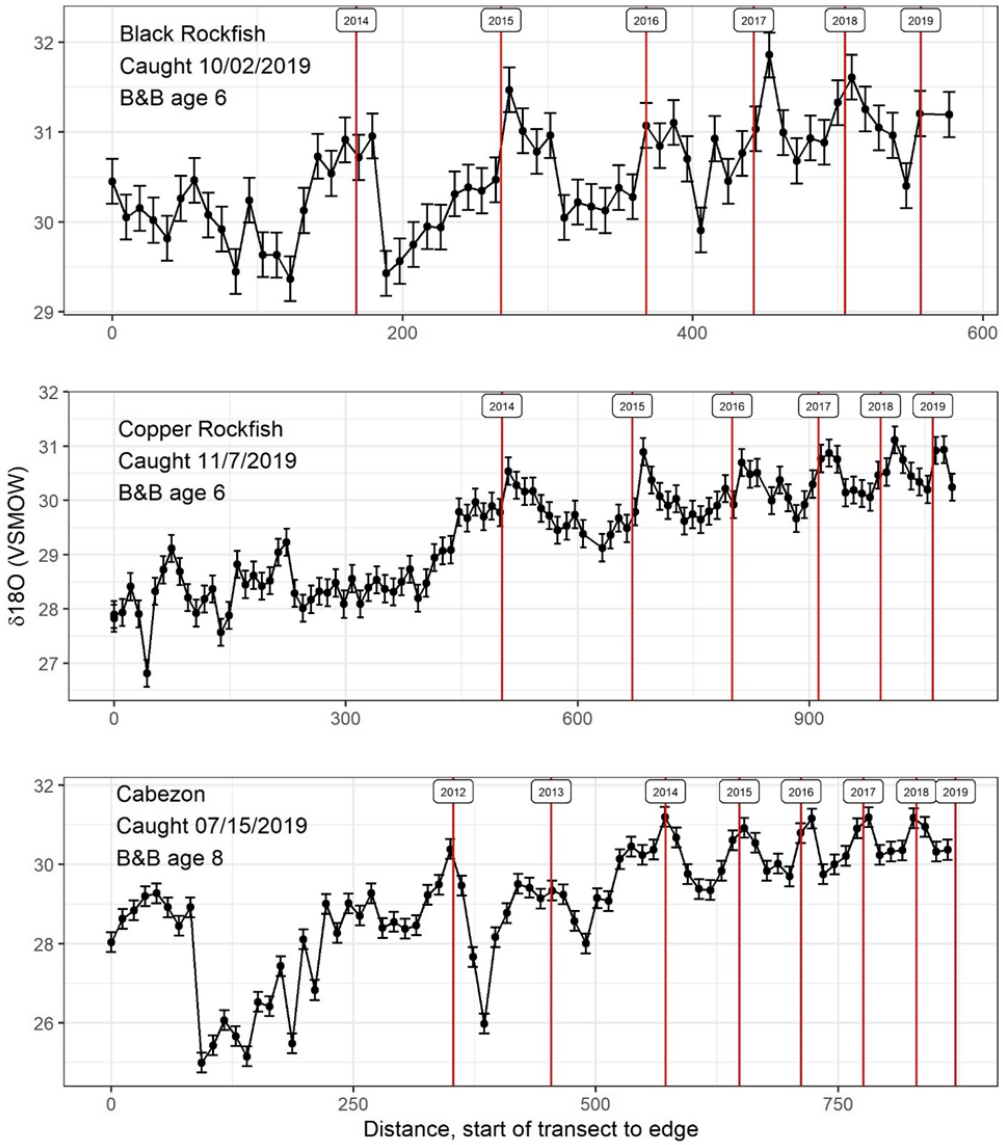

Figure 1. Measurements of $\delta^{18}O$ values (‰ VSMOW) from a representative black rockfish, copper rockfish, and cabezon. Error bars represent ±2σ. Red vertical lines represent locations of growth marks along the SIMS transect, with corresponding calendar year of formation above each line. Probe transect stopped prior to the edge for this cabezon sample, where a growth mark was present. Growth marks are found on the otolith edge in late spring of each year.

G. Northwest Fisheries Science Center Newport (NWFSC) – (Patrick McDonald)

Status

We continued to work from home during the calendar year 2021. We were given the ability to return to onsite work for lingcod fin ray preparation to support the 2021 assessment and for further collection of otolith weights. Patrick McDonald is the lead and ageing staff include Betty Kamikawa, Nikki Paige, Tyler Johnson, James Hale, and Denise Parker. The lab finalized support for the 2021 assessments.

We provided age data to support research evaluating the use of biological information from bottom trawl surveys and at-sea observer programs to augment coastwide Pacific hake acoustic surveys. The lab participated in a multi-agency collaborative project to evaluate the use of otoliths as a viable age structure for lingcod. A virtual meeting was held with participants providing a background of the structures they have or are going to collect. Further meetings are planned for 2022. The NWFSC has close to 300 paired lingcod otolith/fin ray structures collected during normal sampling protocols from the 2016 and 2017 bottom trawl surveys.

We continued to send samples to AFSC to collect near infrared spectra for our participation in the NOAA Strategic Initiative. AFSC has scanned US West Coast surveys of Pacific hake, canary rockfish, sablefish, and Dover sole. The fielding of a near infrared spectrometer to Newport is expected in the summer of 2022.

Assessments supported through age reading in 2021

2021

Copper Rockfish
Vermilion Rockfish
Quillback Rockfish
Dover Sole
Sablefish
Lingcod

2022

Pacific Hake

Numbers of aged otoliths for 2021

2021: Total numbers are 33,291 (production and double reads combined)

Exchanges Participated - 2021

Pacific hake – We were able to age 100 Pacific hake sent to us from CDFO. We attempted to send 100 of our Pacific hake to CDFO, but the sample was rejected due to a lack of an import permit. We had very good agreement (83%) between our lead hake age reader and the CDFO ages. The average age of the sample was 8.22 yr and bias was even (net bias positive 1%). This was an official CARE exchange.

Vermilion rockfish – We aged 366 vermilion rockfish from the SWFSC. This was a request by the SWFSC to assess ageing error. These samples were originally aged by the SWFSC. This was not logged as a CARE exchange, and results were reported to the SWFSC stock assessment author.

Personnel/Staffing

We hired an additional age reader in July 2021 to assist with Pacific hake ageing. We now have five full-time agers and one team lead.

H. Southwest Fisheries Science Center (SWFSC) – (Melissa Monk)

Melissa Monk remains the contact for otolith requests and manages the otolith library at the SWFSC Santa Cruz. The exchange of vermilion rockfish otoliths in preparation for

the 2021 vermilion rockfish stock assessment provided insight and needed information for the stocks assessments. Further analyses and a publication are forthcoming.

The SWFSC is working to develop ageing criteria for chilipepper rockfish (*Sebastes goodei*). David Stafford is currently re-reading a number of chilipepper rockfish otoliths from multiple years of the NMFS NWFSC trawl survey and working on this effort. Chilipepper rockfish will be the first species we explore for the FT-NIRS strategic initiative. Due to COVID-19 restrictions, we are still working to complete set up of the spectrometer in Santa Cruz.

B. Age Structure Exchanges

Age structure exchanges occur periodically to assess calibration among CARE age-reading agencies. Depending on results, specimens of interest (e.g., demonstrated biases) are then reviewed and discussed. Exchanges are tracked by the CARE Vice-Chair. Data from exchanges are available on the CARE website.

There were 10 age structure exchanges initiated in 2020, two in 2021, and one so far in 2022. Seven of the 2020 and one of the 2021 exchanges have been finalized and have been added to the CARE website's 'Structure Exchange table'.

Table 1. CARE age structure exchanges

Exchange ID #	Species	N	Capture Area	Originating Agency	Coordinator	Participating Agency (Cooperators)	Exchange Complete (y/n)
2020 Exchanges							
20-001	Dover sole	50	US west coast	NWFSC-PSMFC	Nikki Atkins	AFSC	Y
20-002	Dover sole	50	Alaska	AFSC	Delsa Anderl	NWFSC	N
20-003	Sablefish	41	Gulf of Alaska	AFSC	Delsa Anderl	ADFG-Juneau, NWFSC, DFO	Y
20-004	Rougheye rockfish	30	Alaska	ADF&G - Juneau	Cathy Mattson	AFSC	N
20-005	Rougheye rockfish	30	Alaska	AFSC	Chris Gburski	ADF&G - Juneau	N
20-006	Yelloweye rockfish	-	Alaska	ADF&G- Homer	Elisa Russ	ADF&G - Juneau	N
20-007	Vermillion rockfish	50	WA Coast	WDFW	Jenny Topping	NWFSC, ODFW, SWFSC	Y
20-008	Vermillion rockfish	60	CA North Pt. Conception	SWFSC	Melissa Monk	WDFW, NWFSC, ODFW	Y
20-009	Vermillion rockfish	60	CA S. Pt. Conception	NWFSC-PSMFC	Patrick McDonald	WDFW, SWFSC, ODFW	Y
20-010	Vermillion rockfish	42	Oregon	ODFW	Mark Terwilliger	NWFSC, WDFW, SWFSC	Y
2021 Exchanges							
21-001	Pacific hake	100	Canada	CDFO	Audrey Ty	NWFSC-PSMFC	Y
21-002	Black rockfish	30	Sitka	ADFG-Juneau	Kevin McNeel	ADFG-Homer	N
2022 Exchanges							
22-001	Black rockfish	90	Alaska	ADFG-Juneau	Kevin McNeel	ADFG-Homer	N

C. CARE Website Committee update

The Website Committee has added 2 new members and now includes: Jon Short (Webmaster, AFSC), Nikki Paige (Forum moderator, NWFSC), Jamie Hale (NWFSC), and Andrew Chin (AFSC). The CARE website is hosted through the PSMFC web server and has been undergoing transfer from Joomla to WordPress. This new WordPress site will be active around the third week of April.

D. Lingcod Working Group update

A Lingcod Working Group initially convened in June 2021 to explore standardization of a common ageing structure, methodology, and ageing criteria among five CARE agencies tasked to provide lingcod ages for stock assessments. Currently, some agencies determine ages using fin rays and others use otoliths. A plan is being developed to study whether ages derived from these two structures are compatible, to determine the efficacy of collecting one structure vs. the other, and to validate the criteria applied in the age determination process. Agencies involved include: ADFG, NWFSC, WDFW, CDFO, & ODFW.

A follow-up working group meeting happened on March 30, 2022. A Lingcod Working Group report will be drafted prior to the tentative November 2022 CARE meeting.

E. CARE Structure Exchange Invoice

Maintaining the CARE Structure Exchange data is tasked to the CARE vice-chair. The current vice-chair and previous vice-chair have proposed a similar but streamlined invoice-reporting data form. This new form will be introduced at the upcoming November 2022 CARE meeting for approval.