Petrale Sole

Stock Assessment Review (STAR) Panel Report

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Overview

A draft assessment of the coastwide petrale sole (*Eopsetta jordani*) off the U.S. west coast using data through 2012 was reviewed by the STAR panel during May 13-17, 2013. This assessment used the Stock Synthesis platform version 3.24o and is structured as an annual model with the start of the fishing year on November 1 and ending on October 31. Fisheries are grouped into four fleets: North Winter, North Summer, South Winter, and South Summer. The North fleets include Washington and Oregon fisheries while the South encompasses California fisheries. Winter season is from November to February and summer season, from March to October. The draft assessment incorporated a variety of data sources into the candidate base model. Data from commercial trawl fisheries included landings, discards, and age- and length-composition data, and standardized winter fishery CPUE indices (1987-2009). Fisheries-independent information includes biological samples and abundance indices collected by the National Marine Fisheries Service (NMFS) early (1980, 1983, 1986, 1989, and 1992) and late (1995, 1998, 2001, and 2004) triennial bottom trawl survey and the Northwest Fisheries Science Center (NWFSC) trawl survey (2003–2012).

Petrale sole was last assessed in 2011. Significant differences in data sources and model configuration between the 2011 and current assessment include:

1. Landings summarized by port of landing rather than area of catch.
2. Combining the Washington and Oregon fleets into a single northern fleet.
3. Use of the Oregon historical landings reconstruction.
4. Addition of data for 2011 and 2012.
5. Revised commercial CPUE and survey indices

Multiple model runs were conducted and reviewed to examine model assumptions and structure, and to identify uncertainties in the assessment. The main focus of the discussion was to better understand the fishery CPUE standardization and survey GLMM analyses. There were no major changes made to the input data or base model structure. Both the STAT and the panel agreed that minor changes made during the review improved the model.

Stock Status – the terminal year depletion rate (SSB_{2013}/SSB_0) from the final base model is 22.3% of unfished biomass, slightly below the management target of 25%. Natural mortality is used to bracket the uncertainty in the states of nature depicted in the decision table.

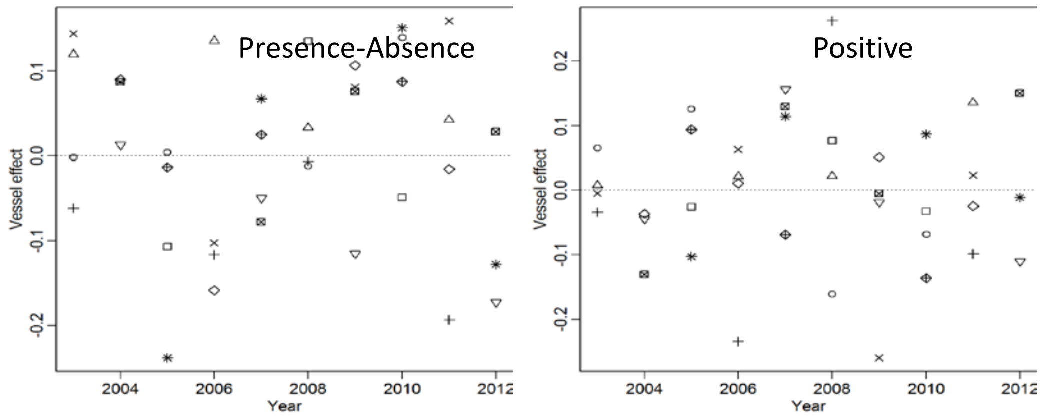
The STAR panel concluded that the petrale sole assessment was based on the best available data and that this new assessment constitutes the best available information for the management of petrale sole off the U.S. west coast. The STAR panel thanks the STAT team for their willingness to respond to panel requests and their dedication to addressing difficult assessment problems.

Discussion and Additional Analyses Requested by the STAR Panel

1. For the survey GLMM, plot random vessel-year effects versus year.

Rationale: Plots could reveal potential confounding between random vessel effects and actual trends in the stock over time

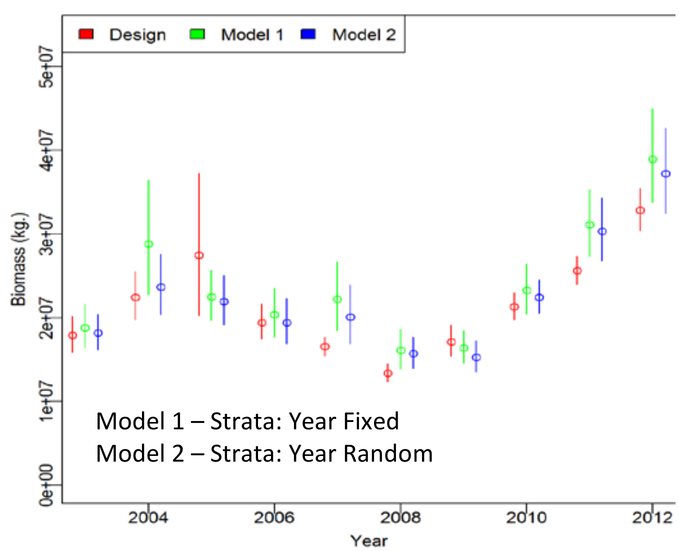
Results: Vessel effects were small and varied without trend over time which does not indicate a confounding problem.



2. Compare NWFSC indices and error bars when year-strata effects are random or fixed, and also compare with design-based indices.

Rationale: Error bars have implications on the weighting of indices in SS3.

Results: All models show similar trends.



3. Report what depth selection was used by fishery CPUE index.

Rationale: Clarity.

Results: The filters were depth ≤ 75 fm in the summer and 150 fm ≤ depth ≤ 400 fm in the winter.

4. Look at von Bertalanffy residuals by year.

Rationale: Examine for evidence of time variation in growth rates in the NWFSC survey data.

Results: Neither series of plots showed patterns indicating time-varying growth.

5. Set the NWFSC extra variance parameter to zero.

Rationale: The extra variance is to account for process error. The estimate from the draft base model was less than zero; and it is an improvement to either set this parameter to zero or set the prior with a lower bound of zero.

Results: Little effects on model outputs. The extra variance parameter will be set to zero in the final base model.

6. Provide a time-series plot of discarded catch by fleet.

Rationale: Discards are estimated in the model. The plot is useful to understand model output.

Results: Graphics showed the discards time series vs. a total catch time series. Discards were an order of magnitude less than total catches.

7. Check for convergence the sensitivity run removes NWFSC 2012 age composition data.

Rationale: There is a significant difference in B_0 after the NWFSC 2012 age composition data were removed. Checking for convergence will validate results from this sensitivity run.

Results: The version in the draft document was with ***all*** NWFSC survey age data removed. The correct outputs from the model run with only the 2012 age data removed showed low sensitivity to this change.

8. Report statistics on jitter analyses for the new base model.

Rationale: Validate results.

Results: A jitter of 0.01 for the base model was run 100 times. 75% of the jitter runs ended at the base case, 17.5% ended at local minima, and 7.5% of jitter runs crashed. This was a satisfactory jitter test although a more aggressive jitter could be done.

9. Provide M and h sensitivity analyses, based on range from hessian-based intervals.

Rationale: Improved understanding of potential axes of uncertainty for the decision table.

Results: The runs showed confounding of M and h, which is expected. However, there may be a concern with estimating both parameters with informative priors. A wider range of M and h should be considered that are ~1.2 negative log likelihood (NLL) points away from the base.

10. Provide a sensitivity run with no commercial CPUE.

Rationale: There is considerable uncertainty in how to standardize commercial catch rates.

Results: Removing the index fits the age composition slightly worse and the length composition slightly better. There are also small changes to M and h with this run. Growth parameters do not change. The population status in 2013 shown as SSB depletion changed from 0.289 to 0.222. It is noted that the "survey" component of the objective function is not comparable between these alternate models because it includes all indices of abundance, and CPUE data have been removed.

Label	Base	NoCommCPUE
TOTAL_like	1459.8	1502.2
Survey_like	-74.9	-22.2
Discard_like	-142.8	-143.2
Mean_body_wt_like	-75.8	-75.7
Length_comp_like	824.4	814.4
Age_comp_like	947.8	950.2
SR_BH_steep	0.84	0.85
NatM_p_1_Fem_GP_1	0.16	0.15
L_at_Amin_Fem_GP_1	15.8	15.9
L_at_Amax_Fem_GP_1	54.3	54.3
VonBert_K_Fem_GP_1	0.13	0.13
CV_young_Fem_GP_1	0.18	0.18
CV_old_Fem_GP_1	0.03	0.03
NatM_p_1_Mal_GP_1	0.18	0.17
L_at_Amin_Mal_GP_1	16.3	16.3
L_at_Amax_Mal_GP_1	42.5	42.5
VonBert_K_Mal_GP_1	0.21	0.21
CV_young_Mal_GP_1	0.13	0.13
CV_old_Mal_GP_1	0.05	0.05

11. If time permits, provide an explanation of what component(s) produced the increase in the total likelihood profile for R_0.

Rationale: Validate results.

Results: The priors' NLLs were missing in the original plot which was causing the total NLL curve to shift. A revised figure was presented.

12. Increase input standard error for commercial log CPUE. Make the standard error about the same as the standard error for the NWFSC survey log index. Do an SS3 run with extra standard error estimated, but with a lower bound of zero on the extra standard error.

Rationale: Although the extra variance parameter for each CPUE index in the draft base model was estimated, the panel wanted to confirm that input standard errors (SEs) were not influencing final model weighting. Generally, the input standard errors for the commercial CPUE seemed too small given the structural uncertainty associated with the CPUE standardization and method of bootstrapping performed. It seemed reasonable that fishery CPUE should be considered, *a priori*, no more precise than the NWFSC survey.

Results: The petrale STAT provided two runs in response. The first run added the average SE from the NWFSC survey and estimated the added SD. This run was essentially the same as the base model in the draft due to a value of zero estimated for the added SD. Therefore, the STAT did a second run with the maximum SD from the NWFSC survey added to the bootstrapped CPUE SDs and turned off the estimation of the added SD for the commercial CPUEs. Adding the maximum SE to the CPUE index degraded the fit to the index itself, but improved the fit to the length comps. All the other data fits were no different. This sensitivity reduced depletion to 0.275, and the run without extra SE reduced depletion further to 0.248. The bottom line is the addition of extra SE to commercial CPUE did not affect model results much.

Label	Base	NoComm-CPUE	IncCommCPUESd-NWFSCMean-EstExtraSD	IncCommCPUE-NWFSCSurvMax-NoEstExtraSD
TOTAL_like	1459.81		1459.45	1463.58
Survey_like	-74.88		-72.79	-63.91
Discard_like	-142.80	-143.21	-142.89	-143.06
Mean_body_wt_like	-75.83	-75.74	-75.82	-75.79
Length_comp_like	824.41	814.41	822.30	817.80
Age_comp_like	947.77	950.15	948.06	948.89
Parm_priors_like	0.18	0.36	0.21	0.30
SR_BH_steep	0.84	0.85	0.84	0.85
NatM_p_1_Fem_GP_1	0.16	0.15	0.16	0.16
L_at_Amin_Fem_GP_1	15.77	15.88	15.78	15.82
L_at_Amax_Fem_GP_1	54.30	54.26	54.30	54.29
VonBert_K_Fem_GP_1	0.13	0.13	0.13	0.13
CV_young_Fem_GP_1	0.18	0.18	0.18	0.18
CV_old_Fem_GP_1	0.03	0.03	0.03	0.03
NatM_p_1_Mal_GP_1	0.18	0.17	0.18	0.17
L_at_Amin_Mal_GP_1	16.30	16.34	16.30	16.32
L_at_Amax_Mal_GP_1	42.54	42.55	42.54	42.54
VonBert_K_Mal_GP_1	0.21	0.21	0.21	0.21
CV_young_Mal_GP_1	0.13	0.13	0.13	0.13
CV_old_Mal_GP_1	0.05	0.05	0.05	0.05

13. Change CPUE catchability model to include an unconstrained random walk in *q* since trip limits were implemented (since 2006).

Rationale: Trip limits may affect catchability. This is an attempt to apply the same logic/treatment of winter CPUE as summer CPUE. Data informing commercial CPUE indices were filtered to minimize the effect of management actions on the index. Winter indices were developed to include only trawl trips during January-February in waters seaward of 150 fm that were identified as petrale fishing grounds via spatial analysis. While there was agreement that management actions affecting the winter fishery were minimal in comparison to those impacting the summer fishery, two management actions were discussed during the STAR panel that were unable to be considered prior to the STAR panel. First, trip limits for petrale sole were specified for the years 2006-2009 (Table 1). The STAT was asked to explore the effect of these trip limits on the index by allowing time-varying catchability for the years 2006-2009.

Table 1. January-February petrale sole trip limits through 2009 for large footrope gear.

Prior to 2006	2006	2007	2008	2009
Unlimited	30,000 lb/mo.	50,000 lbs/2 mo.	40,000 lbs/2 mo.	25,000 lbs/2 mo.

Results: Time-varying unconstrained *q* unsurprisingly fits the CPUE index nearly perfectly, but with little improvement in the likelihood (overfitting) and without improving fits to the other data. Mr. Leipzig, the GAP representative, remarked this was not surprising since trip limits >10,000 lbs/mo. did not seem to affect the fishery; vessels rarely landed more than 10,000 lbs of petrale per delivery.

In addition to trip limits, the vessel buyback program was also discussed during the panel, a factor that had not been previously considered. The STAT therefore did an additional run with a *q* time block in 2006-2009 to address these potential effects (i.e., effort reduction) on CPUE. The Block-*q* run improved overall fits to the interim new base run with input commercial CPUE SEs equal to the bootstrap estimates plus the maximum from the NWFSC survey (total NLL reduced from 1463.58 to 1458.81). The fits improved for length compositions (NLL reduced from 817.8 to 815.0) and the survey index (NLL reduced from -63.91 to -66.68).

After the initial sensitivity runs were conducted, it was brought to the panel's attention that the time block should have been two years earlier, since the buyback was implemented in 2004. The time block for *q* was therefore moved back 2 years to the beginning of the buyback program in 2004. This improved the total NLLs by 4 points relative to the first Block-*q* model. This is the new proposed base model. The depletion is essentially identical to the Block-*q* 2006 model, which is below B_{MSY} (~22.3%).

The magnitude of the survey *q*'s generated much discussion in the 2009 and 2011 assessments of this stock. Values obtained for flatfish stocks off the east coast of Canada are presented in Appendix A. The panel concludes that, although the range provided in Appendix A is large, the value of *q* for petrale sole (3.4) is plausible.

14. Axis of uncertainty should include a range of M values derived from the likelihood profile. Make sure the range of M is wide enough to capture 1.2 NLL units. Verify how this range compares to the interval based on asymptotic normal approximation with Hessian-based standard error.

Rationale: There was a concern that the asymptotic interval was too narrow.

Results: See request 16.

15. Profile full suite of output for new base case.

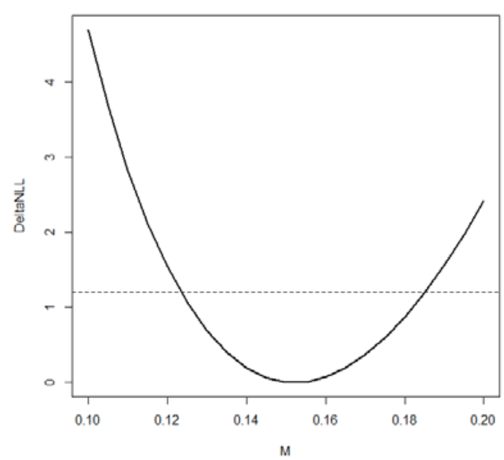
Rationale: Validate new base model outputs.

Results: Various diagnostic plots were presented. The new base model seems to perform well.

16. Rerun likelihood profile for M and update low- and high-M sensitivity runs.

Rationale: Runs requested to bracket the alternative states of nature.

Results: Based on the change of 1.2 NLL units in base model profile, low and high M are set at 0.12 and 0.19, respectively.



17. Projections based on models in request 16 using the catch stream assuming the default ABC buffer (ABC = OFL - 4.4%) and then application of the 25-5 ACL control rule.

Rationale: For constructing the decision table.

Results: The results appeared to show expected behavior and contrast among the states of nature, consistent with the sensitivity analyses previously presented. The panel concluded this decision table structure would be appropriate for management use.

			M low (0.12)		Base		M high (0.19)	
Rule	Year	Catch	SB	Depl	SB	Depl	SB	Depl
ABC 25:5	2015	2827.7	9095.5	0.244	9461.5	0.292	10016.9	0.352
	2016	2922.3	9519.4	0.255	9739.3	0.300	10136.5	0.357
	2017	2894.7	9530.6	0.256	9591.6	0.296	9818.8	0.346
	2018	2819.7	9393.1	0.252	9330.3	0.288	9427.3	0.332
	2019	2750.5	9254.6	0.248	9122.0	0.281	9145.0	0.322
	2020	2708.3	9158.9	0.246	9006.2	0.278	9004.5	0.317
	2021	2692.0	9103.2	0.244	8965.6	0.276	8970.6	0.316
	2022	2691.9	9072.2	0.243	8968.8	0.277	8993.5	0.316
	2023	2698.5	9051.6	0.243	8989.3	0.277	9032.8	0.318
	2024	2705.9	9033.1	0.242	9011.2	0.278	9065.7	0.319

Description of Base Model and Alternative Models Used to Bracket Uncertainty

The final base model assumes a U.S. coastwide stock and uses catch data split by sex, region (north and south), and winter and summer seasons. The catch history starts in 1876. The model estimates separate selectivity curves for each of the commercial fleets (region and season) over several periods with time blocks. The NWFSC survey and the Triennial survey data are used to develop indices of abundance. The model also fits to standardized CPUE indices from winter-north fleets, with an input SE equal to the values estimated via bootstrap of the data plus the maximum input value for the NWFSC shelf-slope survey, and separate catchability parameters for 1987-2003, and 2004-2009. Recruitment dynamics are assumed to follow the Beverton-Holt stock-recruit function. Length compositions and conditional age-at-length data from the surveys are fit, while length and age compositions (appropriately weighted) are fit for the commercial fleets. Discards are estimated. Updated priors are used for natural mortality and steepness.

Summary:
Start year of the model = 1876; one area; two genders; four fishery fleets (north and south, summer and winter, respectively); and discard estimated within the model.

Biology:
Natural mortality (M) for each sex is estimated separately in the model, assuming lognormal prior distributions based on Hamel’s method.
Von Bertalanffy growth, all growth parameters are estimated within the model for females and males separately;
Beverton-Holt stock-recruitment model, steepness (*h*) and recruitment deviations are estimated.

Selectivity:
Asymptotic length-based selectivity for fisheries and surveys.

Abundance indices:
AFSC triennial trawl survey (1980-2004), divided into two time series stratified in 1995;
NWFSC shelf-slope bottom trawl survey (2003-2012);

Winter north commercial CPUE, divided into two time series in 2004.

Length frequencies:
Trawl fisheries;
AFSC triennial trawl survey; and
NWFSC shelf-slope bottom trawl survey.

Age frequencies:
Trawl fisheries; and
NWFSC shelf-slope bottom trawl survey.

The base model estimate for 2013 spawning depletion (SSB_{2013}/SSB_0) is 22.3%. Uncertainty about the state of nature is bracketed by the estimated natural mortality using the likelihood profile. The base model estimate of M (0.15) was varied by 1.2 unit NLL resulting in values of 0.12 and 0.19 for the low and high states of nature, respectively in the decision table.

Comments on the Technical Merits of the Assessment

The petrale sole STAT team was well-prepared, communicated the draft analyses effectively, and provided a thorough response to all requests. The STAR panel discussion and requests focused primarily on better understanding the details of the survey GLMM and fishery CPUE analyses, and on the axis of uncertainty for the decision table. The changes made to the base model during the review were either minor (improving the treatment of the extra SD parameter for the survey) or based on new information/interpretation made available during the panel (treatment of the CPUE series). Both the STAT and STAR panel members agreed that these changes improved the assessment. The panel endorsed the base case model as the best available science for use in determining stock status and management decisions and the decision table results for describing the uncertainty about the base case.

Areas of Disagreement

There were no major areas of disagreement between the STAT and the STAR Panel.

Unsolved Problems and Major Uncertainties

Problems unresolved at the end of the meeting form the basis for some of the research recommendations below. They include uncertainty in catch (historical catch and transboundary issues), biological information (outdated and limited geo-coverage of maturity data), and statistical analyses for abundance indices.

Concerns Raised by the GMT and GAP Advisors During the Meeting

For those sensitivity runs that included no winter commercial CPUE index, the GMT and GAP advisors noted that there is important information in those data that may not be captured in the summer survey. They provided information on regulatory changes and possible effects of the buyback. The latter helped the STAT improve the fits to those data.

Prioritized Research Recommendations

1. The states of California and Oregon have completed comprehensive historical catch reconstructions. Washington historical data are not yet available. Completion of Washington historical catch reconstruction would provide a better catch series.

2. Update both the maturity and fecundity relationships using samples with wider geographic coverage to include California, and from more recent years for petrale sole would be beneficial.

3. Studies on stock structure and movement of petrale sole indicating transboundary movement of petrale sole between U.S. and Canadian waters, particularly with regard to the winter-summer spawning migration. It will be informative to include a time-series plot of fishery catch from Canadian waters in future assessment.

4. Increased collection of commercial fishery age data as well as re-aging any available historical samples from California would help reduce uncertainty. While some recent age data were made available from California, sample sizes could be increased and this data collection needs to continue into the future. Without good age data, the ability to estimate year-class strength and the extent of variation in recruitment is compromised.

5. Where possible, historical otolith samples aged using a combination of surface and break-and-burn methods should be re-aged using the break-and-burn method. Early surface read otoliths should also be re-aged using the break and burn method. Historical otoliths aged with a standard method will allow the further evaluation of the potential impacts of consistent under-aging using surface read methods, changes in selectivity during early periods without any composition information, and potential changes in growth.

6. The effect of the implementation of the IFQ (catch shares) program that began during 2011 on fleet behavior, including impacts on discards, fishery selectivity, and fishing locations, would benefit from further study.

7. The extent of spatial variability on productivity processes such as growth, recruitment, and maturity is currently unknown and would benefit from further research.

8. The Panel appreciated the delta-GLMM approach to derive an index of stock size from commercial CPUE data. However, there may still be factors other than stock size that affect time-trends in the standardized CPUE indices. The panel recommends:
    a. Investigate using effort as an offset in the model. That is, rather than modeling catch/effort = effects, use catch = effort*effects. When a log-link is used then log(effort) can be included as an additive offset, and most GLMM packages include this option. The advantage of this approach is that it is easy to investigate if catch is proportional to effort or not. For example, it may be that CPUE can be higher when effort is low than when effort is high.
    b. Include further consideration of the impacts of trip limits on CPUE. Such limits were gradually introduced since 2006 in the winter fisheries and this may impact

CPUE. This consideration should involve consultations with fleet members to understand how their fishing behavior was affected by trip limits.

Given that this CPUE series will not be extended and, following the changes made for the final base case model, the results showed little sensitivity to its treatment, the STAR panel concluded that additional work on the CPUE standardization should be considered low priority for future petrale assessments.

9. General recommendations for all species:
   a. Recommend that STAT teams present a sensitivity analysis (Tables and Figures) in the draft document for any axis of uncertainty that is likely to be considered for the decision table. This would facilitate efficient discussions during the meeting.

   b. It would be helpful to routinely include a time series of species-specific Canadian (B.C.) landings for comparison with U.S. landings and trends.

   c. The specific treatment and results of model tuning procedures should be reported in the document including all input/output sample sizes, effective sample sizes, sigmas, RMSEs (including recruitment deviations), that are applicable.

   d. For survey GLMM analyses, the STAT teams need to report a standard summary of the raw data, and fitting of the model including both results and diagnostics. Additional research should attempt to identify (and perhaps simulation test) a method for model selection including the error distribution, the treatment of random vs. fixed effects and the inclusion of ECE mixture distributions that can be reliably applied across all species.

   e. Maturity schedules are often largely determined by size and not age. An additional option is needed in Stock Synthesis to allow the modeling of maturity-at-length with an asymptote < 1.0 to reflect atresia or skip-spawning.

   f. General recommendation to identify where and when E.J. Dick's fecundity relationships are better than existing data for a given species.

Appendix A

Some Recent Estimates of *q* for Flatfish Stocks off the East Coast of Canada

The estimated catchability parameters (*q*'s) for survey indices of total stock size (aka swept-area *q*'s) may indicate model misspecification if the estimates fall outside of a reasonable range. That is, if the q's are too low this may indicate the assessment model has overestimated stock size overall, and vice-versa if the q's are too high this may indicate underestimation.

Estimates of q's from recent assessments for some flatfish stocks off the east coast of Canada are provided in Table 2 to help address the feasibility of the petrale sole q estimates. These east coast assessments use many surveys and only the fully selected *q*'s for contemporary surveys are provided. Some *q*'s are derived from age-aggregated production models and are not directly comparable to fully selected *q*'s from age-based models.

Note that catchability will depend on whether the survey covers the entire range of the stock and other factors such as diel variability, age-pattern in *q*, gear type and other configurations that may influence herding, etc. These factors should be considered when comparing *q*'s from different surveys and stocks.

Table 2. Estimates of survey swept-area catchability parameters (*q*'s) from recent assessments for some flatfish stocks off the east coast of Canada.

Stock	**Area**	**Source**	**Model-type**	**Survey**	***q* estimate**
American plaice (*Hippoglossoides platessoides)*	Grand Banks (NAFO Divs. 3LNO)	Rideout et al. (2011)	Age-based ADAPT	Spring	6.16
				Fall	9.51
	South coast of NL (NAFO SubDiv. 3Ps)	Morgan, Dwyer, and Shelton (2013)	Bayesian production model	Spring	2.2
Yellowtail Flounder (*Limanda ferruginea*)	Grand Banks (NAFO Divs. 3LNO)	Parsons et al. (2011)	ASPIC production model	Spring	3.23
				Fall	3.31
				Spanish	1.29
American plaice (*Hippoglossoides platessoides)*	Southern Gulf of St. Lawrence (NAFO Div. 4T)	Morin and LeBlanc (2012)	Age-based* ADAPT	Summer	0.912

*A model with relatively high natural mortality (M) parameters

References

Morgan, M.J., Dwyer, K.S., and Shelton, P.A. 2013. Reference points and assessment update for American Plaice (*Hippoglossoides platessoides*) in NAFO SA2 + Div. 3K and Subdiv. 3Ps. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/152. iii + 64 p.

Morin, R., et LeBlanc, S.G. 2012. Évaluation de la plie canadienne (*Hippogolossoides platessoides*) du sud du golfe du Saint-Laurent (division OPANO 4T). Secr. can. de consult. sci. du MPO. Doc. de rech. 2012/099. iv + 35 p.

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Rideout, R. M., Morgan, M. J., Parsons, D. M., Brodie, W. B., Healey, B. P., Power, D., & Dwyer, K. S. Serial No. N5917 NAFO SC SCR 11/032 SCIENTIFIC COUNCIL MEETING– JUNE 2011.