Pink Salmon Vessel Calibration Coefficient Discussion

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1 Objective

To determine the vessel calibration coefficient to calculate the corresponding index of juvenile abundance for the 2021 SEAK pink salmon forecast models.

2 Background

Excerpted from Wertheimer et al. 2010:

"From 1997 to 2007, SECM used the NOAA ship *John N. Cobb* to accrue an 11 year time series of catches with a Nordic 264 rope trawl fished at the surface... (Orsi et al. 2000, 2008)... In 2007, in anticipation of the decommissioning of the *John N. Cobb*, the *Medeia* and the *John N. Cobb* fished synoptically for 28 pairs of trawl hauls to develop calibration factors in the event of differential catch rates between the two vessels (Wertheimer et al. 2008). In 2008, the *Medeia* fished synoptically with the chartered research vessel *Steller* to determine relative fishing efficiency so that *Steller* catches could then be compared and calibrated to the SECM data series from the *John N. Cobb* (Wertheimer et al. 2009). In 2009, the commercial trawler *Chellissa* was chartered to fish the SECM transects in the northern and southern regions of Southeast Alaska. The *Medeia* was again fished synoptically in the northern region transects to determine relative fishing efficiency (Table 1)."

For the 2021 SEAK pink salmon forecast, there was a discussion as to which vessel calibration coefficient to use going forward. Using the four potential vessel calibration types (pink_cal_mixspecies, pink_cal_mixpool, pink_cal_species, pink_cal_pool; Table 1), the corresponding index of juvenile

abundance was slightly different (i.e., CPUE; standardized pink salmon catch based on a 20 minute trawl set by year; Table 2). To calculate the index of juvenile abundance by calibration type, the log-transformed pink salmon catch (standardized to an effort of a 20 minute trawl set), by haul, is multiplied by a vessel calibration coefficient (Table 1). Then, this value is averaged by month and year; whichever month had the highest average catches in a given year is then used as the juvenile abundance index for that particular year (Table 2). This index of juvenile abundance is then used as the variable 'CPUE' in the 2021 SEAK pink salmon forecast models.

Table 1: Vessel calibration coefficients (inverse of the fishing power coefficients in Table 3) used to convert vessel-specific catches to *Cobb* units.

Vessel	pink_cal_mixspecies	pink_cal_mixpool	pink_cal_species	pink_cal_pool
Cobb	1.00	1.00	1.00	1.00
Chellissa	0.66	0.66	0.70	0.74
NW Explorer	0.66	0.66	0.70	0.74
Steller	1.04	0.95	1.04	0.95
Medeia	0.88	0.84	0.88	0.84

Table 2: The datasets for the variable CPUE (index of juvenile pink salmon abundance based on log-transformed catches that are standardized to an effort of a 20 minute trawl set) using different vessel calibration coefficients.

year	pink_cal_mixspecies	pink_cal_mixpool	pink_cal_species	pink_cal_pool
1997	2.477744	2.477744	2.4777444	2.4777444
1998	5.622380	5.622380	5.6223800	5.6223800
1999	1.597723	1.597723	1.5977233	1.5977233
2000	3.729985	3.729985	3.7299847	3.7299847
2001	2.868826	2.868826	2.8688260	2.8688260
2002	2.784664	2.784664	2.7846641	2.7846641
2003	3.077820	3.077820	3.0778204	3.0778204
2004	3.899407	3.899407	3.8994067	3.8994067
2005	2.040345	2.040345	2.0403454	2.0403454
2006	2.572781	2.572781	2.5727807	2.5727807
2007	1.167639	1.167639	1.1676386	1.1676386
2008	2.555111	2.323473	2.5551107	2.3234731
2009	2.094192	2.094192	2.2053878	2.3330031
2010	3.687782	3.687782	3.8835930	4.1083181
2011	1.305918	1.305918	1.3752584	1.4548381
2012	3.161036	3.161036	3.3288788	3.5215052
2013	1.923429	1.923429	2.0255583	2.1427677
2014	3.426619	3.426619	3.6085629	3.8173733
2015	2.201588	2.201588	2.3184867	2.4526465
2016	3.905705	3.905705	4.1130877	4.3510925
2017	0.310436	0.310436	0.3269194	0.3458366
2018	1.233765	1.171558	1.2337651	1.1715584
2019	1.202606	1.141971	1.2026065	1.1419709
2020	2.261529	2.147502	2.2615289	2.1475023
average	2.546210	2.526689	2.5949191	2.6313000

3 Vessel Calibration Coefficients

The four types of vessel calibration coefficients are defined as:

- pink_cal_mixspecies is a mixture of species-specific (*Chellisa:Medeia*) and pooled-species (*Medeia:Cobb*) coefficients for the *Chellissa* and the *N/W Explorer* (i.e., 1/(1.19 x 1.27) where 1.19 is the pooled-species fishing power coefficient from the *Medeia:Cobb* and 1.27 is the species-specific fishing power coefficient from the *Chellisa:Medeia*; see Table 3), and species-specific coefficients for the *Steller* and the *Medeia*. This ends up with a time series that is based on coefficients that vary with species, but are partially derived from a mixture of species-specific and pooled-species coefficients.

- pink_cal_mixpool is a mixture of species-specific (*Chellissa:Medeia*) and pooled-species (*Medeia:Cobb*) coefficients for the *Chellissa* and the *N/W Explorer* (i.e., 1/(1.19 x 1.27)), and pooled-species coefficients for the *Steller* and the *Medeia*.

- pink_cal_species uses species-specific coefficients for the *Chellisa*, *Steller*, and *Medeia*, and the *N/W Explorer* uses a species-specific coefficient from the *Chellisa*.

- pink_cal_pool uses pooled-species coefficients for the *Chellisa*, *Steller*, and *Medeia*, and the *N/W Explorer* uses a pooled-species coefficient from the *Chellisa*.

The term species-specific refers to a pink salmon specific vessel calibration coefficient, and the term pooled-species refers to a pink, chum, sockeye, and coho (i.e., catch of all species summed) vessel calibration coefficient.

The four vessel calibration coefficients (Table 1) are calculated as the inverse of the fishing power coefficients (Table 3).

Table 3: Estimated fishing power coefficients for juvenile salmon catches by the different vessels used during the Southeast Alaska Coastal Monitoring survey (Wertheimer et al. 2008, 2009, and 2010). One of the primary trawl vessels, F/V *Northwest Explorer*, has not been calibrated and it is assumed to have the same fishing power as the *Chellissa*.

Species	Medeia:Cobb	Chellissa:Cobb	Steller:Cobb	Medeia:Steller	Chellissa:Medeia	mixed Chellissa:Cobb
Pink	1.13	1.44	0.96	1.18	1.27	1.51
Chum	1.21	1.44	1.16	1.04	1.19	1.42
Sockeye	1.19	1.18	1.05	1.13	0.99	1.18
Coho	1.26	1.32	0.85	1.48	1.05	1.25
Total Salmon	1.19	1.36	1.05	1.13	1.14	1.36

Table 4 (below) shows how the vessel calibration coefficients (in Table 1) are calculated by taking the inverse of the fishing power coefficients in Table 3.

Table 4: Specific calculations for determining the vessel calibration coefficients from the fishing power coefficients.

Vessel	pink_cal_mixspecies	pink_cal_mixpool	pink_cal_species	pink_cal_pool
Cobb	1.00	1.00	1.00	1.00
Chellissa	1/1.51	1/1.51	1/1.44	1/1.36
NW Explorer	1/1.51	1/1.51	1/1.44	1/1.36

Vessel	pink_cal_mixspecies	pink_cal_mixpool	pink_cal_species	pink_cal_pool
Steller	1/0.96	1/1.05	1/0.96	1/1.05
Medeia	1/1.13	1/1.19	1/1.13	1/1.19

4 Analysis

Performance metrics (Akaike Information Criterion corrected for small sample sizes; AICc values; Burnham and Anderson 2004; mean and median absolute percentage error (MAPE, MEAPE); mean absolute scaled error (MASE) (Hyndman and Kohler 2006)) were used to evaluate forecast accuracy of four alternative vessel calibration coefficients (Table 1) using the same model. For all of these metrics, the smallest value is the preferred model. The model used for the comparison of the vessel calibration coefficients was:

$$E(y) = \alpha + \beta_1 X_1 + \beta_2 X_2,$$

where X_1 is CPUE (i.e., juvenile pink salmon abundance index based on one of the four different vessel calibration coefficients; Table 2), and X_2 is the average temperature in Icy Strait in May, June, and July at the eight SECM stations in Icy Strait. CPUE data are log-transformed. Statistical analyses were performed with the R Project for Statistical computing version 3.6.3 (R Core Team 2020).

Table 5: Comparison of the performance metrics for a model based on calculating a time-series of juvenile pink salmon abundance using different vessel calibration coefficients.

model	AdjR2	AICc	MAPE	MEAPE	MASE	forecast	lower_80	upper_80	index
CPUE+ISTI	0.811	16	0.079	0.061	0.262	31.3	20.9	46.9	pink_cal_mixspecies
CPUE+ISTI	0.820	15	0.077	0.060	0.256	29.8	20.1	44.1	pink_cal_mixpool
CPUE+ISTI	0.820	15	0.077	0.070	0.257	30.6	20.6	45.3	pink_cal_species
CPUE+ISTI	0.830	14	0.074	0.060	0.249	28.5	19.4	41.7	pink_cal_pool

5 Conclusion

Based on performance metrics, the pooled-species vessel calibration coefficient was preferred (Table 5). Therefore, the index of juvenile abundance for the 2021 SEAK pink salmon forecast will be based on the pooled-species vessel calibration coefficient.

6 References

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