Committee of Age Reading Experts

2014 Committee Report

and

Executive Summary of the

Eighteenth Biennial Meeting April 14-17, 2015

Prepared for the Fifty-sixth Annual Meeting of the

Technical Subcommittee of the Canada-USA Groundfish Committee

April 28 –29, 2015

Prepared by
Elisa Russ
2013-2015 CARE Chair
Alaska Department of Fish and Game
Central Region Commercial Groundfish
Age Determination Project Manager
3298 Douglas Place
Homer, Alaska
99603

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 January 1 – December 31, 2014. However, to promote timely reporting of work and recommendations occurring during the recent CARE conference, an Executive Summary of the 18th CARE conference held April 14-17, 2015 is included here as part of the TSC report. Current officers through June 30, 2015 (elected at April 2013 meeting) are:

- Chair - Elisa Russ (ADF&G)
- Vice-Chair - Chris Gburski (AFSC)
- Secretary - Lance Sullivan (NWFSC)

The Secretary will prepare a draft of the minutes from the recent CARE meeting to be distributed to CARE members for review and subsequent approval prior to the end of his term. Due to the close proximity of the TSC meeting following the CARE meeting, it is necessary to for the Chair to prepare the report to TSC to include proceedings of the recent meeting as an executive summary (since minutes were not yet available).

3. CARE Conference – Executive Summary

CARE meets biennially for a conference that usually lasts three days. Conferences typically consist of one and a half "business" days and one and a half days for 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.

a. Overview: The most recent biennial CARE Conference was held in Seattle, WA, April 14-17, 2015 at the NOAA Western Regional Center at the Alaska Fisheries Science Center (AFSC) Sand Point facility, and hosted by the Age and Growth AFSC staff. As part of the 2015 CARE Conference, a crustacean age determination workshop led by Dr. Raouf Kilada was scheduled, which began on April 14 with the CARE business meeting commencing on April 15. The conference was attended by 49 CARE members (Table 1) from participating agencies ADF&G (12), AFSC (15), CDFO (6), IPHC (4), NMFS/AFSC – ABL (1), NWFSC/PSMFC (3), ODFW (1), University of New Brunswick, St. John (1), and WDFW (6). The next CARE Conference in 2017 will be held prior to the TSC meeting during the first week of April at the same location, NOAA AFSC, Sand Point facility, Seattle, WA. The following officers were elected at the April 2015 meeting and will take office July 1:

- Chair - Chris Gburski (AFSC)
- Vice-Chair - Lance Sullivan (NWFSC)
- Secretary – Kevin McNeel (ADF&G)

b. Business Session Highlights:

i. Scientific presentations:

An official Call for Presentations and Posters for the 2015 CARE Conference was sent to members on January 23 (Appendix III). Submissions were requested to address three topic sessions:

1. New techniques in age determination methods.
2. Age validation studies.
3. Age-based models for fisheries stock assessment and management.

Other presentations and posters related to the scope of CARE were also welcomed for consideration. Abstracts were due to the CARE Chair by March 13, 2015. There were eight oral presentation and seven poster abstracts submitted by the deadline. A book of Abstracts (Appendix IV) was compiled and available to members during the business meeting.

Eight oral presentations in PowerPoint format were given during the CARE meeting:

Topic Session 1: New techniques in age determination methods

1. Dr. Raouf Kilada (crustacean workshop presenter), *Finally, we can say how old this crab is.* (45 minutes)
2. Irina Benson, *Preliminary Results on the Use of Otolith Microchemistry for Developing Ageing Criteria for Eulachon (Thaleichthys pacificus).* (20 min)

Topic Session 2: Age Validation Studies

3. Thomas Helser, *Estimation of Ageing Bias Using Bomb Radiocarbon* $\Delta^{14}C$ *Signatures in Fish Otoliths: Beyond Plot and Cluck.* (30 min)
4. Craig Kastelle, *Use of the stable oxygen isotope,* ^{18}O*, in otoliths as an indicator of fish life history events and age validation.* (25 min)
5. Stephen Wischniowski, *Incorporation of bomb-produced* ^{14}C *into fish otoliths. An example of basin-specific rates from the North Pacific Ocean.* (15 min) – due to S. Wischniowski being absent due to a medical emergency, Thomas Helser gave the presentation.
6. Kevin McNeel, *Assessing yearly growth increment criteria used to assign ages for groundfish at the Alaska Department of Fish and Game Age Determination Unit using bomb radiocarbon.* (20 min)
7. Kristin Politano, *Using otolith measurements to refine quality control procedures.* (20min)

Topic Session 3: Age-based models for fisheries stock assessment and management

8. Dr. Kray Van Kirk, *The use of age data in contemporary fisheries stock assessment and management.* (20 min)

Eight posters were presented during a poster session with presenters held at 3:00 pm April 16. See Appendix IV for titles and abstracts.

ii. Agency Reports:

CDFO (Joanne Groot), IPHC (Joan Forsberg), AFSC (Thomas Helser), ADF&G-all sites (Elisa Russ, Kevin McNeel, Sonya El Mejjati/Joan Brodie), NWFSC/PSMFC (Patrick McDonald), WDFW (Andrew Claiborne), and ODFW (Lisa Kautzi) provided reports summarizing and updating agency activities, staffing, organization, new species and projects. Important to note was the retiring of Darlene Gillespie (CDFO); Stephen Wischniowski is the lead for the CDFO age determination program however he was unable to attend CARE due to a medical issue. There was no representative at CARE from SWFSC or CDFG. Details from agency reports will be available in the CARE minutes which will be finalized and published to the CARE website by year's end.

iii. Summary of 5th International Otolith Symposium (IOS)

The 5th IOS was held in Mallorca, Spain October 20-24, 2014. CARE members that attended and presented at the conference were Thomas Helser, Craig Kastelle and Cindy Tribuzio from AFSC. Craig Kastelle provided a summary of IOS. Over 300 scientists attended with over 300 presentations given. There were four themes that described environmental, population, community, and individual indicators. There were two workshops at IOS that focused on age validation and otolith shape analysis.

iv. Discussion of long-term storage of otoliths in glycerin-thymol:

This discussion was continued from the 2013 CARE meeting and also in response to the TSC recommendation in 2014 to develop a set of best practices for short and long term otolith preservation and storage. In 2013, Sandra Rosenfield (WDFW) reported some archived otoliths stored in glycerin-thymol solution had shown signs of deterioration and questioned the use of that medium. Delsa Anderl (AFSC) and Joan Forsberg (IPHC) volunteered to do a cursory review of samples from their archived otolith collections stored in that medium. There were some archived otoliths that had shown degradation, however, there was not consensus that the solution was the issue but instead might be attributed to cleanliness of samples, incorrect solution mixing, or possibly the age of fish sampled (e.g. young sablefish otoliths appeared to be affected after long-term storage). Although there was some affected otoliths, agencies utilizing glycerin-thymol solution for otolith storage, as well as those using ethanol or storing otoliths dry, plan to continue with current practices and therefore there was no consensus between agencies about the best method to employ.

v. Crustacean Age Determination Workshop

Interest from the CARE membership resulted in a special workshop being organized for the 2015 CARE Conference that focused on a new age determination technique developed by Dr. Raouf Kilada from the University of New Brunswick, Saint John. Dr. Joel Webb (ADF&G) assisted Elisa Russ (CARE Chair) in the organization and planning of the workshop, and also assisted Dr. Kilada in conducting the workshop. CARE members have already been involved with shellfish age determination for bivalves (e.g. geoduck clams, weathervane scallops) and TSC was consulted for approval prior to planning the crustacean workshop. The workshop focused on Dungeness crab, snow crab, and spot shrimp (prawn), and participants provided specimens. AFSC had excellent facilities and equipment to host the workshop and aspects included dissection of the age structures - eyestalks and gastric mills (crab only), embedding in resin, sectioning, and imaging. Participants in the workshop were able to successfully prepare specimens for age determination. There were a total of 20 participants from AFSC, ADF&G, CDFO, ODFW, and WDFW. Participants anticipate future age structure exchanges and calibration work as techniques are further developed and implemented. See Appendix II for workshop agenda.

vi. Hands-on Session Highlights and Demonstrations:

a) Hands-On Age Reading at Microscopes:

A total of 28 readers reviewed 13 species during the hands-on workshop, mainly for the purpose of calibration between age readers and agencies. Members aged black rockfish, canary rockfish, china rockfish, quillback rockfish, yelloweye rockfish, shortraker rockfish, Pacific cod, walleye pollock, lingcod, sablefish, rex sole, Greenland turbot, and geoduck clam. Species aged, participating members, and agencies are listed in Table 2.

b) Micro-mill demonstration:

A micro-milling demonstration was led by Craig Kastelle (AFSC). Craig demonstrated techniques for operating the micro-mill using a Pacific cod otolith and imaging software. Participants included Andrew Claiborne, Bethany Stevick (WDFW), Joanne Groot, Barbara Campbell (CDFO), Lance Sullivan, Patrick McDonald (NWFSC), Rob Dinneford, Andrew Pollak, and Elisa Russ (ADF&G). The demonstration was particularly helpful for CDFO staff as that agency has just acquired a micro-mill.

B. CARE Subcommittee (Working Group) Reports – Executive Summary

There were five active working groups that reported at the 2015 CARE Conference.

1. **CARE Manual/Glossary Subcommittee** – The members of the manual working group are lead Elisa Russ (ADF&G), Betty Goetz (AFSC), Lisa Kautzi (ODFW), and new member Chris Gburski (AFSC). Barb Campbell (CDFO) is also a member although she was unable to attend the working group meeting at the 2015 CARE meeting due to conflict with sablefish working group.

   The Manual/Glossary Committee working group members develop and update age-reading chapter sections or definitions for age-reading terms suggested by CARE members. These chapter sections and definitions are subsequently approved by CARE members and added to the CARE Manual/Glossary.

   The subcommittee addressed topics discussed 2013 manual recommendations, drafted 2015 recommendations, and delegated tasks. Tasks include compiling edits and finalizing the lingcod section that ADF&G-Juneau (ADU) staff submitted, incorporate thin sectioning methods and edit rockfish ageing section (Elisa), compile information from all agencies on baking otoliths and draft section (Elisa, Betty, Lisa), revise draft of ergonomics section to be included with equipment information (Betty) [Julie Pearce (AFSC) attended manual working group committee, provided additional suggestions/information on ergonomic equipment from perspective of new age reader and will supply equipment list to Betty by end of April], and draft walleye pollock section (research and provide draft at 2017 meeting – Elisa). An Acknowledgments Section will be prepared for manual version generated after 2015 meeting and the manual subcommittee will work with the website subcommittee to post archived editions of the manual. Manual working group will review sablefish section once submitted by sablefish working group. Manual working group will work with Cindy Tribuzio (AFSC) on a new spiny dogfish section for the manual since she has draft age determination manual for that species in process of publication. After review and approval by the Manual Working Group, all revisions will be submitted to the full CARE membership for final review and approval followed by incorporation into the CARE manual. Recommendations are included in CARE to CARE 2015.

2. **CARE Website Subcommittee** – Jon Short (AFSC) lead and webmaster, Nikki Atkins (NWFSC – not present), and new members Thomas Helser (AFSC) and Dion Oxman (ADF&G).

   The CARE website working group administers to the appearance, operation, and access to the site, through the cooperation of the PSMFC website and webmaster. The CARE web page is located at http://www.psmfc.org/care/.

   J. Short requested 2014 production numbers and will update the CARE website with 2014 production numbers, 2014 age structure exchanges, and the 2015 CARE meeting minutes once approved. N. Atkins continued to maintain the CARE Forum in 2014 (link on website).

   The website subcommittee included Tim Frawley (ADF&G) by teleconference to discuss the future of the existing website. The website working group discussed the possibility of adding publications of fish ageing and validation to the website so that relevant information is more accessible to the age reading community and stock assessors. One option was to add links to the existing species information page and the ageing method table. Another option is to create a more sophisticated database back-end that would allow users to search by species, ageing technique, validation method, author, etc. Publication entries could be added by agency representatives into an online form that would populate the database back end, and automatically link to appropriate species information pages. ADF&G staff expressed interest in building the web application if they would be able to employ their expert knowledge of

ASP.NET and IIS Web Services on the project. The existing web technology of Joomla that utilizes mySQL and PHP is not a technology they support.

The CARE website is on a Joomla 1.0 document management system (DMS) that was implemented in 2008 on a PSMFC server. The Joomla version is past its supported lifespan and the current version of Joomla is 3.4. It is a major undertaking to update the website to the current version of Joomla, so we discussed the possibility of converting the site and the CARE Forum to a different technology. Tim expressed willingness to support the effort to move to an ASP.NET website if that option is available on the PSMFC web server. Jon Short agreed to research options with PSMFC to see what choices are available. As of 2012, PSMFC themselves had switched from Joomla to a WordPress website, so that is one option if CARE decides to leave Joomla for another open source DMS. Both Jon and Tim expressed concern about committing to a major project such as converting the CARE website, but both are willing to assist on the project as time allows.

3. **Charter Subcommittee** – Elisa Russ (ADFG) and Betty Goetz (AFSC)

   The Charter, initiated in 2000, provides a framework in which the original intent of CARE may continue. It also familiarizes new CARE members to the function of CARE and the responsibilities of its officers and members. The committee is responsible for facilitating changes and updates to the Charter, and the charter was revised following the 2008 CARE meeting.

   The charter working group reviewed the charter and made recommendations to CARE to edit information on timelines including TSC report preparation following same year CARE meeting, add information on submission of production numbers (species aged table), and coordination with the Chair and host agency regarding meeting logistics. The revised charter will be submitted to the membership for approval by June 2015.

4. **Sablefish ad hoc Working Group** – Current members are Delsa Anderl (AFSC) as the lead and other members Patrick McDonald (NWFSC), Kevin McNeel (ADF&G), Barb Campbell (CDFO), Lance Sullivan (NWFSC), and John Brogan (AFSC).

   Due to some past members leaving their positions, tasks were reassigned with plans to update the sablefish section in the age determination manual with the draft complete by the end of 2015 and submission to the manual subcommittee by summer 2016, with review and approval by the membership prior to the 2017 CARE meeting. Additionally, some members of the group reviewed sablefish otolith to continue work on calibration and age determination criteria.

5. **Shortraker ad hoc Working Group** – This is a new ad hoc working group formed for the 2015 CARE meeting with exchanges completed prior to the meeting. Working group members are Charles Hutchinson (AFSC) as the lead and Kevin McNeel (ADF&G), Joanne Groot (CDFO), Delsa Anderl (AFSC), and Stephen Wischniowski (CDFO – absent).

   The shortraker rockfish working group convened in 2015 and discussed the age structure exchange (n=46; 2 exchanges GOA & Canadian stocks) that was initiated in 2014 between 5 members of the working group from AFSC, ADF&G, & CDFO. The group utilized camera microscopes and imaging software during a mini-workshop to discuss the sectioned shortraker otoliths and pattern interpretation in detail. AFSC members have the most experience ageing shortraker rockfish and the working group was utilized for calibration and training for the less experienced age readers. In addition to the members of the working group, three additional CARE members from AFSC and ADF&G participated for training on pattern interpretation. Shortraker rockfish growth patterns exhibit a lot of checks during early years up until approximately age 10 and then uneven growth increments after age 10. The shortraker rockfish working group made a recommendation to continue work on pattern interpretation

through future exchanges of age structures (otoliths) and images culminating in a final shortraker rockfish workshop at the 2017 CARE meeting with the intention of developing the ageing criteria.

C. 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 eleven age structure exchanges initiated in 2014 which are listed in Table 3.

D. Recommendations CARE and TSC

In 2015 recommendations were made by CARE to CARE, CARE to TSC, and TSC to CARE. Some recommendations may take more than one cycle to complete. This list contains recommendations that are still pending or provide background for those made by CARE/TSC in response to prior recommendations.

1. 2015 Recommendations
   1.1. CARE to CARE recommendations 2015
      1.1.1. Recommends the Manual/Glossary subcommittee continue revision and expansion of the CARE Manual on Generalized Age Determination with the following sections:
         i. Lingcod Otolith Ageing section – finalize draft and incorporate into manual, May 2015 *(thanks ADF&G – Juneau ADU staff).*
         ii. Thin Sectioning Method – add section under General Ageing Procedures; finish draft, finalize, and submit to membership approval prior to 2017 meeting.
         iii. Rockfish Ageing Procedures – finish draft, finalize, and submit to membership approval prior to 2017 meeting.
            a. Edit to avoid redundancy with Thin Sectioning section.
            b. Revise/move some info to Otoliths Ageing Procedures where appropriate.
         iv. Add section on baking otoliths under General Ageing Procedures – research methodologies with agencies where techniques employed and submit draft for 2017 meeting.
         v. Ergonomics – section to be included with general information on equipment with included list of ergonomic equipment recommendations for age readers; finish draft, finalize, and submit to membership for approval by June 2015.
         vi. Walleye Pollock Ageing Procedures (new) – **collaborate** between agencies and submit draft at 2017 meeting (use AFSC manual as starting point).
         vii. Sablefish Ageing Procedures section – draft to update the sablefish section in the CARE manual will be completed by sablefish working group by end of 2015 then after edits/revision will be submitted to manual working group by June 2016 for finalization with submission to membership for approval prior to 2017 meeting.
         viii. Spiny Dogfish Ageing Procedures section (new) – prepare draft for 2017 meeting.
            a. (Following publication of CARE member Cindy Tribuzio's spiny dogfish age determination manuscript and use techniques described.)
         ix. Remove documentation sections regarding changes to manual (also incomplete):
            a. Add Acknowledgements Section – submit to membership for approval for 2017 meeting;
            b. See Recommendation 1.1.2 to post archived editions.

1.1.2. Recommends the manual working group submit archived editions of the CARE Manual to the website committee for posting on the website to preserve historical records.

1.1.3. Recommends that the CARE Forum be continued.

1.1.4. Recommends the website committee research the possibility and process of adding publications of fish ageing and validation to the website so that relevant information is more accessible to the age reading community and stock assessors.

i. One option is to add links to the existing species information page and the ageing method table.
ii. Publication entries could be added by agency representatives into an online form that would populate the database back end, and automatically link to appropriate species information pages.
iii. Another option is to create a more sophisticated database back-end that would allow users to search by species, ageing technique, validation method, author, etc.

1.1.5. Additional recommendations for the website to be completed prior to 2017 meeting:

i. Add information at top of Species Info page to "Check with specific agency about changes in historical age determination techniques"; report that "Methods listed are for most recent reporting year", or adjust in conjunction with changes incorporated in 1.1.6;
ii. Edits such as consistent capitalization on Species Info page;
iii. Update agency production numbers annually,
    a. Include methods for current reporting year and use appropriate codes (B&BN= Break & Burn, B&BK= Break & Bake),
    b. Update Species Info page to include new codes,
iv. Add table for agency contacts with e-mail address – if possible, hyperlink from Ageing Method table (Agency field),
v. Add webpage for age structure inventories (links may be spreadsheet or links) for participating agencies, including protocol information.

1.1.6. Recommends the Website committee research the possibility of converting the site and the CARE Forum to a different technology (Joomla out of date and major undertaking to update to new version):

i. Consider moving to an ASP.NET website and research options available on the PSMFC web server, however, amount of work involved and cost will be assessed prior to implementation;
ii. Other option is to consider WordPress website (as of 2012, PSMFC had switched from Joomla to a WordPress website), if instead decide to leave Joomla for another open source DMS, load a new version of Joomla for the CARE website, or other recommended CMF (e.g. WordPress or Drupal).

1.1.7. Recommend the Charter Working Group revise charter and submit to membership for approval by June 2015. Changes to include:

i. information on timelines including preparation of TSC report following same year CARE meeting,
ii. submission of production numbers (species aged table), and
iii. Chair coordination with host agency regarding meeting logistics.

1.1.8. Recommends consideration of how to document changes in methods and age reading techniques by agencies for specific species and the process to report this information (e.g. website through species-specific methods, addendum to manual, and/or new document) – discuss at 2017 meeting by member agencies. (See recommendation 1.1.5)

1.2. CARE to TSC recommendations 2015

1.2.1. Recommend to remove the TSC to CARE 2014 recommendation for CARE to develop a set of best practices for short and long term otolith preservation and storage. There is currently no consensus on best storage protocol between or within agencies because method suitability may be dependent on species, fish age, and/or archive space availability.

i. Reports from agencies using glycerin-thymol, including recommended recipe for solution, will be included in the TSC report.

ii. Agencies will continue to research whether current methods of long-term storage are adequate for preservation of otolith integrity.

1.2.2. Recommend that new age readers are oriented to available ergonomic equipment and its proper use for minimum strain. Further recommend that implementation of ergonomic equipment continue and be supported by agency managers, and proactive standard operating procedures be in place to prevent workplace injury.

i. Reports on use of ergonomic equipment were provided by CARE member agencies in 2015 and:

a. Most upgrades were implemented after requests by age reading staff or local project managers;

b. Although some agencies have preventative and proactive protocols in place through either self-evaluation (see Appendix V for Laboratory Ergonomics Checklist) or ergonomic specialists available for evaluation of workstation, need to ensure that is available for all agencies.

1.2.3. Recommend that CARE continue to explore and develop new methods of shellfish age determination (with the support of TSC).

1.2.4. Recommend that the TSC schedule their odd-year meetings (same year as CARE meeting) no earlier than the last week of April (preferably later) in order to allow the CARE Chair adequate time to prepare the report to TSC.

Note: CARE meeting for 2017 has been scheduled for the first week of April to allow at least two weeks to prepare the CARE report to TSC (if the TSC meeting is scheduled no earlier than the last week of April).

1.3. TSC to CARE recommendations 2015

Note: These recommendations were received from the TSC following their April 2015 meeting and incorporated into this final report. The TSC to CARE recommendations directly address the CARE to TSC recommendations for 2015 listed above.

1.3.1. The TSC thanks CARE for taking time during their biennial meeting to work towards developing a set of best practices for short and long-term storage of otoliths. However, the TSC is discouraged that CARE was unable to come to agreement on this and considers this important to all member agencies. The TSC believes that CARE members are experts in the field of otolith reading and storage, and are thus best suited to develop and use best practices. The TSC asks CARE to reconsider TSC's request at their next meeting and initiate this process by documenting structures and storage methods currently in use (by species and agency) with notes on their benefits and deficits. TSC will also move this request forward to the U.S. groundfish management teams for their consideration through the SSCs to develop a study proposal to investigate best practices. TSC acknowledges the

valuable work of CARE and encourages work on this problem and recognizes that this is a long term goal for agencies.

1.3.2. The TSC understands the importance of ergonomic issues for CARE members and shares their concern regarding potential ergonomic injuries to age readers. In response, the TSC voiced their concern about this issue in the 2014 Letter to Supervisors that was sent to each TAC member agency, specifically to supervisors and managers for groundfish research activities in each agency. TSC places this issue within agencies' health and safety policies and urges agencies to pursue this matter directly through lab supervisors and their agency's health and safety committees. TSC recommends that, where there are concerns in this regard, CARE send a letter to the specific agency or supervisor, with specific suggestions to alleviate the ergonomic conditions, highlighting the health and safety issue.

1.3.3. The TSC is supportive of CARE taking on non-groundfish work because it advances fisheries research. However, the TSC reminds CARE that its mandate has always been groundfish and they should be given priority within CARE. CARE does not need to include shellfish investigations in their report to the TSC.

1.3.4. The TSC understands that CARE is concerned about the short amount of time, usually less than one month, between the biennial CARE meeting and the TSC meeting which makes it difficult for the CARE Chair to prepare the CARE minutes in time for the TSC meeting. If there is not enough time to submit a full report for the TSC annual meeting, the TSC will accept a brief summary and conclusions from the CARE meeting along with any recommendations to the TSC. The full report can then be submitted at a later date when the final agency reports are due, usually the end of June.

Note from TSC: In recent years the TSC has met the last week of April, and that should not change. The TSC cannot schedule their meeting any later because many TSC members start their research season the first week of May.

2. 2014 Recommendations

2.1. TSC to CARE

2.1.1. Held over ergonomic injury recommendation from 2013 and TSC suggested looking at ergonomic injuries and solutions in similar assembly type work (circuit boards) and medical pathology (microscope slide reading).

2.1.2. The TSC understands that CARE is looking into issues surrounding long-term storage of otoliths. TSC suggests that CARE researchers document their findings and develop a set of best practices for short and long term otolith preservation and storage.

3. 2013 Recommendations

3.1. CARE to TSC

3.1.1. At the 2013 CARE meeting, the manual working group drafted a section on Ergonomics for inclusion in the CARE Manual on Generalized Age Determination. It is important that agency leaders recognize the health risks associated with age reading and equipment options that may be available to mitigate these risks.

3.2. TSC to CARE

3.2.1. TSC acknowledges CARE's concerns regarding ergonomic injuries caused by extended period ageing fish and has recommended that the Parent Committee request Agencies to investigate ergonomic remedies to minimize ergonomic injuries.

4. 2012 Recommendations
   4.1. TSC to CARE
      4.1.1. The TSC thanks CARE for their continued good work and would like to acknowledge their continued work to support the online posting of otolith archives by member agencies in light of their many other work pressures.

         CARE Response: The 2015 CARE to CARE recommendation 1.1.5.v. addresses this TSC to CARE recommendation from 2012. This was addressed in 2013, however, not all agencies agreed to participate and at the 2015 meeting it was recommended that different formats be utilized for those agencies that choose to participate based on each agency's organization of archived age structures (e.g. links or spreadsheets). Some agencies also require a specific request and a link will provide the user with the required submission documentation.

5. 2011 Recommendations
   5.1. CARE to TSC (also see 2015 CARE to CARE recommendation 1.1.5.v. and *CARE Response* to 2.1.1)
      5.1.1. With regards to *"…examining the feasibility of preparing an on-line summary of the material that is archived by each of the west coast groundfish research agencies":* Most agencies do not have publicly accessible age data sample inventories now, except AFSC. CARE recognizes that there are advantages and disadvantages associated with making inventories public. A CARE portal, the website, may be a possible platform to identify inventories. CARE requests clarification on what data the TSC envisions would be made available on said inventory. Then CARE members would consult their agencies regarding the TSC recommendation and will formulate a reply by year end.

   5.2. 2011 TSC to CARE Recommendations:
      5.2.1. *"TSC would like to fully endorse the activities of CARE and acknowledge their great contribution to groundfish research and stock assessment.*

         TSC thanks CARE for their discussions and consideration of the 2010 request to examine the feasibility of preparing an on-line summary of archived ageing material from their member agencies. Since most agencies do not currently maintain publicly accessible on-line inventories, TSC appreciates that this task will be laborious. "

         a. To clarify for CARE, TSC's 2010 information request includes the following by species:
            Number of ageing structures collected by:
            i. structure type
            ii. agency
            iii. year
         b. Number of structures aged by year (already on the website)
         c. A link to a contact person at each agency.

      5.2.2. CARE Chair query regarding 2011 archive recommendation:
         "*Am I correct in assuming that the TSC is looking for numbers of fish age structures (#1) collected for all groundfish species going back as far as each agency has records for?"*
      5.2.3. The TSC reply was:
         "This is something that we would like CARE to work toward beginning with the most recent years and progressing back in time if resources permit. This needn't be a

scrupulously thorough and exhausting exhumation of numbers of structures and could be an effort that begins with the easiest information and gets added to as they can. But the more information, the better, eventually."

5.2.4. 2011 CARE reply to TSC:

i. Three CARE member agencies are willing to compile and forward "an on-line summary of archived ageing material". This could increase as two more member agencies are willing pending approval. Each member agency has selected a contact person for the website link.

ii. Three CARE member agencies chose not to participate. Some will link the CARE website to their agency website and provide a contact name.

iii. The CARE executive committee is considering how to include the summary of archived ageing material on to the website. In 2012 changes will be made to the CARE website to record the summary of archived ageing material and be ready to implement after the 2013 CARE meeting, pending membership approval.

5.2.5. CARE recommends that the 2013 agenda address the effects of long-term storage of otoliths in glycerin.

6. 2010 Recommendations

6.1. TSC to CARE

6.1.1. Recognizing the value of carbon dating and other potential uses of archived ageing material, TSC recommends that CARE examine the feasibility of preparing an on-line summary of the material that is archived by each of the West Coast groundfish research agencies.

Table 1. Attendees of the CARE Conference, April 14-17, 2015, Seattle, Washington, U.S.A.

Last name	First name	Agency	Location	Country	Email
Russ	Elisa	ADF&G	Homer	USA	elisa.russ@alaska.gov
Pollak	Andrew	ADF&G	Homer	USA	andrew.pollak@alaska.gov
McNeel	Kevin	ADF&G	Juneau	USA	kevin.mcneel@alaska.gov
Dinneford	Rob	ADF&G	Juneau	USA	rob.dinneford@alaska.gov
Politano	Kristin	ADF&G	Juneau	USA	kristin.politano@alaska.gov
Oxman	Dion	ADF&G	Juneau	USA	dion.oxman@alaska.gov
Webb	Joel	ADF&G	Juneau	USA	joel.webb@alaska.gov
Smith	Quinn	ADF&G	Juneau	USA	quinn.smith@alaska.gov
Van Kirk	Kray	ADF&G	Juneau	USA	kray.vankirk@alaska.gov
El Mejjati	Sonya	ADF&G	Kodiak	USA	sonya.elmejjati@alaska.gov
Brodie	Joan	ADF&G	Kodiak	USA	kayla.bevaart@alaska.gov
Bevaart	Kayla	ADF&G	Kodiak	USA	kayla.bevaart@alaska.gov
Tribuzio	Cindy	AFSC/NMFS - ABL	Juneau	USA	cindy.tribuzio@noaa.gov
Anderl	Delsa	AFSC	Seattle	USA	delsa.anderl@noaa.gov
Benson	Irina	AFSC	Seattle	USA	irina.benson@noaa.gov
Brogan	John	AFSC	Seattle	USA	john.brogan@noaa.gov
Gburski	Chris	AFSC	Seattle	USA	christopher.gburski@noaa.gov
Goetz	Betty	AFSC	Seattle	USA	betty.goetz@noaa.gov
Helser	Thomas	AFSC	Seattle	USA	thomas.helser@noaa.gov
Hutchinson	Charles	AFSC	Seattle	USA	charles.hutchinson@noaa.gov
Johnston	Chris	IPHC	Seattle	USA	chris.johnston@noaa.gov
Kastelle	Craig	AFSC	Seattle	USA	craig.kastelle@noaa.gov
Matta	Beth	AFSC	Seattle	USA	beth.matta@noaa.gov
Pearce	Julie	AFSC	Seattle	USA	julie.pearce@noaa.gov
Piston	Charlie	AFSC	Seattle	USA	charlie.piston@noaa.gov
Short	Jon	AFSC	Seattle	USA	jon.short@noaa.gov
Tenbrink	Todd	AFSC	Seattle	USA	todd.tenbrink@noaa.gov
White	Vanessa	AFSC	Seattle	USA	vanessa.white@noaa.gov
Campbell	Barbara	CDFO	Nanaimo	Canada	Barbara.Campbell@dfo-mpo.gc.ca
Dunham	Jason	CDFO	Nanaimo	Canada	Jason.Dunham@dfo-mpo.gc.ca
Fong	Ken	CDFO	Nanaimo	Canada	Ken.Fong@dfo-mpo.gc.ca
Gillespie	Graham	CDFO	Nanaimo	Canada	Graham.Gillespie@dfo-mpo.gc.ca
Groot	Joanne	CDFO	Nanaimo	Canada	Joanne.Groot@dfo-mpo.gc.ca
Rutherford	Dennis	CDFO	Nanaimo	Canada	dennis.rutherford@dfo-mpo.gc.ca
Forsberg	Joan	IPHC	Seattle	USA	joan@iphc.int
Johnston	Chris	IPHC	Seattle	USA	chris@iphc.int
Gibbs	Linda	IPHC	Seattle	USA	linda@iphc.int
Rudy	Dana	IPHC	Seattle	USA	dana@iphc.int
McDonald	Patrick	NWFSC	Newport	USA	patrick.mcdonald@noaa.gov
Sullivan	Lance	NWFSC	Newport	USA	lance.sullivan@noaa.gov

Table 1. continued. Attendees of the CARE Conference, April 14-17, 2015, Seattle, Washington, U.S.A.

Whiteside	Cassandra	NWFSC	Newport	USA	cassandra.whiteside@noaa.gov
Kautzi	Lisa	ODFW	Newport	USA	lisa.a.kautzi@state.or.us
Claiborne	Andrew	WDFW	Olympia	USA	andrew.claiborne@dfw.wa.gov
Hildebrandt	Anna	WDFW	Olympia	USA	Anna.Hildebrandt@dfw.wa.gov
Jones	Colin	WDFW	Olympia	USA	Colin.Jones@dfw.wa.gov
Rosenfield	Sandy	WDFW	Olympia	USA	greenthumb51@hughes.net
Stevick	Bethany	WDFW	Olympia	USA	Bethany.Stevick@dfw.wa.gov
Topping	Jennifer	WDFW	Olympia	USA	toppijat@dfw.wa.gov

Table 2. 2015 CARE Hands-On "Scope Time" Session – Species Aged, Participants, and Agency.

Species	Participants	Agency	Comments
Walleye pollock	Chris Gburski	AFSC	Calibration, Training
	Sonya El Mejjati	ADF&G	
	Joan Brodie	ADF&G	
	Andy Pollak	ADF&G	
	Chris Johnston	AFSC	
	Elisa Russ	ADF&G	
	Betty Goetz	AFSC	
	Delsa Anderl	AFSC	
Lingcod	Sonya El Mejjati	ADF&G	Calibration
	Rob Dinneford	ADF&G	
	Sandra Rosenfield	WDFW	
	Lance Sullivan	NWFSC	
	Patrick McDonald	NWFSC	
	Lance Sullivan	NWFSC	
	Kristin Politano	ADF&G	
	Joan Brodie	ADF&G	
Sablefish	Patrick McDonald	NWFSC	Calibration
	Kevin McNeel	ADF&G	
	John Brogan	AFSC	
	Lance Sullivan	NWFSC	
	Kristin Politano	ADF&G	
Black rockfish	Andy Pollak	ADF&G	Calibration
	Lisa Kautzi	WDFW	
Canary rockfish	Andy Pollak	ADF&G	Calibration
	Patrick McDonald	NWFSC	
China rockfish	Andy Pollak	ADF&G	Calibration
	Cassandra Whiteside	NWFSC	
Quillback rockfish	Andy Pollak	ADF&G	Calibration
	Cassandra Whiteside	NWFSC	
Yelloweye rockfish	Andy Pollak	ADF&G	Calibration
	Cassandra Whiteside	NWFSC	
Shortraker rockfish	Charles Hutchinson	AFSC	Calibration, Exchange, Training
	Kevin McNeel	ADF&G	Mini-Workshop Focus
	Betty Goetz	AFSC	
	Joanne Groot	CDFO	
	Kristin Politano	ADF&G	
	Delsa Anderl	AFSC	
	Elisa Russ	ADF&G	
Rex sole &	John Brogan	AFSC	Training
Greenland turbot	Joan Forsberg	IPHC	
	Linda Gibbs	IPHC	
	Dana Rudy	IPHC	
	Chris Johnston	IPHC	
Pacific cod	Craig Kastelle	AFSC	Calibration, Training
	Lance Sullivan	NWFSC	
	Andy Pollak	ADF&G	
	Rob Dinneford	ADF&G	
Geoduck clam	Bethany Stevick	WDFW	Calibration, Training
	Colin Jones	WDFW	
	Kristin Politano	ADF&G	

Table 3. CARE age structure exchanges initiated in 2014.

Exchange ID No.	Species	Originating Agency	Coordinator	Coordinating Agencies
14-001	Rougheye Rockfish	WDFW	S. Rosenfield	NWFSC/PSMFC
14-002	Spiny Dogfish	AFSC/ABL - Juneau	C. Tribuzio	AFSC
14-003	Lingcod	ADF&G - Kodiak	S. El Mejjati	ADF&G (ADU)
14-004	Big Skate	CDFO	J. King	AFSC, PSRC*
14-005	Big Skate	CDFO	J. King	AFSC, PSRC
14-006	Longnose Skate	CDFO	J. King	AFSC, PSRC
14-007	Longnose Skate	CDFO	J. King	AFSC, PSRC
14-008	Shortraker Rockfish	CDFO	J. Groot	AFSC, ADF&G
14-009	Shortraker Rockfish	AFSC	C. Hutchinson	AFSC, ADF&G
14-010	Lingcod	ADF&G – Kodiak	S. El Mejjati	ADF&G - Homer
14-011	Black Rockfish	ODFW	L. Kautzi	WDFW

*PSRC=Pacific Shark Research Center, Moss Landing Marine Laboratories

Figure 1: Attendees of the 2015 CARE Conference, April 14-17 2015 Group Photo, Shortraker Rockfish ad hoc working group, Crustacean Age Determination workshop, hands-on session calibration microscope work, and Poster Session.

APPENDIX-I

Eighteenth Biennial Meeting of the Committee of Age Reading Experts

Working Group of the Canada – US Groundfish Committee TSC
AFSC Sand Point Facility, NOAA Western Regional Center
7600 Sand Point Way, NE, Seattle, WA, USA
Bldg. #4, Jim Traynor Conference Room
April 14 – 17, 2015

CARE Agenda

Tuesday April 14, 2015

Crustacean age determination workshop – see workshop agenda (participation limited – workshop full)

Wednesday April 15, 2015

I. Welcome and Opening Statements for CARE 2015 Meeting (8:30 – 9:00)
- A. Call to Order (Elisa Russ, CARE Chair)
  1. Minutes will be taken by Lance Sullivan, CARE Secretary
- B. Host Statements
  1. Opening statements (Thomas Helser)
  2. Host information (Chris Gburski, CARE Vice-Chair)
- C. Introductions
  1. Round-table introductions (name, agency, location)
  2. Attendance, address, phone, email (written list)
- D. Approval of the 2015 agenda

II. Agency Overviews and Updates (9:00-9:45)

*No PowerPoint; 5 minute updates (staffing, organizational, new species/projects, etc.)

- A. CDFO (Steve Wischniowski)
- B. IPHC (Joan Forsberg)
- C. AFSC (Tom Helser)
- D. ADFG (Elisa Russ, Sonya El Mejjati, Kevin McNeel)
- E. NWFSC (Patrick McDonald)
- F. SWFSC
- G. WDFW (Andrew Claiborne)
- H. ODFW (Lisa Kautzi)
- I. CDFG

III. CARE to CARE recommendations from 2013 – Review (9:45-10:15)
- A. Recommends the manual working group post archived editions of the CARE Manual on the website with a link to the year of publication.
- B. Recommends the Manual/Glossary committee continue revision and expansion of the CARE Manual on Generalized Age Determination with the following sections:
  1. Lingcod Otolith Ageing – finalize draft and incorporate into manual.

2. Thin Sectioning Method – edit updated draft
3. Rockfish Ageing Procedures –
    a. Edit to avoid redundancy with Thin Sectioning section.
    b. Revise/move some info to Otoliths Ageing Procedures where appropriate.
4. Add section on baking otoliths under General Ageing Procedures.
5. Ergonomics – write short section to be included with general information on equipment.
6. Walleye Pollock Ageing Procedures – draft new section – collaborate between agencies.
7. Sablefish Ageing Procedures Section – revise.
8. Remove documentation sections in beginning of manual as is incomplete:
    a. See Recommendation A to post archived editions.
    b. Add Acknowledgements Section.

C. Recommends that the CARE Forum be continued.

D. Recommends the Website committee load a new version of Joomla for the CARE website, or other recommended CMF (e.g. WordPress or Drupal).

1. Future plans include:
    a. Edits such as consistent capitalization on Species Info page,
    b. Update agency production numbers,
    c. Add webpage for age structure inventories.

E. Recommend further study of otoliths stored long term in glycerin-thymol,

1. Report on observations regarding the media in 2015,
2. Provide recommendation to manual committee in 2015 regarding storage.

F. Recommend to the Charter Working Group to expand charter to include timelines for reports and meetings for possible additions to the charter pending CARE membership approval.

IV. CARE to TSC recommendations from 2013

A. At the 2013 CARE meeting, the manual working group drafted a section on Ergonomics for inclusion in the CARE Manual on Generalized Age Determination. It is important that agency leaders recognize the health risks associated with age reading and equipment options that may be available to mitigate these risks.

V. TSC to CARE recommendations from 2013

A. TSC acknowledges CARE's concerns regarding ergonomic injuries caused by extended period ageing fish and has recommended that the Parent Committee request Agencies to investigate ergonomic remedies to minimize ergonomic injuries.

VI. TSC to CARE recommendations from 2014

A. Held over ergonomic injury recommendation from 2013 and TSC suggested looking at ergonomic injuries and solutions in similar assembly type work (circuit boards) and medical pathology (microscope slide reading).

B. The TSC understands that CARE is looking into issues surrounding long-term storage of otoliths. TSC suggests that CARE researchers document their findings and develop a set of best practices for short and long term otolith preservation and storage.

Break (10:15-10:30) – Posters may be set up prior to the meeting commencement or during breaks today.

VII. Working Group Reports / Activity Since CARE 2011 (10:30-11:30)

A. 2014 TSC Meeting (Elisa Russ)

1. Replies to TSC regarding 2013/2014 recommendations.
2. Long-term otolith storage; review from 2013; glycerin-thymol observation reports.

B. Age structure exchanges (Chris Gburski)

C. Website (Jon Short)

1. Archived structures added to website - progress? Location, agency contacts, links (AFSC)

D. Forum (Nikki Atkins – written report since absent)

E. CARE Manual (Elisa Russ)

F. Charter Committee (Elisa Russ)

G. Sablefish (Delsa Anderl) – tabled until CARE 2017

VIII. Topics for Discussion / New Business (11:30-12:00)

A. Summary of 5th International Otolith Symposium 2014 (Helser)

B. Other Conferences since 2013 that members attended?

C. Species Info on the website - need Agency updates & verification

D. Additional topics

E. Non-agenda items

Lunch (12:00-1:15)

IX. Oral Presentations – 3 Topics (1:15-5:00)

A. Topic Session 1: New techniques in age determination methods

1. Dr. Raouf Kilada (crustacean workshop presenter), *Finally, we can say how old this crab is.* (45 minutes)

2. Irina Benson, *Preliminary Results on the Use of Otolith Microchemistry for Developing Ageing Criteria for Eulachon (Thaleichthys pacificus).* (20 min)

B. Topic Session 2: Age Validation Studies

1. Thomas Helser, *Estimation of Ageing Bias Using Bomb Radiocarbon* $\Delta^{14}C$ *Signatures in Fish Otoliths: Beyond Plot and Cluck.* (30 min)

2. Craig Kastelle, *Use of the stable oxygen isotope,* ^{18}O*, in otoliths as an indicator of fish life history events and age validation.* (25 min)

Break (3:15-3:30)

3. Stephen Wischniowski, *Incorporation of bomb-produced* ^{14}C *into fish otoliths. An example of basin-specific rates from the North Pacific Ocean.* (15 min)

4. Kevin McNeel, *Assessing yearly growth increment criteria used to assign ages for groundfish at the Alaska Department of Fish and Game Age Determination Unit using bomb radiocarbon.* (20 min)

5. Kristin Politano, *Using otolith measurements to refine quality control procedures.* (20 min)

C. Topic Session 3: Age-based models for fisheries stock assessment and management

1. Dr. Kray Van Kirk, *The use of age data in contemporary fisheries stock assessment and management.* (20 min)

Dinner at Elliott Bay Brewing Company, 12537 Lake City Way NE, Seattle (5:30-?)

Thursday, April 16, 2015

X. Working groups & Workshops (8:30 am-5:00 pm, schedule lunch as appropriate for respective groups)

A. Crustacean workshop – see workshop agenda

B. Working Groups (Traynor Room or Room 2079)

1. Meet and discuss activity since 2013
2. Formulate written recommendations and prepare for presentation Friday morning

C. Hands-on microscope work and calibration (Traynor Room)

1. Sign up for dual scope station use (time)

D. **POSTER SESSION** – posters available for viewing during breaks from other tasks all day and session at 3 pm

Friday April 17, 2015

XI. Recommendations (8:30-9:00)

A. 2015 CARE to CARE

B. 2015 CARE to TSC

XII. Concluding CARE business (9:00-10:00)

A. Administration nominations

B. Schedule and location of 2017 meeting

XIII. Working groups & Hands-on Workshop (10:00-12:00)

A. Working Groups – additional time available to meet and schedule tasks for 2017

B. Hands-on Workshop – dual microscopes available for calibration work until noon

XIV. CARE Business Meeting Adjourns (12:00 noon)

XV. Crustacean Workshop Resumes (1:00-5:00)

A. May adjourn earlier depending on student needs

APPENDIX-II

Crustacean Age Determination Workshop

April 14-17, 2015 – Seattle, Washington

TUESDAY, APRIL 14

8:30 – 9:30 AM (Traynor Room)

- Welcome
- Introductions, schedule , Q&A
- Age determination in aquatic species with reference to crustaceans – Dr. Raouf Kilada, University of New Brunswick (St. John), New Brunswick, Canada

9:30 AM – 9:40 AM Coffee Break

- A novel age determination technique and case studies for crustaceans – Dr. Raouf Kilada

10:15 AM – 10:30 PM

- Workshop Orientation – Objectives, Groups, Rooms, Stations

10:30 AM – 12:00 PM

- Group 1 – Dissection (Observer Wet Lab) and embedding (Age and Growth/RACE Labs)
- Group 2 – Sectioning and mounting (Age and Growth Lab, Room 1114)

12:00 PM - 1:30 PM – Lunch Break

1:30 PM – 2:30 PM (continued from before lunch)

2:30 PM – 4:30 PM

- Group 1 – Sectioning and mounting (Age and Growth Lab)
- Group 2 – Dissection (Observer Wet Lab) and embedding (Age and Growth/RACE Labs)
- Viewing and imaging (Age & Growth Imaging Lab, Room 1110)

4:30 PM - 4:45 PM (Traynor)

- Debrief and Q&A

WEDNESDAY, APRIL 15 – No workshop during CARE Meeting

With support from:

BSFRF
Bering Sea Fisheries Research Foundation

THURSDAY, APRIL 16

8:30 AM – 8:45 AM (Observer Wet Lab)

- Objectives for the day

8:45 AM – 12:00 PM

- Sectioning and mounting dissected specimens (Age & Growth Imaging Lab, Room 1110)
- Open stations for dissection, embedding, sectioning, viewing/imaging

12:00 PM – 1:30 PM – Lunch Break

1:30 PM – 4:00 PM

- Imaging of mounted specimens from dissections (Age & Growth Imaging Lab, Room 1110)
- Open stations for dissection, embedding, sectioning, viewing/imaging

4:00 PM - 4:30 PM (Observer Wet Lab)

- Debrief and Q&A

Friday, April 17, 2015

1:00 PM – 4:00 PM (Traynor Room)

- Review of results by species
- Progress and future directions
- Q&A

With support from:

BSFRF
Bering Sea
Fisheries
Research
Foundation

APPENDIX-III

CARE CONFERENCE 2015

April 14-17, 2015

NOAA Alaska Fisheries Science Center,
Sand Point facility, Seattle, WA

CALL FOR PRESENTATIONS & POSTERS

The Committee of Age Reading Experts is pleased to announce the Call for Presentations and Posters for the 2015 CARE Conference.

The topic sessions will focus on:

1. Age validation studies.
2. New techniques in age determination methods.
3. Age-based models for fisheries stock assessment and management.

Other presentations and posters related to the scope of CARE are also welcome for consideration.

Please submit abstracts by March 13, 2015 to Elisa Russ, CARE Chair at elisa.russ@alaska.gov

- Submit abstract as a Word document (preferably) and include the following information:
  - Type of presentation (oral or poster)
  - Title
  - First and Last Name of Author(s)
    - Include any preferred appellation (e.g. Dr. or Ph.D.)
    - Name of Presenter (if more than one author)
    - Include any affiliations (spell out agency), city, country, and e-mail
  - Text of abstract in 250 words or less.
  - Amount of time needed for presentation (maximum of 20 minutes).
    - More time may be available upon request & will be considered after deadline.

The CARE membership meeting including presentations, age reader calibration, and workgroup meetings will be held April 15-17, 2015 and presentations will occur on Wednesday, April 15, 2015.

The 2015 CARE Conference will also feature a 2.5 day crustacean age determination workshop led by Dr. Raouf Kilada. The workshop will begin on Tuesday, April 14, one day before the CARE meeting convenes. The workshop is full but reply with interest in the event space becomes available.

CARE Website: http://care.psmfc.org/

APPENDIX-IV

Eighteenth Biennial Meeting of the Committee of Age Reading Experts

Working Group of the Canada – US Groundfish Committee TSC
AFSC Sand Point Facility, NOAA Western Regional Center
April 14 – 17, 2015

Abstracts

Oral Presentations – 3 Topics

A. Topic Session 1: New techniques in age determination methods

1. Dr. Raouf Kilada (crustacean workshop presenter), *Finally, we can say how old this crab is.* (45 minutes)
2. Irina Benson, *Preliminary Results on the Use of Otolith Microchemistry for Developing Ageing Criteria for Eulachon (Thaleichthys pacificus).* (20 min)

B. Topic Session 2: Age Validation Studies

1. Thomas Helser, *Estimation of Ageing Bias Using Bomb Radiocarbon $\Delta^{14}C$ Signatures in Fish Otoliths: Beyond Plot and Cluck.* (30 min)
2. Craig Kastelle, *Use of the stable oxygen isotope, ^{18}O, in otoliths as an indicator of fish life history events and age validation.* (25 min)
3. Stephen Wischniowski, *Incorporation of bomb-produced ^{14}C into fish otoliths. An example of basin-specific rates from the North Pacific Ocean.* (15 min)
4. Kevin McNeel, *Assessing yearly growth increment criteria used to assign ages for groundfish at the Alaska Department of Fish and Game Age Determination Unit using bomb radiocarbon.* (20 min)
5. Kristin Politano, *Using otolith measurements to refine quality control procedures.* (20min)

C. Topic Session 3: Age-based models for fisheries stock assessment and management

1. Dr. Kray Van Kirk, *The use of age data in contemporary fisheries stock assessment and management.* (20 min)

Poster Presentations – See abstracts for author and agency info.

A. *A 200 year archeozoological record of Pacific cod life history as revealed through Ion Microprobe oxygen isotope ratios in otoliths.*
B. *Modeling Environmental Factors Affecting Assimilation of Bomb-produced Δ14C in the North Pacific Ocean: Implications for age validation studies.*
C. *Age validation of Pacific cod (Gadus macorcephalus) using high resolution stable oxygen isotope (δ 18O) signatures in otoliths.*
D. *What to do when dogfish lie about their age?*
E. *Bomb Dating and Age Estimates of Big Skate (Beringraja binoculata) and Longnose Skate (Raja rhina).*
F. *Changes in Pacific cod otolith weight over time.*
G. *Re-ageing of archived otoliths from the 1920s to the 1990s.*
H. *Preparing baked thick sections of Pacific halibut otoliths*

Direct determination of age in shrimps, crabs, and lobsters

Raouf Kilada[a], Bernard Sainte-Marie[c], Rémy Rochette[b], Neill Davis[b], Caroline Vanier[d], Steven Campana[e]

[a]University of New Brunswick (Saint John), 100 Tucker Park Road, Saint John, NB E2L 4L5, Canada; and Department of Marine Science, University of Suez Canal, Ismailia, Egypt.
[b]University of New Brunswick – Saint John, 100 Tucker Park Road, Saint John, NB E2L 4L5, Canada.
[c]Marine Invertebrate Biology and Conservation, Maurice Lamontagne Institute, Fisheries and Oceans Canada, 850 route de la Mer, C.P. 1000, Mont-Joli, QC G5H 3Z4, Canada.
[d]Institut des sciences de la mer de Rimouski (ISMER), Université du Québec à Rimouski, 300 allée des Ursulines, Rimouski, QC G5L 3A1, Canada.
[e]Bedford Institute of Oceanography, Fisheries and Oceans Canada, P.O. Box 1006, Dartmouth, NS B2Y 4A2, Canada.

Abstract
The detection and measurement of annual growth bands preserved in calcified structures underlies the assessment and management of exploited fish populations around the world. However, the estimation of growth, mortality, and other age-structured processes in crustaceans has been severely limited by the apparent absence of permanent growth structures. Here, we report the detection of growth bands in calcified regions of the eyestalk or gastric mill in shrimps, crabs, and lobsters. Comparison of growth band counts with reliable, independent estimates of age strongly suggests that the bands form annually, thus providing a direct and accurate method of age determination in all of the species examined. Chemical tags in the lobster cuticle were retained through one or two molts that occurred over the duration of an experiment, as apparently was the mesocardiac ossicle containing the growth bands in the gastric mill. Growth bands are not the previously documented lamellae of the endocuticle, and their formation was not associated with molting. Sex-specific growth curves were readily developed from growth band examination in multiple species, suggesting that routine measurement of growth and mortality in decapod crustaceans may now be possible.

Preliminary Results on the Use of Otolith Microchemistry for Developing Ageing Criteria for Eulachon (*Thaleichthys pacificus*)

Irina Benson, Craig Kastelle, Thomas E. Helser, Jon Short, Delsa M. Anderl
NOAA Fisheries, Alaska Fisheries Science Center, 7600 Sand Point Way, NE., Seattle, WA

Abstract
Laser-ablation inductively-coupled plasma mass spectrometry (LAICP-MS) was used to analyze the temporal change of Ba/Ca ratios in the otoliths of eulachon (*Thaleichthys pacificus*). Specimens were collected off the coast of Oregon, in the coastal areas and rivers of Southeast Alaska, and in the southeastern Bering Sea. Annual upwelling along the Pacific Coast causes fluctuation of barium concentration in surface water and may leave distinct chemical signatures in the otoliths. Attempts to age eulachon using otolith surfaces proved to be difficult. We used trace element analysis to help interpret otolith surface patterns and to develop ageing criteria for eulachon. For each otolith thin section, a continuous scan started at the core and proceeded to the proximal margin. The Ba/Ca ratios along this transect were plotted for each specimen. For the Oregon specimens Ba/Ca signature fluctuations appeared consistent with annuli in most but not all cases. Analysis of the Ba/Ca oscillations was not as straightforward as expected. Therefore, further studies need to be done to evaluate the usefulness of otolith chemistry as a tool for developing ageing criteria for eulachon.

Estimation of Ageing Bias Using Bomb Radiocarbon $\Delta^{14}C$ Signatures in Fish Otoliths: Beyond Plot and Cluck

Thomas E. Helser and Craig Kastelle

NOAA Fisheries, Alaska Fisheries Science Center, 7600 Sand Point Way, NE., Seattle, WA

Abstract

Atomic bomb testing during the 1950s and 1960s produced atmospheric radiocarbon, which after a slight delayed response, diffused into the marine environment and became incorporated into fish otoliths alive during that time. In recent years, measured bomb-produced radiocarbon ($\Delta^{14}C$) was developed as an age validation tool which compares the $\Delta^{14}C$ signature from test specimens to the $\Delta^{14}C$ of known age fish (reference chronology). To date, calcium carbonate structures in dozens of animals across different taxa have been measured for $\Delta^{14}C$, but only a handful of true reference chronologies have been developed with which to compare the $\Delta^{14}C$ signatures. In addition, a variety of statistical models and methods have been proposed to describe the functional form of radiocarbon chronologies and provide a quantitative means to compare them. However, none have been completely satisfactory in quantifying ageing bias and its uncertainty. We developed a multi-level Bayesian model and used Markov Chain Monte Carlo Simulation to estimate parameters of different functional response models and to derive a statistical framework for hypothesis tests concerning ageing bias. The model incorporates both observation and process errors and provides framework to estimate the probability of ageing bias overall from a given sample but also the probability conditional on the animal's age. Results presented are based on a comparison of canary rockfish (*Sebastes pinniger*) and Pacific Ocean perch (*Sebastes alutus*) $\Delta^{14}C$ data to the Gulf of Alaska halibut reference chronology. Canary rockfish showed a high probability of being under aged with as high as a 95% probability that under aging was occurring by as much as 6 years. In contrast, the mean ageing bias for Pacific Ocean perch was +1.4 years but considerable density of the marginal posterior encompassed zero suggesting the evidence was weak to conclude any bias. Finally, we extended the complexity of the Bayesian model by incorporating over a dozen different $\Delta^{14}C$ chronologies from California to the Gulf of Alaska into a hierarchically structured model and tested for the effects of different oceanographic factors on the functional response of the radiometric curves. The index of ocean upwelling was negatively related to the overall magnitude of ^{14}C measured in calcified structures of marine animals while the parameter commonly used to test bias was weakly positively correlated. This suggests the potential for age bias interpretations to be confounded when $\Delta^{14}C$ test samples are compared to reference chronologies derived from different oceanographic regions.

Use of the stable oxygen isotope, ^{18}O, in otoliths as an indicator of fish life history events and age validation

Craig Kastelle[a], Tom Helser[a], Jennifer McKay[b], Delsa Anderl[a], Beth Matta[a], Chris Collins-Larsen[c], Sukyung Kang[d]

[a]Alaska Fisheries Science Center, USA
[b]Oregon State University, USA
[c]University of Washington, USA
[d]National Fisheries Research and Development Institute, Republic of Korea

Abstract
The isotopic or elemental content of otoliths provides a view into the life history of fish. The stable oxygen isotope (^{18}O) in seawater is thought to be in equilibrium with marine calcium carbonate ($CaC0^3$) structures such as otoliths. We applied the principle that $\delta^{18}O$ variability in marine $CaC0^3$ is inversely related to water temperature. This presentation is an overview of what can be learned by microsampling otoliths and measuring $\delta^{18}O$ by mass spectrometry. We analyzed $\delta^{18}O$ from three species of fish from three regions in the North Pacific: Pacific cod (*Gadus macrocephalus*) from the Eastern Bering Sea, saffron cod (*Eleginus gracilis*) from the Chukchi Sea, and small yellow croaker (*Larimichthys polyactis*) from the Yellow Sea. Up to 10 microsamples were extracted from any one year's otolith deposition, and up to 42 microsamples from a 5 year old otolith, representing the life history of the fish. We confirmed the relationship between water temperature and $\delta^{18}O$ in the otoliths ($r^2 = 0.74$) using otoliths with a known temperature history. In the larger body of our study, we saw evidence of seasonal temperature fluctuations, ontogenetic migrations, and possibly a tool to investigate temperature trends over time. In exploited populations of Pacific cod, the life-history $\delta^{18}O$ signal provided a method of developing a more accurate age reading criteria and an age validation. A comparison between Pacific cod and saffron cod $\delta^{18}O$ signals indicated different life history strategies in terms of temperature preference and possibly differences in habitat usage.

Incorporation of bomb-produced ^{14}C into fish otoliths. An example of basin-specific rates from the North Pacific Ocean

Stephen G. Wischniowski[1], Craig R. Kastelle[3], Timothy Loher[2], and Thomas E. Helser[3]

[1]Sclerochronology Laboratory, Fisheries & Oceans Canada, Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, B.C. Canada V9T 6N7
[2]International Pacific Halibut Commission, 2320 West Commodore Way, Suite 300, Seattle, WA 98199, U.S.A.
[3]National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, 7600 Sand Point Way, Seattle, WA 98115, U.S.A.

Abstract
Sagittal otoliths from juvenile Pacific halibut (*Hippoglossus stenolepis*) of known age were used to create a bomb-produced radiocarbon reference chronology for the eastern Bering Sea (EBS) by fitting a coupled-function model to $\Delta^{14}C$ values from each specimen's birth year. The newly-created EBS reference chronology was then compared to a reference chronology previously created for Pacific halibut from the Gulf of Alaska (GOA). Adult Pacific halibut age-validation samples from the EBS were also analyzed for ^{14}C and modeled to validate age- estimation accuracy. A Bayesian model was developed and Markov Chain Monte Carlo simulation was used to estimate model parameters and adult Pacific halibut ageing bias. Differences in reference chronologies between ocean basins were reflected in large (deviance information criterion) (ΔDIC) between models, supporting the hypothesis that two separate coupled-function models were required to adequately describe the data, one each for the EBS and GOA. We determined that regionally specific GOA and EBS oceanography plays a considerable role in the $\Delta^{14}C$ values, and must be taken into consideration when selecting a reference chronology for bomb-produced ^{14}C age-validation studies. The age-validation samples indicated that the current ageing methodology used in Pacific halibut assessments is accurate and has provided accurate age assignments for Pacific halibut in the EBS.

Assessing yearly growth increment criteria used to assign ages for groundfish at the Alaska Department of Fish and Game Age Determination Unit using bomb radiocarbon

Kevin McNeel, Alaska Department of Fish and Game, Age Determination Unit (ADU), Juneau, Alaska

Abstract
To address the accuracy of yearly increment assignment, the Alaska Department of Fish and Game Age Determination Unit (ADU) has directed, collaborated on, and participated in several age validation studies. Published validations have addressed many high profile teleosts, but direct or indirect age validation should be conducted on all species and criteria. Rises in atmospheric ^{14}C due to atomic bomb testing between 1950 and 1960, and otolith reference curves have proven useful for estimating the birth year from otolith core samples (targeting the first year of growth). Predicted and estimated birth years can be compared to validate yearly increment criteria or suggest biases. To address unvalidated criteria and concerns regarding age estimation criteria at the ADU, approximately 220 otolith cores (representing 23 groundfish species) were sent to the Lawrence Livermore National Laboratory to be processed for carbon isotope concentrations using accelerator mass spectrometry. Otoliths were selected based on availability of known-age specimens and estimated birth years between 1958 and 1965. Corrected ^{14}C fractions for each otolith core along with the expected year at age 1 (using increment counts) were compared with known age and validated reference $\Delta^{14}C$ curves to validate age criteria, identify biases between estimated and expected ages, or highlight future research needs. Preliminary analysis shows that tested values follow trends established by reference curves and suggest that some species need further studies. These findings also stress the need to target specimens between optimal birth years and providing adequate samples to target rises in $\Delta^{14}C$ values.

Using otolith measurements to refine quality control procedures

Kristin Politano, Kevin McNeel, April Rebert; Alaska Department of Fish and Game, ADU, Juneau, AK

Abstract
Age data quality control is typically done utilizing somatic length at age correlations. For many of the species aged by the Alaska Department of Fish and Game Age Determination Unit (ADU), however, the relationship between somatic length and age is asymptotic. Therefore, as long-lived fishes get older, length is no longer a reliable proxy for age. To improve quality control procedures, we examined the relationship between age and otolith length, weight, and height for groundfish and developed a protocol to test for outlying age estimates. Our initial analysis revealed a continual change in otolith weight at age after fish reached $L\infty$ in sablefish (*Anoplopoma fimbria)*, yelloweye rockfish (*Sebastese ruberrimus*), rougheye rockfish (*S. aleutianus*), shortraker rockfish (*S. borealis)*, and lingcod (*Ophiodon elongatus*), suggesting it may be an appropriate parameter for use in quality control procedures. To establish a protocol for identifying outlying age estimates, data were modeled with otolith weight and somatic length using sigmoidal or exponential regression. An expected otolith weight and somatic length range for a given age and species was established using predicted mean and standard deviation. Models for a given species were separated by geographic location and gender given adequate sample size. After evaluating the models with a separate set of age data, mean ± 2SD was indicated as a reasonable cut off for the detection of gross outliers. The utility and feasibility of incorporating this process into age production needs to be evaluated, and more complex models should be tested. However, otolith weight has proven useful in improving data quality at the ADU and our findings support the further use and analysis of otolith morphometrics in a production setting to refine data quality control and identify unique or difficult growth patterns that may have been previously misidentified.

Poster Abstracts

A 200 year archeozoological record of Pacific cod life history as revealed through Ion Microprobe oxygen isotope ratios in otoliths

Thomas E. Helser[1](presenter), Craig Kastelle[1], John Valley[2], Aron L. Crowell[3], Ian Orland[2], Reinhard Kozdon[2], and Takayuki Ushikubo[4]

[1]Alaska Fisheries Science Center, National Marine Fisheries Service, 7600 Sand Point Way N.E., Seattle, WA
[2]WiscSIMS Laboratory, Department of Geoscience, University of Wisconsin, Madison, WI
[3] Arctic Studies Center, Department of Anthropology, National Museum of Natural History, Smithsonian Institution, 121 West Seventh Avenue, Anchorage, AK
[4] WiscSIMS Laboratory and Kochi Institute for Core Sample Research, JAMSTEC, 200 Monobe-otsu, Nankoku, Kochi 783-8502 Japan

Abstract
Fish otolith oxygen isotope ratios ($\delta^{18}O$) are considered "flight recorders," providing records of sea water temperature and habitat use over the animal's life span.
We measured $\delta^{18}O$ values in modern and archeological Pacific cod otoliths using a high precision ion microprobe. Values of $\delta^{18}O$ were measured in as many as eighty 10-micron spots along transects from the otolith core to its margin with high spot-to-spot analytical precision ($\delta^{18}O$ ±0.3‰). We obtained sample densities along a linear transect that were at least 2 to 3 times greater than micromilling/conventional mass spectrometry techniques. From modern Pacific cod otoliths (using *in situ* temperatures from electronic archive tags) we calibrated the fractionation equation of aragonite (r^2 = 0.75, p<0.001, $\delta^{18}O_A$ = 2.13-0.25T°C) to predict sea water temperature. Sinuous variability of $\delta^{18}O$ values along core-to-margin transects likely reflect seasonal temperature changes and suggest similar longevity between modern and archeological cod. Generally increasing $\delta^{18}O$ values from the otolith core to the margin revealed an ontogenetic migration from warmer near shore habitat during the first year of life to cooler deeper waters at later ages, a behavior that has not changed over the past 200 years. A decline in the average $\delta^{18}O$ of core spot samples from archeological (200+, 100+ YBP) to modern otoliths suggest increasing sea surface temperatures from the late Little Ice Age to present. Temperatures calculated from the $\delta^{18}O$ in aragonite suggest a 2-3°C rise in coastal marine sea surface temperatures in the Gulf of Alaska over the last 200 years.

Modeling Environmental Factors Affecting Assimilation of Bomb-produced $\Delta^{14}C$ in the North Pacific Ocean: Implications for age validation studies

Thomas E. Helser[1](presenter), Craig R. Kastelle[1], and Han-lin Lai[2]

[1]Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, National Oceanic and Atmospheric Administration, 7600 Sand Point Way, Seattle, WA 98115, U.S.A.
[2]Office of Science and Technology, National Marine Fisheries Service, National Oceanic and Atmospheric Administration,1315 East West Highway, Silver Spring, MD 20901 U.S.A

Abstract
The bomb radiocarbon ^{14}C chronometer has become the gold standard for assessing the accuracy of age estimates of fish based on otolith growth rings. In the northeast Pacific Ocean, nearly a dozen age

validation studies have been conducted, ranging from California to Alaska, most of which have relied on a single reference chronology from the Gulf of Alaska. As such, it seems quite likely that oceanographic factors affecting the uptake and assimilation of ^{14}C in marine carbonates can lead to a misinterpretation of age determination error when the test samples and reference curve are not from the same region. To explore this possibility, we developed a hierarchical Bayesian meta-analysis using bomb-produced radiocarbon from data sets in the northeast Pacific Ocean. We investigated whether latitude and upwelling exerts an influence on the parameters that describe the rapid radiocarbon $\Delta^{14}C$ increase in marine calcium carbonates. Models incorporating both latitude and upwelling as linear covariates of a 4-parameter logistic model were favored based on ΔDIC statistics. There was substantial evidence to support that the timing of the $\Delta^{14}C$ pulse was advanced and that total $\Delta^{14}C$ uptake increased with increasing latitude. In contrast, increased oceanographic upwelling resulted in lower total radiocarbon input as well as a delay in the timing of the pulse curve, as is characteristic of the upwelling dominated California Current System. The Gulf of Alaska appears to be more tightly coupled to atmospheric radiocarbon input with greater surface mixing, and less upwelling, than other regions in the northeast Pacific, resulting in earlier timing of $\Delta^{14}C$ rise and greater total radiocarbon input into the marine environment.

Age validation of Pacific cod (*Gadus macorcephalus*) using high resolution stable oxygen isotope ($\delta^{18}O$) signatures in otoliths

Craig R. Kastelle[1](presenter), Thomas E. Helser[1], Jennifer McKay[2], Chris G. Johnston[3], Delsa M. Anderl[1], and Mary E. Matta[1].

[1]Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 7600 Sand Point Way, Seattle, WA
[2] College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR
[3] International Pacific Halibut Commission, 2320 West Commodore Way, Suite 300, Seattle, WA

Abstract

Pacific cod (Gadus macrocephalus) is the second most important fishery in the North Pacific. However, Pacific cod age determination has historically been difficult, so uncertainty may exist in biological reference points. To address ageing inaccuracy, we conducted an age validation study using the stable isotope 18O (δ18O). This approach is based upon the principle that variability in marine carbonate δ18O is inversely related to water temperature, and thus seasonal changes in temperature would be reflected in otolith δ18O values. We sequentially microsampled Pacific cod otoliths, from the core to the margin, to measure 18O (δ18O). This provided up to ten δ18O measurements per posited annual growth zone, and approached 45 sequential samples per specimen. We developed individual life history signatures of δ18O from 40 Pacific cod otoliths with estimated ages of 2 to 5 years. Our goals were to identify the annual seasonal variation (cyclical pattern of otolith δ18O values) and determine if the number of δ18O maxima and minima was consistent with the age derived from growth zone counts. We also estimated the probability of age reading bias by treating the number of δ18O maxima and minima as an indication of "true fish age." The relationship between δ18O in Pacific cod otoliths and known water temperature was also independently verified (r2 = 0.74). Age reading bias in specimens from ages 2 to 5 was, on average, estimated to be relatively small. The probability of an age reader assigning an age based on visual growth zone counts equal to the true age was approximately 64%, whereas the probabilities of assigning an age greater to or less than the true age by one year were approximately 19% and 17%, respectively. However, there did appear to be an age-specific bias at age

5; the probability density was non-symmetric and indicated a probability of assigning the true age was 49%, with a 51% probability of under-ageing true age by one or more years.

What to do when dogfish lie about their age?

Cindy A. Tribuzio[1](presenter), Beth Matta[2], Chris Gburski[2], Cal Blood[3], Walter Bubley[4], Gordon H. Kruse[5], William Bechtol[6]

[1]Auke Bay Laboratories, AFSC, NMFS, Juneau, Alaska
[2]Alaska Fisheries Science Center, National Marine Fisheries Service, 7600 Sand Point Way N.E., Seattle, WA
[3]Resource Ecology and Fisheries Management, AFSC, NMFS, Seattle, Washington
[4]South Carolina Department of Natural Resources, Marine Resources Research Institute, Charleston, SC
[5]School of Fisheries and Ocean Sciences, UAF, Juneau, Alaska, USA
[6]Bechtol Research, Homer, Alaska, USA

Abstract
Historical methods for ageing spiny dogfish (*Squalus suckleyi*) result in low precision of age estimates, particularly for older fish exhibiting spine erosion, prompting a search for improved methods of ageing. Spiny dogfish were aged by historical methods and by a new method involving vertebral thin sections obtained from the same specimens. We estimated inter-reader precision and variance associated with each structure. The two structures yielded similar ages for younger animals but not for older animals. Similar to other ageing structures, individual variability can impact thin section quality, particularly in larger older animals. Each method has advantages and disadvantages. The fin spine method was validated previously by both oxytetracycline and bomb radio carbon dating, but between-reader agreement is poor. Moreover, worn or broken fin spines require another step, where lost annuli are estimated through regression methods, which introduce an additional source of error into age estimation. In comparison, the vertebral thin section method substantially improved between-reader agreement and does not require the additional regression step, but processing of vertebrae is time consuming, the quality of the thin section impacts the age estimates, and validation of ages for larger animals has not yet been realized. In summary, the vertebrae thin section method is promising, but more work is required to examine individual variability in thin sections (i.e. quality) and ages need to be compared among the two methods from a larger sample size of large, old fish that have been age validated by bomb radio carbon dating.

Bomb Dating and Age Estimates of Big Skate (*Beringraja binoculata*) and Longnose Skate (*Raja rhina*)

Jacquelynne King[1], Thomas Helser[2], Christopher Gburski[2] (presenter), David Ebert[3], Craig Kastelle[2], and Gregor Cailliet[3]

[1] Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, BC, V9T6N7, Canada
[2]Alaska Fisheries Science Center, Age and Growth Program, Seattle, WA, 98115, USA
[3]Pacific Shark Research Center, Moss Landing Marine Laboratories, Moss Landing, CA, 95039, USA

Abstract

Age and growth curve estimates have been produced for big skate (*Beringraja binoculata* [formerly *Raja binoculata*]) and longnose skate (*Raja rhina*) populations in the Gulf of Alaska, British Columbia and California. Age estimation for these two skate species relies on growth band counts of sectioned vertebrae. However these studies have not produced similar results for either species, highlighting the need for age validation. Archived large specimens of big skate and longnose skate collected in 1980 and 1981 had minimum age estimates old enough to suggest that radiocarbon (14C) signals from bomb testing conducted in the late-1960s could be used to establish dates of growth band formation. Accelerator mass spectrometry provided measures of Δ14C associated with a year of growth band formation based on skate age estimates. We used Bayesian statistics to compare these values to reference Δ14C a marine teleost otolith chronology produced that exists for California.

Changes in Pacific cod otolith weight over time

Rob Dinneford (presenter) and Kristin Politano
Alaska Department of Fish & Game, Age Determination Unit, Juneau, AK

Abstract
Variability of otolith weight over time merits attention as otolith measurements including weight are used in quality control procedures, specimen verification, and age studies at the Alaska Department of Fish & Game's Age Determination Unit. Sagittal otoliths of Pacific cod (Gadus macrocephalus) have a relatively high surface area to weight ratio, and are likely to highlight trends in otolith weight variability. Weekly weight measures were taken from 84 dry stored P. cod otoliths for 31 – 46 weeks on and following extraction days. Scale performance and environmental conditions including ambient temperature, in-situ temperature & humidity, were also examined. Week of measurement and environmental conditions show slight significance with otolith weight within observed weight variance; however scale performance also possibly accounts for 4% to 86% of observed variation (scale sd = 0.00037 g). Otolith weights universally decreased between 1.1% and 1.9% from extraction days to the following week over a range of 0.0041 – 0.0111 g. Samples' otolith weight varied from sd = 0.0006 g (CV = 0.10% for data set without extraction day) to sd = 0.0015 g (CV = 0.28% for data sets including extraction day). Results suggest most otolith weights are stable (excluding extraction week measures), yet small-scale variations over time and conditions should be considered in pertinent models &etc. Analyses & reporting should be limited to 0.001 g to account for scale variance beyond this resolution. Sagittal otoliths for other species and size ranges should be analyzed to see if results are similar.

Re-ageing of archived otoliths from the 1920s to the 1990s

Joan E. Forsberg (presenter) and Ian J. Stewart
International Pacific Halibut Commission, 2320 W. Commodore Way, Seattle, WA 98199

Abstract
The International Pacific Halibut Commission has collected otoliths for age determination since 1925. After otoliths are aged, they are stored and archived. The Commission's otolith collection contains samples from over 1.6 million halibut. Age determination techniques used for halibut have changed over time; prior to 1992, all otoliths were surface aged. Beginning in 1992, otoliths that met certain criteria (high surface age, difficult pattern, etc.) were also aged by break-and-burn or break-and-bake method in addition to surface aging. The break-and-burn/bake method was determined to provide more accurate ages. Therefore beginning in 2002, all otoliths collected from setline surveys or the

commercial catch were aged by break-and-bake. To provide information on the bias and imprecision of historical surface ages relative to age data from the 1990s onward, subsets of otoliths from each decade from the 1920s to the 1980s were re-aged by both the surface and break-and-bake technique and original surface ages were compared to the ages made in 2014. Additionally, systematic subsamples of otoliths collected in 1992, 1993, and 1998 that were previously only surface-aged were re-aged by break-and-bake and included in this analysis. Results indicated that historical samples contained very few fish aged older than 15 years by either method. Based on simultaneous estimation of bias and imprecision for up to four unique ages per otolith, the properties of historical surface ageing methods were found to be very similar to current methods, becoming increasingly biased and imprecise beyond 15 years.

Preparing baked thick sections of Pacific halibut otoliths

Chris Johnston

International Pacific Halibut Commission, 2320 W. Commodore Way, Seattle, WA 98199

Abstract

Halibut otoliths from several different collection years were selected for an increment study looking at changes in size at age. Measurements were made on baked transverse "thick" sections of blind-side sagittal otoliths. The procedure for preparing baked thick sections is described. The posterior end of the otolith was the preferred end to bake since it leaves the anterior end for surface reading. Some otoliths had already been aged by break-and-bake technique while others had only been surface-aged. Previously-baked otolith halves were cut about 1.5 to 2 mm below the reading surface and mounted onto individual glass slides, reading surface facing up, and polished. Whole otoliths were cut transversely either side of the 1st year, baked for 10 minutes at 500° F then mounted anterior end up on individual glass slides. The sections were then polished down to expose the nucleus using the polishing procedure described above. Polishing progress was monitored using a stereomicroscope. Polished sections were submerged in water to eliminate glare and photographed under 12X to 25X magnification.

APPENDIX-V

Reducing Ergonomic Risks in Laboratories

Employee education and training is essential for prevention of laboratory injuries. Workers should have a basic understanding of ergonomic principles, and be able to recognize risk factors symptoms. The design of the job itself (work/rest schedules, job rotation), work tools and the workstation (dimension/layout) also has a direct impact on the risk of injury. Incorporating ergonomic principles into the design of laboratory tools and workstations, and reviewing work processes to maximize efficiencies can help prevent work related injuries. Periodic review of the work environment, tools and procedures helps to assure that necessary modifications are made as processes change.

Laboratory Checklist

This document will help you identify risk factors associated with laboratory environments. Designed for use by both safety specialists and laboratory workers, the checklist also includes information to help eliminate or reduce identified risks.

How to Use the Checklist

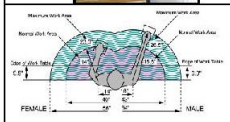
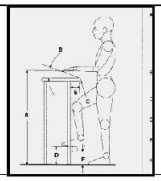
Step One: If you work with a safety specialist or safety committee, see if the following information if available for your laboratory: (1) list of musculoskeletal injuries; and (2) worker complaints or concerns about performing specific tasks.

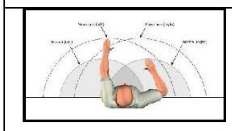
Step Two: Contact the workers and supervisor and discuss the purpose for performing the ergonomic survey. Ask the supervisors and workers if there are any issues or concerns that they have regarding laboratory work tasks.

Step Three: Complete the Laboratory Checklist for the tasks being completed in the laboratory. Answer N/A if the question does not apply to the task.
Include all meaningful comments for each area.

Step Four: *Each "NO" answer indicates a risk of injury or sub-optimal condition*. For each "NO" answer, concerning changes or modifications to the workstation or task to result in a yes response. When considering changes, obtain input from the workers, supervisors, and other safety specialists if available. Whenever possible, evaluate equipment before making purchases and before modifying the work areas or tasks. This process will help increase product acceptance, test product usability, and durability, and take advantage of worker experience.

Laboratory Ergonomics Checklist

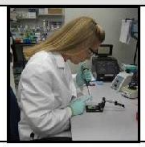
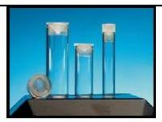
		Yes	No	Change/Modification	Comments
	Standing Bench				
	1. Is the height of the bench appropriate for the work performed? a. Work can be positioned close to elbow height (~ 36-40") b. Work can be performed with shoulders relaxed	☐	☐	☐ Adjustable height benches ☐ Adjustable chair ☐ Temporary standing platforms ☐ Move the task to a seated bench with adjustable chair	
	2. Are primary work tools and supplies located within arm's reach (4-18") from table edge?	☐	☐	☐ Reposition tools and supplies within 18" distance ☐ Provide tool organizers, turntable workstations, turntables, storage bins, pipette holders and carousels	
	3. Is there knee and foot clearance when completing standing tasks in front of the bench? a. 4" deep knee clearance b. 4" high and 4"deep foot clearance	☐	☐	☐ Work at open bench cut outs ☐ Remove supplies and equipment from bench cut out areas ☐ Modify bench surface with clamp on cut out extensions to increase knee and foot clearance	
	4. Is a foot rail or prop available (6" from floor)	☐	☐	☐ Install rails or foot props ☐ Use footrest ☐ If bench has undersurface cabinet, open or remove door and place foot on lower shelf	
	5. Are there floor mats in areas where prolonged standing tasks are completed?	☐	☐	☐ Provide floor mats ☐ Use cushioned shoes and in-soles	

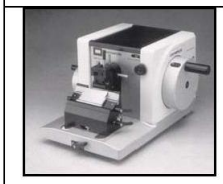
		Yes	No	Change/Modification	Comments
	6. Does the bench have rounded or padded edges to reduce contact stress?	☐	☐	☐ Add edge rests and protectors to eliminate sharp edges ☐ Use gel pads on surface to protect elbows ☐ Wear custom padded sleeves under lab coat	
	7. Is standing bench available for tasks requiring frequent movement between workstations?	☐	☐	☐ Redesign work to reduce movement between stations to optimize workflow	
	Seated Bench				
	8. Are bench cutouts available for seated workers? a. Minimum 15" depth b. Minimum 20" width	☐	☐	☐ Redesign benches to provide cut-outs for seated work ☐ Provide sit-stand chairs to improve knee clearance when working ☐ Clear out cutouts if cluttered with supplies or equipment	
	9. Are work items within close reach? a. Maximum 24"	☐	☐	☐ Reposition tools and supplies within 24" distance ☐ Provide tool organizers, turntable workstations, turntables, storage bins, pipette holders and carousels	
	10. Is seated bench available for tasks requiring precision and close inspection?	☐	☐	☐ Provide arm supports for stability if not available ☐ Provide sit-stand stools ☐ Provide adjustable work platforms to position work at optimal height	
	Laboratory Chairs				

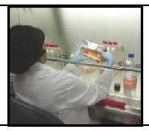
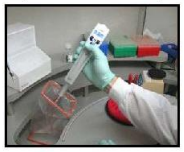
		Yes	No	Change/Modification	Comments
	11. Can the laboratory chairs be adjusted to accommodate all workers? a. Seat height appropriate for work at height of benches? b. Feet supported on floor, ring or footrest?	☐	☐	☐ Provide chairs with adjustable height and angle seats and backrests ☐ Provide chairs with foot rings ☐ Provide footrests	
	12. Are armrests adjustable or removable if they interfere with work?	☐	☐	☐ Adjust armrests to provide support with shoulders in neutral postures ☐ Remove armrests	
	13. Are appropriate footrests or footrings provided?	☐	☐	☐ Provide industrial footrest ☐ Install foot ring on chair ☐ Install rail or platform	
	14. Do employees know how to adjust chairs?	☐	☐	☐ Train employees to adjust chair	
	Microscopes				
	15. Can employees view the eyepiece with neutral neck, shoulder and back postures? (Neck flexion < 25°, shoulders relaxed, back upright and supported by chair?)	☐	☐	☐ Reposition microscope ☐ Adjust height ☐ Adjust angle ☐ Reposition worker ☐ Adjust posture ☐ Adjust seat height ☐ Adjust seat angle ☐ use arm support/pad	

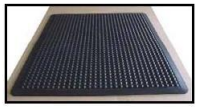
		Yes	No	Change/Modification	Comments
	16. Is the microscope positioned within easy reach of the worker? (Generally close to the edge of the workbench)	☐	☐	☐ Reposition microscope ☐ Move closer to front of counter ☐ Reposition worker ☐ Adjust posture ☐ Sit closer to bench	
	17. Can the microscope be positioned to promote neutral head, neck, shoulders and arm postures when used?	☐	☐	☐ Reposition microscope ☐ Use microscope adapters ☐ Positioning plate ☐ Ergo adapter ☐ Scopease ☐ Optical wedge ☐ Extended eyetube ☐ Eyepiece adapter ☐ Use video system	
	18. Are arms supported by worksurface, chair armrests, or pads for prolonged work?	☐	☐	☐ Use arm supports ☐ Use pads ☐ Adjust armrests ☐ Adjust worker position	
	19. Can the worker use the microscope controls with arms supported and relaxed?	☐	☐	☐ Reposition microscope ☐ Use microscope adapters ☐ Use arm supports/pads ☐ Adjust armrests ☐ Adjust worker position	
	20. Is there sufficient legroom and foot support when using the microscope?	☐	☐	☐ Work at bench cut-out ☐ Clear cut-out of clutter ☐ Provide footrest ☐ Provide foot ring	
	21. Are microscope work breaks provided?	☐	☐	☐ Institute work rotation ☐ Institute work breaks	

		Yes	No	Change/Modification	Comments
	Pipettes				
	22. Is manual pipette use limited to less than 4 hours per day?	☐	☐	☐ Institute work rotation ☐ Institute work breaks ☐ Consider use of alternative pipettes	
	23. If pipette use is more than 4 hours per day, are multi-channel, electronic or latch mode pipettes available?	☐	☐	☐ Evaluate use of alternative pipettes ☐ Electronic ☐ Latch-mode ☐ Multi-channel	
	24. Have employees been trained to select appropriate pipettes for pipetting task?	☐	☐	☐ Employee training	
	25. Are racks, trays, beakers and supplies available and placed within easy reach?	☐	☐	☐ Provide racks and trays ☐ Position supplies within close reach ☐ Use pipette racks and organizers	
	26. Are vials, tubes and receptacles as low profile as possible?	☐	☐	☐ Provide short beakers and vials ☐ Provide short tips and tubes ☐ provide short/angled waste receptacles	

		Yes	No	Change/Modification	Comments
	27. Do workers pipette with shoulders relaxed, and arms and wrists in neutral postures?	☐	☐	☐ Employee posture training ☐ Adjust work position ☐ Adjust workstation set-up	
	28. Are rest breaks provided?	☐	☐	☐ provide work breaks or work rotation	
	Micromanipulation				
	29. If forceps are used for prolonged periods, are locking mechanisms, o-rings or other adapted aides used to reduce prolonged or static pinch forces?	☐	☐	☐ Provide adapted tweezers/forceps ☐ O-rings ☐ Pads/foam grips ☐ Self-closing ☐ Low force tools ☐ Alternate fingers/hands	
	30. Are vials easy to cap and thread?	☐	☐	☐ Provide easy opening caps ☐ Provide vials with minimal number of threads	
 	31. Are cap openers available?	☐	☐	☐ Provide decapping tools	
	32. Are clamps and holders available to support test tubes and other materials that must be help for prolonged periods?	☐	☐	☐ Provide vial clamps ☐ Provide racks, holders, shelves, or organizers	

		Yes	No	Change/Modification	Comments
	Microtome/Cryostat				
	33. Can workers operate the microtome with hands in a pistol grip position? (Wrist aligned with forearm and in handshake position)	☐	☐	☐ Re-position worker ☐ Re-position height, angle or position of microtome ☐ Employee training in work postures ☐ Use foot operated controls ☐ Modify handle position	
	34. Is equipment placed in a bench cut out allowing for adequate leg and knee clearance?	☐	☐	☐ Work at bench cut-out ☐ Clear area around microtome/cryostat of obstacles	
	35. Is an adjustable chair available at the microtome or cryostat that provides back and foot support?	☐	☐	☐ Provide adjustable chair ☐ Provide chair with head support if working in reclined position ☐ Consider mirror system to improve view of samples	
	36. Do employees have access to a motorized microtome/cryostat for high intensity/volume work?	☐	☐	☐ Consider electronic cryostat for high volume workloads	
	Laboratory Hoods and Biosafety				

		Yes	No	Change/Modification	Comments
	Cabinets				
	37. Is leg, knee clearance available to promote neutral sitting postures when using the hood or cabinet?	☐	☐	☐ Clear knee area under cabinet or hood ☐ Use sit/stand stool	
	38. Can workers work with shoulders relaxed when sitting or standing?	☐	☐	☐ Consider height adjustable hood or cabinet ☐ Use height adjustable stool/chair	
	39. Is padding available to reduce soft tissue compression (edge padding or arm pads)?	☐	☐	☐ Use elbow pads ☐ Use edge padding ☐ Use arm supports	
	40. Are materials inside the hoods and cabinets as close as possible to the worker to avoid over-reaching?	☐	☐	☐ Position receptacles within close reach ☐ Use turntables, rotating organizers, angled platforms	

		Yes	No	Change/Modification	Comments
	41. Are vials, tubes and receptacles as low profile as possible?	☐	☐	☐ Provide low profile vials, tubes and receptacles ☐ Angle receptacles to position within closer reach	
	42. Are anti-fatigue mats used if employees stand for more than 4 hours per day?	☐	☐	☐ Provide anti-fatigue mats ☐ Provide foam insoles for shoes ☐ Provide supportive shoes	
	Miscellaneous				
 	43. Are bottle dispensers and bottom dispensing carboys available to dispense liquids?	☐	☐	☐ Provide bottle dispensers ☐ Provide bottom dispensing carboys ☐ Provide bottles with handles	
	44. Is there adequate and appropropriate storage for supplies? a. Is sufficient space available for supplies? b. Are heavy bottles and boxes stored on low shelves?	☐	☐	☐ Provide storage for supplies ☐ Place heavy items on shelves between knees and chest level	

		Yes	No	Change/Modification	Comments
	45. Are cut-outs clear of storage and available for use?	☐	☐	☐ Clear cut-outs of clutter ☐ Provide cut-out areas for working at bench using work surface cut-outs or platforms	
	46. Are jars easy to open or are jar openers available?	☐	☐	☐ Provide jar openers	
	47. Are temporary platforms available for tasks that require elevting arms above chest level for prolonged periods?	☐	☐	☐ Consider standing platforms or elevated work areas (Consider safety issues and reduce fall risks before using)	
	48. Are there adequate bins and racks for frequently used items?	☐	☐	☐ Provide bins, racks and shelves for frequently used items	