BSAI 2015 chum salmon age information for NPFMC salmon bycatch analyses[1]

Background

The Auke Bay Laboratories (ABL) Ecosystem Monitoring and Assessment staff in Juneau has a renewed effort to provide age information for the individual chum salmon prohibited species catch (PSC) processed for genetic stock composition from the commercial walleye pollock fishery in the Bering Sea/Aleutian Islands (BSAI). Specifically, this includes salmon bycatch from Bering Sea catch from all pollock catcher vessels, during plant deliveries, and all pollock catcher processor and mothership hauls at sea (AFSC 2014). Scales collected by NMFS Observers for species verification of the genotyped chum salmon were used to assign age to individual fish. In 2016, the ABL Genetics Program used the individual fish age information to generate age-specific stock composition estimates for the 2015 PSC chum salmon from the BSAI commercial pollock fishery.

The objective of this ABL project is to provide age information for individual chum salmon used in the genetic stock identification (GSI) analyses. This information can be used to estimate age-specific stock composition. The goal is to develop a time series of age-specific stock composition of PSC chum salmon in the BSAI pollock fishery from 2004 forward.

Report Details

1. *Scale samples from genotyped chum salmon*

Scales collected by NMFS Observers from PSC chum salmon used in the GSI analyses in 2015 were read for age. Scales are stored in coin envelopes. To process the scales for age, the scales were taken out of the coin envelopes, mounted onto gum cards, and pressed onto plastic acetate cards. The acetate impressions of the scales were then viewed under a microfiche reader and read for age. Error codes were assigned if the scale was from a different species (contamination, usually pollock or a different salmon species), illegible, regenerate, from near the lateral line, not readable, non-preferred, or the reader questioned the age (age 2 or 3?). Appendix 1 shows the status of scale processing for chum salmon analyzed for GSI, 2004-2016.

Each scale has data associated with an individual specimen (see Kondzela AKFIN Report, 2017). Records include year, observer last name, cruise number, haul/offload number, delivery vessel code, trip target species code, NMFS reporting area, primary Alaska Department of Fish and Game (ADFG) statistical area, fishery management plan (FMP) area, FMP subarea, salmon species code, specimen number, sex, sample from haul or offload, haul/offload date, length (fork length in cm), and weight (kg).

2. *Ageing chum salmon using scales*

[1] Prepared by Ellen Yasumiishi and Chris Kondzela at the NOAA Auke Bay Lab, Juneau AK

Scales can be used to determine age in salmon, which is designated as the number of winters of life (Figure 1). Chum salmon spend one winter in the gravel rearing as fry in freshwater and from 2 to 5 years in saltwater (Salo 1991). Total age is determined by the number of winter annuli plus one (LaLanne and Safsten 1968).

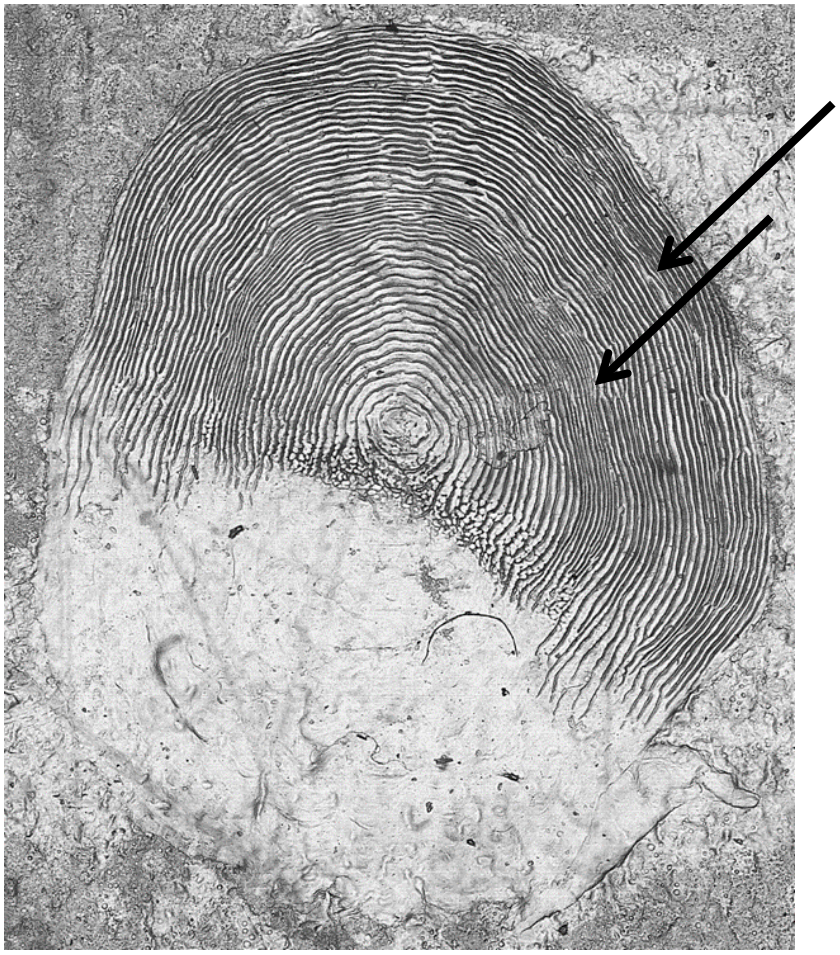

Figure 1. Image of a scale from an age 3 chum salmon, as indicated by two marine annuli.

More specifically, saltwater annuli are identified by the transition between winter and spring growth patterns on the scale. For example, the image of a scale from a chum salmon in Figure 1 has two saltwater annuli and is an age 3 fish. Scales grow in a concentric pattern and form rings called circuli around a focus. During winter, when food is limited and metabolism slows, the growth is slower and spacings between circuli are narrower. During spring (February to June), salmon begin to grow rapidly as the water warms, food becomes more available, and circuli are more widely spaced. The transition between slow growth (narrowly spaced circuli) and rapid growth (widely spaced circuli) is called an annulus. The use of scales is advantageous over the use of fish length to age salmon. Length frequency distributions are difficult to determine age of chum salmon after the first winter at sea (> 300 mm), from age 3 to 6 (Figure 2).

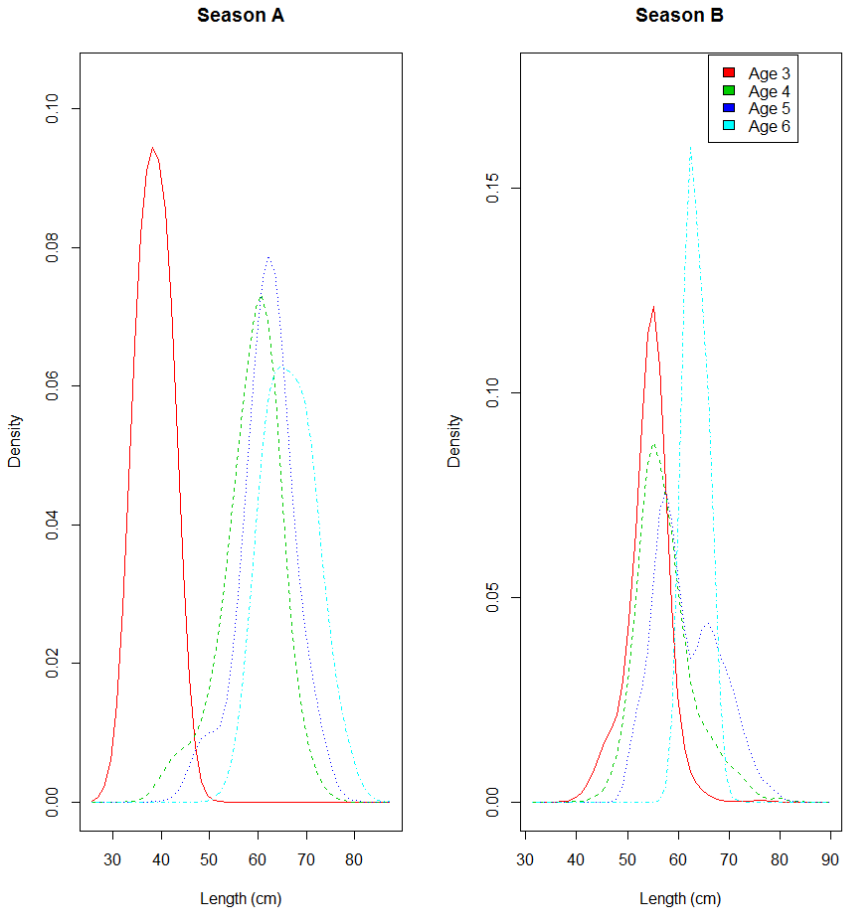

Figure 2. Density plots of lengths (cm) of age 3-6 chum salmon captured incidentally in the BSAI pollock fishery in 2015. The A-season occurs between late January and May; the B-season occurs between early June and November. Only two age 2 fish were available from the B season and were not included in the plot.

3. *2015 age composition of chum salmon genotyped samples*

For 2015, scales were available for 142 chum salmon from the A-season and 1,867 chum salmon from the B-season. Approximately 78% of the scales were readable for age: 105 scales (74%) for the A-season and 1,461 scales (78%) for the B-season. During the A-season, age composition was 2% for age 3s (n=2), 43 % for age 4s (n=43), 44% for age 5s (n=44), and 16% for age 6s (n=16). During the B-season, age composition was <1% for age 2s (n=2), 51.6 % for age 3s (n = 754), 42.4% for age 4s (n=619), 5.5% for age 5s (n=81), and <1% for age 6s (n=5).

4. *Summary*

In 2015, the age-composition of PSC chum salmon differed during the A and B-seasons. Older fish (age 4 and 5) were seen during the A-season and younger fish (age 3 and 4) were seen

during the B-season (Figure 3). Chum salmon typically mature from age 3 to 6 (Salo 1991) and may arrive into the Bering Sea at younger ages during the summer and over winter.

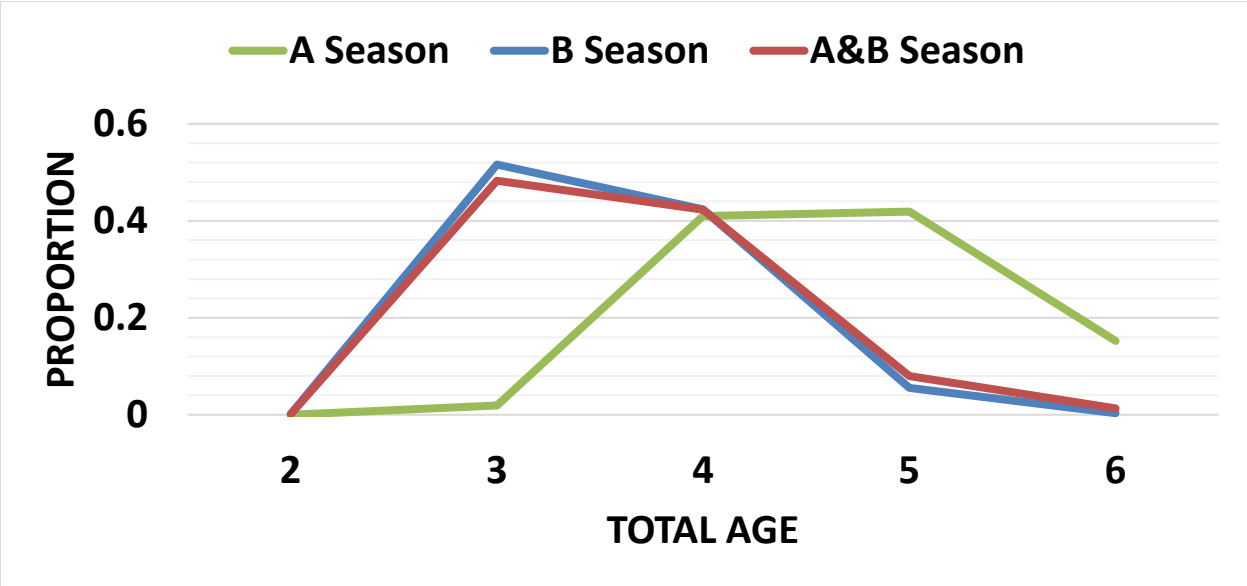

Figure 3. Age composition of the genotyped chum salmon from the A and B-seasons of the commercial walleye pollock fishery in the BSAI during 2015.

Relative to historical age composition, the PSC chum salmon during the B-season in 2015 were younger than in years from 2004 to 2009 (Figure 4). The 2015 anomalous year of age composition is reflected in the GSI showing a higher proportion of Gulf of Alaska chum salmon in 2015 relative to past years (Kondzela et al. 2017). In the eastern North Pacific Ocean, chum salmon of southern origin generally mature at younger ages than in the north (Helle and Hoffman 1995, Salo 1991) so the increase in the composition of age 3 fish in the sample corroborates the increase in southern chum salmon in stock composition estimate. Southern fish likely mature at younger ages due to the longer growing season in the south that allows them to reach an optimum size for spawning earlier than northern origin chum salmon (Bilton and Ludwig 1966, LaLanne 1971, Ricker 1964, Morita and Fukuwaka 2007). Other possible explanations of the increase in younger chum salmon in the BSAI include recent reductions in age at maturity of chum salmon, northward migration of chum salmon due to the impact of consecutive warm years (2014-2015) that correspond with lower zooplankton and forage fish productivity, and an increase in the influx of southern predators into the Gulf of Alaska (Zador and Yasumiishi 2016). A time series of age-specific stock composition estimates of chum salmon stratified by area may assist in understanding the mechanisms of spatial and temporal changes in the stock composition of chum salmon caught in the BSAI pollock fishery.

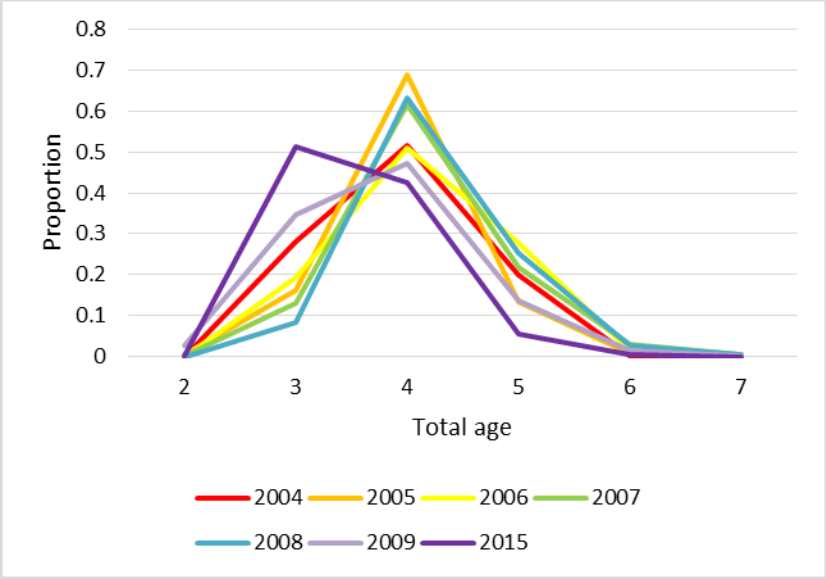

Figure 4. Age composition of the genotyped chum salmon from the B-season of the commercial walleye pollock fishery in the BSAI during 2004-2009 and 2015.

In the future, the 2013 chum salmon GSI samples (all samples received) will be used to evaluate the impact of sub-sampling on the age composition of the PSC salmon samples, as was done for GSI. We plan to compare estimates of age composition from systematic sub-samples (all samples, every 2nd fish, and every 4th fish) of the samples processed for GSI at ABL.

In addition, we plan to work with the Auke Bay Laboratories (ABL) Genetics Program to add age information to chum salmon records in the online Alaska Fisheries Information Network (AKFIN) (NMFS 2016). AKFIN reports are updated weekly with data consolidated from the PSMFC AKFIN Program, Alaska Fisheries Science Center (AFSC) Observer Program, and Alaska Regional Office (AKR) database sources.

Other possible applications of age-specific stock composition include extrapolating age-specific estimates of the samples to the total bycatch. Additional, these estimates could be used in the adult equivalency model to estimate the impact of commercial fisheries on chum salmon populations (Ianelli and Stram 2014). Age information provides an additional level of detail allowing for estimating stock composition by an added stratum in analyses of stock composition,

Appendices

Appendix 1. Status of processing scales for determining age of chum salmon captured incidentally in the BSAI walleye pollock commercial fishery.

Year	Species	Status
2004	Chum	Complete
2005	Chum	Complete
2006	Chum	Complete
2007	Chum	Complete
2008	Chum	Complete
2009	Chum	Complete
2010	Chum	Processing
2011	Chum	Processing
2012	Chum	Processing
2013	Chum	Processing
2014	Chum	Processing
2015	Chum	Complete
2016	Chum	Not started

References

AFSC (Alaska Fisheries Science Center). 2014. 2015 Observer sampling manual. Fisheries and Monitoring and Analysis Division, North Pacific Groundfish Observer Program. AFSC, 7600 Sand Point Way N.E., Seattle, Washington, 98115. http://www.afsc.noaa.gov/FMA/Manual_pages/MANUAL_pdfs/manual2015.pdf, accessed 3/27/2017.

Bilton, H. T., and Ludwig, S. A. M. 1966. Times of annulus formation on scales of sockeye, pink, and chum salmon in the Gulf of Alaska. Journal of the Fisheries Board of Canada, 23(9), 1403-1410.

Helle, J. H., and Hoffman, M. S. 1995. Size decline and older age at maturity of two chum salmon (Oncorhynchus keta) stocks in western North America, 1972-92. Canadian Special Publication of Fisheries and Aquatic Sciences, 245-260.

Ianelli, J. N., and Stram, D. L. 2014. Estimating impacts of the pollock fishery bycatch on western Alaska Chinook salmon. ICES Journal of Marine Science: Journal du Conseil, fsu173.

Kondzela, C. M., J. A. Whittle, S. C. Vulstek, Hv. T. Nguyen, and J. R. Guyon. 2017. Genetic stock composition analysis of chum salmon from the prohibited species catch of the 2015 Bering Sea walleye pollock trawl fishery and Gulf of Alaska groundfish fisheries. U.S. Department of Commerce, NOAA Technical Memo. NMFS-AFSC-345, 64 p.

http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-345.pdf

LaLanne, J. J., and Safsten, G. 1969. Age Determination from Scales of Chum Salmon (Oncorhynchus keta). Journal of the Fisheries Board of Canada, 26(3), 671-681.

LaLanne, J. J. 1971. Marine growth of chum salmon. International North Pacific Fisheries Commission Bulletin 27:71-91.

Morita, K., and Fukuwaka, M. A. 2007. Why age and size at maturity have changed in Pacific salmon. Marine Ecology Progress Series, 335, 289-294.

NMFS (National Marine Fisheries Service). 2016. Catch Accounting System data. NMFS Alaska Regional Office. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Juneau. [URL not publicly available as some information is confidential.]

Ricker, W. E. 1964. Ocean growth and mortality of pink and chum salmon. Journal of the Fisheries Board of Canada, 21(5), 905-931.

Salo, E. O. (1991). Life history of chum salmon (Oncorhynchus keta).

Zador, S., and Yasumiishi, E., 2016. Ecosystem Considerations 2016: Status of the Gulf of Alaska Marine Ecosystems, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.