GROUNDFISH MANAGEMENT TEAM REPORT ON THE CLASSIFICATION OF STOCKS IN THE GROUNDFISH FISHERY MANAGEMENT PLAN

This report follows the Groundfish Management Team's (GMT) suggested approach for evaluating the classification of stocks in the Fishery Management Plan (FMP) (i.e., the "in the fishery" issue). The approach described here is the same as recommended by the GMT in past biennial cycles, which the GMT most comprehensively described in September 2011.[1]

This year the FMP classification issue has been presented to the Council as part of the larger evaluation of the stock complexes. And much of the information presented there has been included here. In this report, we pull that information out and present it in a different context so that the Council may give the "in the fishery" issue more focused consideration.

Following the structure of the National Standard 1 Guidelines, the "in the fishery" classification is a threshold question in which the Council considers which species are in need of conservation and management with annual catch limits (ACLs). The organization of the stock complexes is a separate question about how to best manage and account for the catch of stocks that are determined to have such a need.

This report intends to provide the basic data on catch and stock vulnerability that the GMT has suggested the Council look to when recommending how to classify stocks in the FMP. No recommendations are made on how specific stocks should be classified. The team will provide further analysis and may offer specific recommendations and alternatives in a supplemental statement after opportunity for full team discussion and public input at the September meeting.

General Overview of the "In the Fishery" Classification

The Council has undertaken the "in the fishery" evaluation with its other three FMPs and did so partially with Amendment 23 to the Groundfish FMP. We therefore only briefly remind the Council of the main factors for consideration. The National Standard 1 Guidelines (the "Guidelines") recommendations of the classification of stocks can be found at 50 C.F.R. § 600.310(d).[2] In brief, the Guidelines recommend that the Council consider which stocks encountered during fishing activities covered by the FMP should be classified as "in the fishery," as Ecosystem Component (EC) species, or left out of the FMP altogether.

---

[1] September 2011 Briefing Book, Agenda Item G.5.a, Attachment 5: *Report of GMT Subgroup and Council Staff on Analysis of Stock Vulnerability and Configuration of Stock Complexes.*

[2] The Guidelines can also be found with explanation of the rationale behind them in the notice announcing the final publication of the last revisions to the Guidelines: 74 Federal Register 3178 (Friday, January 16, 2009).

As a reminder, the National Marine Fisheries Service (NMFS) suggested the "in the fishery" classification framework in response to the question about which stocks encountered in a fishery needed status determination criteria (SDC) and ACLs. One view put forth was that every stock encountered should have an ACL. When crafting the final Guidelines, NMFS rejected that view and instead recommended that ACLs be focused on stocks where the risk of overfishing or overfished status is of concern. Following this line of reasoning, the Guidelines recommend that the FMP's "in the fishery" classification be used for: (1) target stocks; and, (2) non-target stocks that are retained for personal use or commercial sale generally or more than just occasionally.

The Groundfish FMP's target stocks are well-known, as are the non-target stocks that are retained and landed. So the main stocks for attention here are those non-target stocks that are mostly discarded at sea and those stocks in the FMP now that are caught rarely if at all.

The team has discussed how well the degree to which a non-target stock is retained might serve as an indicator of the need for conservation and management. Some have questioned the usefulness of focusing on the difference between "occasional" and "general" retention of non-target stocks and think that the degree of discard should be at most a secondary factor in the Council's consideration. The line between "occasionally" and "generally" could be tough to draw. And more importantly, that line might not be the right one to focus on: a non-target stock that most everyone discards in a multispecies fishery could be driven to low abundance if it is frequently caught with valuable target stocks.[3]

A more direct approach to evaluating non-target stocks is suggested by Section (d)(5) of the Guidelines. This section lists criteria for which non-target stocks could be designated as EC species. The two key factors are that EC species should:

- "[n]ot be determined to be subject to overfishing, approaching overfished, or overfished;" or
- "[n]ot be likely to become subject to overfishing or overfished, according to the best available information, in the absence of conservation and management measure."

The implication is that stocks that do not meet these criteria should be designated as "in the fishery."

The question to evaluate for each stock is therefore whether, in the absence of conservation and management, the stock would face a likely risk of overfishing or being reduced to overfished status. This risk can be weighed directly to the extent that stocks have assessments that determine fishing mortality and population status relative to Overfishing Limits (OFLs) and the Minimum Stock Size Threshold (MSST). The GMT's approach, described below, is intended to

[3] Spiny dogfish provides an example. People may differ on whether dogfish are retained "in general" in many fishery sectors. Some have targeted dogfish but the great majority of catch is now non-target and discarded. Despite the high discard, dogfish catch has approached the stock's OFL in recent years.

help the Council weigh the likelihood of overfishing or overfished for stocks without this information.

The General Approach

The GMT has suggested that the Council use two main indicators to compare the conservation and management need of stocks encountered by the groundfish fisheries: (1) total catch, and; (2) the vulnerability scores produced from the Productivity and Susceptibility Analysis (PSA) recommended by NMFS.[4] As just discussed, the risk of overfishing or overfished status cannot be directly evaluated for many stocks. For such stocks, catch and PSA Scores allow for a comparison and evaluation of relative need for conservation and management. The logic is that stocks facing similar levels of catch and similar PSA scores should be treated similarly as "in the fishery," as EC species, or determined to be not in need of conservation and management and left out or removed from the FMP altogether.[5]

Neither catch nor PSA scores are perfect metrics. There may be other reasons to explain where what looks like inconsistent treatment between stocks based on catch and PSA scores could be otherwise reasonable.

The Catch Dataset

Commercial catch estimates for the years 2002 to 2011 were compiled and provided to the GMT by West Coast Groundfish Observer Program (WGCOP) staff. This dataset includes catch estimates from the sectors monitored by WCGOP, the shoreside whiting sector, and those at sea sectors, tribal and non-tribal, monitored by the Alaska Fisheries Science Center's (AFSC) observer program.[6] The WCGOP monitored sectors include fisheries managed through other FMPs or the states that catch groundfish incidentally (e.g. the California Halibut fishery).

The three states also provided recreational catch estimates for ocean trips in the years, 2004-2011.[7] To use a common timeframe between the commercial and recreational data and to reflect recent conditions in the fisheries, we display catch estimates for the years 2007-2011. The recreational catch data also includes catch from trips where groundfish are caught incidentally or at least secondarily to other target stocks.

Research catch has not been added to the dataset. The NMFS Bottom Trawl Survey would be the largest source of catch for most species. However, we do not suspect adding it would change the

---

[4] *See* NMFS's website on Assessing Vulnerability (http://www.nmfs.noaa.gov/msa2007/vulnerability.htm).

[5] NMFS' letter disapproving the Council's recommendation to remove dusky rockfish and dwarf red rockfish from the FMP as part of Amendment 23 provides additional guidance: http://www.pcouncil.org/wp-content/uploads/am_16-5_and_23_dec_letter.pdf

[6] Prior to the start of the individual fishing quota (IFQ) program, WCGOP did not observe the shoreside whiting sector. It was instead a maximized retention fishery where all fish were to be landed except in limited circumstances.

[7] The year 2004 was chosen for the recreational fisheries because of the change in California's catch estimation methodology and because there is also a chance in how data is available from RecFIN pre- and post- 2004.

overall picture because research catch should occur in close proportion to what is seen in the commercial catch.

Filters Applied to the Catch Data

There are over 430 non-FMP species and species categories reported in the combined commercial and recreational datasets and not currently managed within the FMP. To narrow in on those potentially facing a risk of overfishing from the FMP's commercial and recreational sectors, we removed several stocks from consideration:

- Species managed under other FMPs (e.g. blue shark) or by the states (e.g. hagfish, California sheephead).[8]
- Species caught predominately in the nearshore and state waters. This includes the surfperches, sea basses, sea chubs, croakers, smelts, many sculpins, and a few species of skates and rays. We applied this filter based on the Council's guidance to focus on stocks found in federal waters.[9]
- Species caught by recreational fisheries likely targeting pelagic species (e.g. Pacific barracuda). These species are found in the recreational data but are mostly likely caught in trips that are not targeting groundfish.
- Invertebrates, including crustaceans and cephalopods.

The GMT can alter these filters if the team has misunderstood the Council's past guidance or if the Council sees reason to look at catches of stocks that have been filtered out. The stocks filtered out based on these criteria and that would have been otherwise displayed based on the average catch criteria discussed below are listed in Table 4 and Table 5.

After removing these species from the dataset, we cast the net broadly for the remaining stocks by reporting any stock with an average annual catch of 1 metric ton or more, rounded to the nearest ton, over the 2007-2011 time period (Table 1). For FMP stocks, we chose an overlapping range and display stocks and stock categories with an average annual catch of 150 mt and less (Table 2).

In addition to average catch, Table 1 reports the percentage of catch coming from the FMP's sectors and the percentage of the total catch that was retained in commercial and recreational fisheries over 2007 to 2011. We considered filtering out species where more than 20 percent of the catch came from non-FMP sectors that catch groundfish incidentally. The reason is that the Council is focused on the risk of overfishing from the sectors managed under the Groundfish FMP. Yet the 20 percent level was arbitrary and it turned out that there are only few species

[8] The Guidelines do make recommendations for how to consider stocks that may span FMPs and those caught in state and federal waters (*see* § 600.310(d)(7) and (e)(5)(iii) of the Guidelines).
[9] The GMT will have to consider certain species like Kelp Greenling and Cabezon, which are in the FMP now but would have been excluded on these grounds if they had not been.

where this threshold would have mattered. Instead of applying the filter we display all stocks with the average catch of at least 1 metric ton and flag those where more than 80 percent of the catch has come from non-FMP sectors.

Slender sole is one that the GMT and others had flagged in earlier reports as a candidate for inclusion in the FMP. Until now we had failed to notice that ~85 percent of the catch comes in Pink Shrimp Trawl fishery. Whether this matters or not in the weighing of the species' relative need for conservation and management should be a point of discussion for the team at the September meeting.

Many stocks in Table 1 are related species or reported as unidentified as species (i.e. "unid."). Figure 1 displays the combined catch of the species and species categories for cat sharks, eelpouts, non-FMP grenadiers, and slickheads. The Council may wish to consider such species groups together. The Guidelines provide guidance on organizing stocks together in complexes, even for stocks designated as EC Species.

The commercial and recreational datasets used here are the best available information and greatly improved over what has been available. At the same time, it should be recognized that catch cannot be monitored perfectly. With the commercial data, we are relying mostly on the discard estimates of WCGOP observers for information on the non-FMP stocks. The focus of observers is on discards. WCGOP then uses fish ticket data to account for the retained and landed catch. Because many if not all of these non-FMP species are not marketed and have not been given much management attention, landings data would not be expected to as reliable as for FMP stocks. The datasets may therefore underestimate both total catch and the percentage retained for some stocks.

To elaborate, landings may not be reported in a way that allows identification to species or even species group. For example, Washington does not require eelpouts to be reported as such but it is known that they are landed together with bottom trawl caught groundfish. And when landed, they would be reported under a miscellaneous category that, unlike the groundfish market categories, would not be sampled for later enumeration/expansion to species. Notes made on a couple recent fish tickets illustrate the issue (Figure 2). However, we would not expect the extent of any such underestimation to be large. These species are likely landed only in small amounts, mixed in with other species and too difficult to sort out at sea. In addition, we would expect that large volumes of miscellaneous fish would be noticed and noted.

The Data – PSA Scores

The Productivity and Susceptibility Analysis and its use in this FMP has been explained in several reports including a publication authored by members of the GMT (Cope et al. 2011).[10] As a brief summary, the method involves gauging the biological productivity of stocks based on a set of life history attributes that can be scored high, medium, or low based on set criteria for each attribute. The contribution of each attribute to the overall Productivity score ("P-score") can be given higher or lower weight, including zero weight, depending on the scorers' judgment about which are most relevant. For example, and as explained in earlier materials, the weights given to the attributes for rockfish were different from those used to score the sharks, skates, and rays.

A second set of attributes is used to gauge a stock's susceptibility to the fisheries, also scored as high, medium, or low based on set criteria. The attributes and criteria contributing to the Susceptibility score ("S-score") are given in the Appendix. In short, they focus on the overlap of a stock's distribution with that of fishing activities, a species' relative selectivity/catchability, and the desirability of the species in the commercial and recreational fisheries.

The PSA Vulnerability Score for a stock is then a function of its P-score and S-score. PSA vulnerability can be displayed graphically, as in Figure 3 and Figure 4. With the P-score plotted on an x-axis running in reverse from 3 to 1, and the S-score plotted along a y-axis running from 1 to 3, the Vulnerability Score is the distance from the graph's origin at x = 3, y = 1.

For this analysis, we reviewed and made a few changes to the PSA scores that we have presented to the Council in earlier cycles, in the Cope et al. (2011) paper, and in the stock complex analysis materials presented this year. These changes include:

- Revising the S-score for Longspine Thornyhead. We had previously given it the lowest possible value of 1.0. After reviewing the scores for this analysis, we decided the susceptibility attributes had not been scored consistently to other stocks. In turn, we made some revisions to the S-score for Shortspine Thornyhead.[11]
- We gave S-scores of 1 to dusky rockfish and dwarf red rockfish instead of zeroes. Giving them S-scores of zero had the effect of increasing their overall PSA score above what a 1 would produce.[12] S-scores of 1 for these species is also somewhat inconsistent with how

---

[10] *See* Section 4.1.1.2 of the Environmental Impact Statement produced for the 2013-14 Harvest Specifications; J. M. Cope et al. (2011). *An Approach to Defining Stock Complexes for U.S. West Coast Groundfishes Using Vulnerabilities and Ecological Distributions*. North American Journal of Fisheries Management 31(4):589-604.

[11] Longspine was given an S-Score of 1 before mainly because the stock's distribution goes deeper than the fishery operates. Considering the information presented in the assessment being considered at this meeting, it does not seem plausible that more than 75 percent of the stock is found in these unfished depths.

[12] The formula for PSA Vulnerability is $\sqrt{(\text{P-Score} - 3)^2 + (\text{S-score} - 1)^2}$, so an S-score of 1 zeroes out its contribution to the overall score whereas an S-score of zero would add a 1.

other stocks have been scored.[13] Another approach would be to remove these stocks from the PSA altogether. The consensus of the GMT and Council staff has been that the overlap of these stocks with the fisheries is minimal if not zero. As Table 2 shows, however, there are several species with only trace amounts of catch.

- We re-weighted all the S-score attributes to eliminate the contribution of management-related-attributes because the Guidelines suggest considering the risk of overfishing in "the absence of conservation and management."[14] This re-weighting resulted in small changes in the S-scores for some stocks but in no change for most. The weighting of each attribute is shown in the Appendix (Table 6 and Table 7).
- We scored two new species/categories—eelpouts and ragfish—using the PSA because of their catch relative to the other stocks we have scored. We scored eelpouts in aggregate because the great majority of catch is not identified to species. The Appendix (Table 8 and Table 9) provides some general information about these stocks and how they were scored in the PSA. The full GMT has not had occasion to review the scores for these new stocks and so they might be revised after they are reviewed. Other non-FMP stocks had already been scored with the PSA. Because of time constraints, we only scored additional non-FMP stocks with an average annual catch of more than 10 mt.[15]

One factor that we could not easily adjust was the effect of the Rockfish Conservation Area (RCA) and other closed areas on the S-scores. These areas were held in mind when scoring the overlap attributes. Closed areas are thought to reduce the overlap of the fisheries with several stocks and so removing the RCA and other areas for an "absence of conservation and management" scenario would increase the S-scores of these stocks. However, re-scoring the overlap attributes with a "no RCA" scenario in mind would have been very time consuming. As an alternative, the GMT will look for sensitivity to the RCA on a stock by stock basis when making more detailed recommendations to the Council.

The PSA scores for species focused on in this analysis are shown in Table 3. The scores and input files used to score all stocks are available upon request to the GMT.[16]

Cope et al. (2011), of which many GMT members were co-authors, concluded that PSA vulnerability of less than 1.8 suggested low concern of an overfishing risk. As Figure 3 and Figure 4 show, there is also a natural break below a PSA vulnerability of 1.5. Non-target stocks

---

[13] To elaborate, the stocks would get high scores of 3's for the discard mortality attribute and this would increase their scores above 1.

[14] This re-weighting has also has the advantage of scoring every stock on the same set of attributes and weights. It also eliminates the possible circularity resulting from using "management strategy" as an attribute. This attribute would increase the S-scores of non-FMP stocks just on the basis that they are not currently managed.

[15] We could have scored file tail cat shark but concluded after reviewing the stock's life history that brown cat shark's PSA score could be used a proxy.

[16] The input files are viewable using the NOAA Fisheries Toolbox PSA tool: http://nft.nefsc.noaa.gov/PSA.html.

around these vulnerabilities could be considered for EC species designation or removal from the FMP.

The PSA tool has been used in various places to advance ecosystem based fisheries management.[17] It provides a high level assessment of risks that helps focus and set priorities for future, more rigorous attention. Its advantage here is that it provides a structured and consistent method for comparing the relative vulnerability of stocks. The scores, however, should be recognized as based on best professional judgment in many cases, especially with the susceptibility attributes. For instance, we do not have good quantitative measures of the range and density of species or of the intensity and fishing locations of all fisheries sectors. The Productivity scores could be considered "data poor" as well because of the lack of basic life history research for many stocks.

Indeed, this cycle is producing assessment results that have shown less of overfishing risk than PSA scores would suggest (e.g. Aurora Rockfish). In close cases, the GMT and others may want to give further scrutiny to scores for individual stocks.

Lastly, the PSA scores should be recognized as ordinal in nature. The decimal intervals between two scores indicate a judgment about the relative vulnerability of two stocks. Yet a PSA vulnerability of 2.4 is not necessarily "twice as vulnerable" as stock with a score of 1.2.

Discussion

The Figures and Tables presented here are intended to provide consistent and as objective as possible metrics for comparing the relative conservation and management need of stocks caught in the groundfish fisheries. As is seen here and has been pointed out before, there is a seeming inconsistency now in that some unmanaged stocks have higher catch levels and higher PSA ranked vulnerability than some stocks listed as FMP species. This fact should not be surprising because it is only in the last management cycle that we began to receive information on the catch of non-FMP stocks. The FMP's existing list of species was likely based mostly on landed species and on species with life history traits that make them vulnerable to overfishing, mainly the rockfishes.

To address this inconsistency the Council is considering three main alternatives for non-target stocks where the risk of overfishing is questionable: (i) designation as "in the fishery," (ii) designation as EC species, or (iii) removing/leaving them out of the FMP. This report focusing on the first step of creating the list of stocks where that risk should be looked at closely.

---

[17] *See e.g.,* A.D.M. Smith et al. (2007). *Scientific tools to support the practical implementation of ecosystem-based fisheries management.* ICES J. Mar. Sci. 64(4): 633-639 (http://icesjms.oxfordjournals.org/content/64/4/633.full).

Table 1. Non-FMP species with average annual catches of at least 1 metric ton (rounded to nearest ton) over the period 2007-2011. Species with less than 20 percent of the catch coming from the FMP's recreational and commercial sectors are shaded. Several other species were excluded based on other factors, as explained in the text.

	Avg. catch (mt)					Avg. catch (mt)			
Species	FMP Sectors	All Sectors	% FMP	Retained %	Species	FMP Sectors	All Sectors	% FMP	Retained %
1. Skate Unid.	725	741	97.8%	95.8%	25. Hornyhead Turbot	0	4	5.5%	55.6%
2. Giant Grenadier	170	170	100.0%	0.0%	26. Longnose Cat Shark	3	3	100.0%	0.0%
3. Slender Sole	21	149	14.4%	0.0%	27. Aleutian Skate	3	3	100.0%	0.0%
4. Grenadier Unid.	135	135	99.9%	93.8%	28. Bigfin Eelpout	2	3	75.5%	0.0%
5. Shark Unid.	114	116	97.8%	7.2%	29. Twoline Eelpout	3	3	100.0%	0.0%
6. Brown Cat Shark	90	90	99.8%	12.6%	30. Eel Unid.	0	2	7.7%	100.0%
7. Bat Ray	26	75	35.5%	34.3%	31. Thornback Skate	1	2	33.6%	32.4%
8. Bering/sandpaper skate	70	70	99.9%	0.1%	32. Threadfin Slickhead	1	1	100.0%	0.0%
9. Black/Roughtail Skate	44	44	100.0%	0.1%	33. Gray Smoothhound Shark	1	1	100.0%	87.7%
10. Ragfish	43	43	100.0%	51.2%	34. Pacific Dogfish Shark	1	1	100.0%	0.0%
11. Eelpout Unid.	33	43	76.4%	0.1%	35. Duckbill Barracudina	1	1	100.0%	75.5%
12. Deepsea Sole	32	32	99.4%	2.5%	36. Cat Unid. Shark	1	1	100.0%	0.0%
13. California Slickhead	28	28	100.0%	0.0%	37. Salmon Shark	1	1	100.0%	0.0%
14. Sanddab Unid.	21	22	96.7%	84.0%	38. Longspine Combfish	0	1	20.5%	0.0%
15. Shovelnose Guitarfish	19	22	87.0%	80.0%	39. Starry Skate	0	1	46.8%	0.0%
16. Pacific Angel Shark	0	13	0.2%	78.7%	40. Tubeshoulder Unid.	1	1	99.9%	3.7%
17. Pacific Electric Ray	1	11	12.2%	0.0%	41. Deepsea Skate	1	1	100.0%	0.0%
18. Filetail Cat Shark	11	11	100.0%	0.0%	42. Slickhead Unid.	1	1	100.0%	0.0%
19. Pacific Sleeper Shark	8	8	100.0%	2.3%	43. Swell Shark	0	1	5.8%	0.0%
20. Brown Smoothhound Shark	2	7	26.5%	13.7%	44. Fantail Sole	0	1	0.0%	18.3%
21. King of the Salmon	6	6	100.0%	44.6%	45. Pacific Black Dogfish	1	1	100.0%	0.0%
22. Snailfish Unid.	5	5	99.2%	0.3%	46. Longnose Lancetfish	1	1	100.0%	64.8%
23. Walleye Pollock	4	4	100.0%	96.2%	47. Sixgill Shark	0	1	75.6%	0.0%
24. California Grenadier	4	4	100.0%	0.0%					

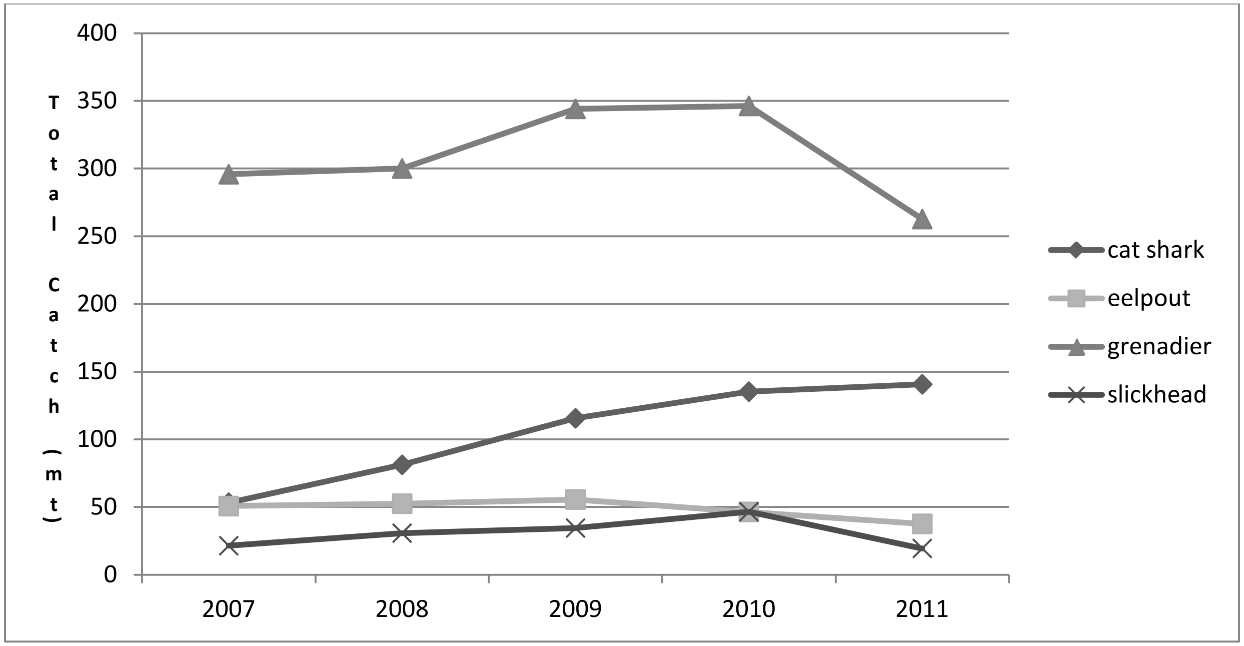

Figure 1. Annual catches of combines species and species categories for cat sharks, eelpouts, non-FMP grenadiers, and slickheads.

Notes: 2 lbs of Misc is Eelpout, 1 lb of Misc is Ratfish, 1 lb of Misc is Starfish,8 lbs of Shelf is Rosethorn, 104 lbs of Slope is Rougheye, 490 lbs of Slope is Splitnose, 14 lbs of Slope is Redbanded, 16 lbs of Slope is Aurora, 2384 lbs of Slope is Blackgil, 13 lbs of Skate is Sandpaper Skate, 2 lbs of Sole is Deep Sea Sole, 13 lbs of Sole is Slender Sole

Notes: 629 lbs of Slope is Splitnose,16 lbs of Misc is Garbage according to the observer, 3 lbs of Shelf is Rosethorn, 174 lbs of Slope is Rougheye, 74 lbs of Slope is Shortraker, 18 lbsa of Slope is Redbanded, 19 lbs of Slope is Shortraker, 3 lbs of Shark is Cat Shark, 1 lb of Misc is Snailfish, 13 lbs of Misc is Ratfish, 10 lbs of Misc is Eelpout, 2 lbs of Misc is Grenadere, 5 lbs of Skate is Sandpaper

Figure 2. Two notes from Washington fish tickets illustrating how non-FMP species are landed under miscellaneous categories that are not enumerated to species. Such notes are not required or entered into the state's landings databases.

Table 2. Catch statistics for FMP stocks with an average annual catch less than 150 mt over 2007 to 2011. Catch is reported to the nearest metric ton (i.e., 0 mt includes catches less than 0.5 mt). The percentage of catch retained combines recreational and commercial catch and will not reflect differences between discarding practices in the two.

	catch (mt)				catch (mt)				catch (mt)		
Species	**avg.**	**max**	**retain. %**	**Species**	**avg.**	**max**	**retain. %**	**Species**	**avg.**	**max**	**retain. %**
1. Spotted Ratfish	146	228	0.2%	*26.* Grass Rockfish	19	23	99.4%	*51.* Rosethorn Rockfish	4	5	23.4%
2. Pacific Ocean Perch Rockfish	135	179	68.9%	*27.* Starry Flounder	17	24	79.6%	*52.* Yellowmouth Rockfish	4	10	53.6%
3. Pacific Grenadier	131	212	0.0%	*28.* Greenstriped Rockfish	15	25	29.2%	*53.* Redstripe Rockfish	4	11	89.1%
4. Blackgill Rockfish	120	164	95.8%	*29.* Quillback Rockfish	15	20	96.6%	*54.* Squarespot Rockfish	3	6	94.0%
5. Blue Rockfish	120	192	91.8%	*30.* Greenspotted Rockfish	15	19	95.1%	*55.* Tiger Rockfish	1	1	96.3%
6. Cabezon	101	128	98.4%	*31.* California Skate	14	18	0.6%	*56.* Butter Sole	1	2	8.1%
7. Big Skate	95	170	1.7%	*32.* Finescale codling/Pacific Flatnose	13	19	0.0%	*57.* Nearshore Rockfish Unid.	1	3	100.0%
8. Brown Rockfish	90	116	97.8%	*33.* Stripetail Rockfish	12	15	0.7%	*58.* Halfbanded Rockfish	1	2	61.2%
9. Gopher Rockfish	85	120	96.7%	*34.* Slope Rockfish Unid.	12	21	100.0%	*59.* Greenblotched Rockfish	1	1	98.8%
10. California Scorpionfish	76	104	90.2%	*35.* Silvergray Rockfish	11	44	17.5%	*60.* Blackspotted Rockfish	1	1	100.0%
11. Bocaccio Rockfish	73	115	77.8%	*36.* Shortraker/Rougheye Unid.	10	34	0.3%	*61.* Cowcod Rockfish	1	1	17.3%
12. Copper Rockfish	69	80	94.4%	*37.* Yelloweye Rockfish	9	12	13.6%	*62.* Calico Rockfish	1	2	17.5%
13. Aurora Rockfish	50	68	51.0%	*38.* Treefish Rockfish	8	14	94.0%	*63.* Mexican Rockfish	0	0	100.0%
14. Sand Sole	49	85	94.5%	*39.* Kelp Rockfish	8	18	96.4%	*64.* Chameleon Rockfish	0	0	99.4%
15. Bank Rockfish	47	93	99.7%	*40.* Soupfin Shark*	8	18	91.9%	*65.* Pinkrose Rockfish	0	0	100.0%
16. Kelp Greenling	43	56	97.1%	*41.* Sharpchin Rockfish	8	12	15.0%	*66.* Pygmy Rockfish	0	0	0.3%
17. Canary Rockfish	42	52	36.4%	*42.* Shelf Rockfish Unid.	7	21	100.0%	*67.* Bronzespotted Rockfish	0	0	78.2%
18. Redbanded Rockfish	36	40	76.9%	*43.* Flag Rockfish	7	9	92.0%	*68.* Swordspine Rockfish	0	0	40.2%
19. Leopard Shark	35	38	81.4%	*44.* Rock Sole	6	8	80.8%	*69.* Freckled Rockfish	0	0	100.0%
20. Shortraker Rockfish	32	35	69.7%	*45.* Shortbelly Rockfish	6	11	2.9%	*70.* Spotted Rockfish Unid.	0	0	0.0%
21. China Rockfish	32	35	92.1%	*46.* Rosy Rockfish	6	7	83.3%	*71.* Dusky Rockfish	0	0	0.0%
22. Olive Rockfish	32	54	94.2%	*47.* Flathead Sole	6	11	36.2%	*72.* Harlequin Rockfish	0	0	43.0%
23. Rockfish Unid.	29	69	7.7%	*48.* Speckled Rockfish	5	8	94.7%	*73.* Pink Rockfish	0	0	100.0%
24. Starry Rockfish	24	30	91.1%	*49.* Honeycomb Rockfish	5	10	85.2%	*74.* Dwarf Red Rockfish	0	0	#N/A
25. Black And Yellow Rockfish	23	32	99.0%	*50.* Curlfin Sole/Turbot	5	10	17.9%				

*Note: Only 15.6% of the catch of Soupfin Shark comes in the FMP's commercial and recreational sectors. The remainder is taken in the California Halibut and other non-FMP sectors.

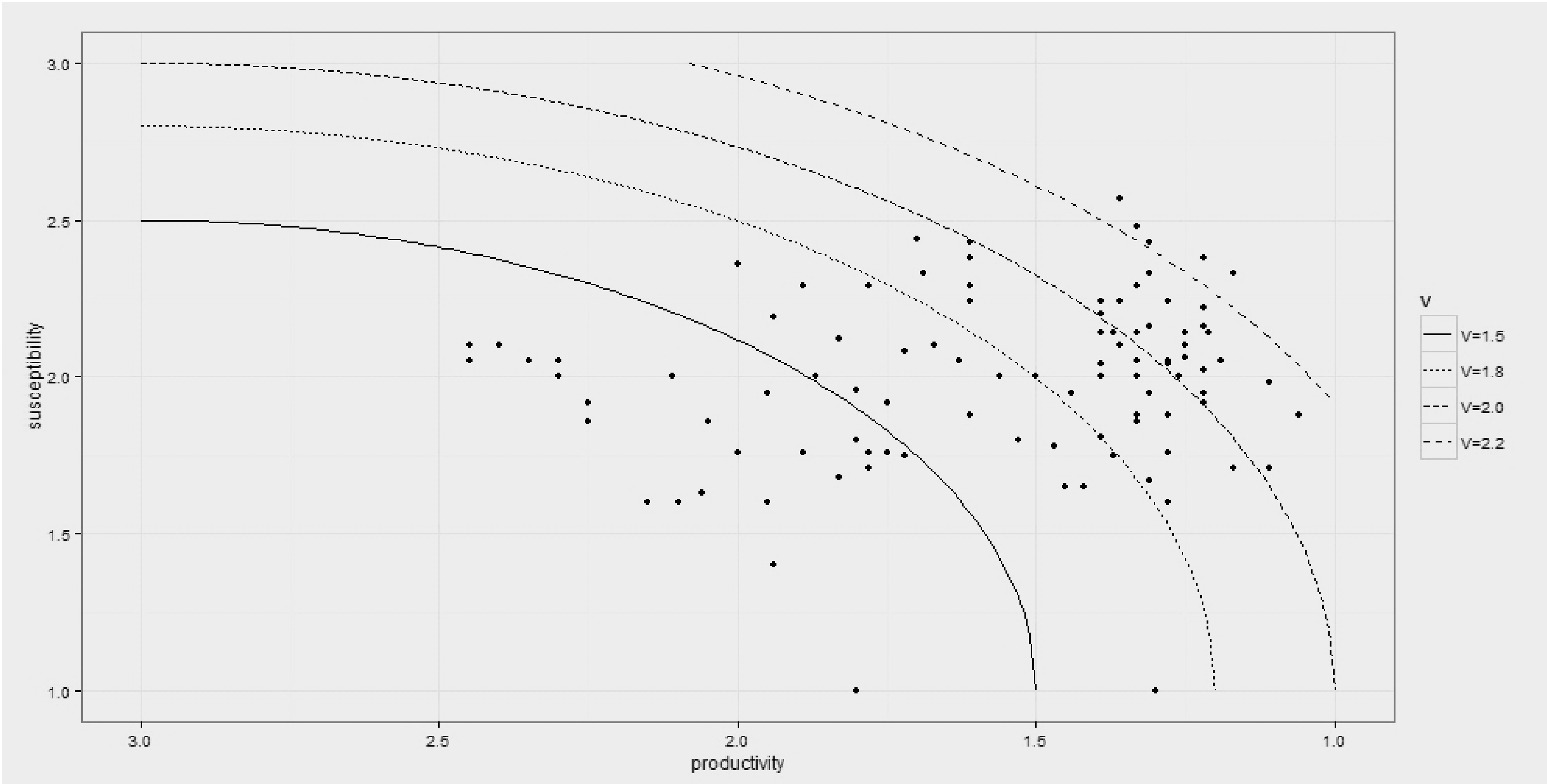

Figure 3. PSA scores for all stocks scored with isoclines delineating scores of 1.5, 1.8, 2.0, and 2.2 (moving from bottom to top).

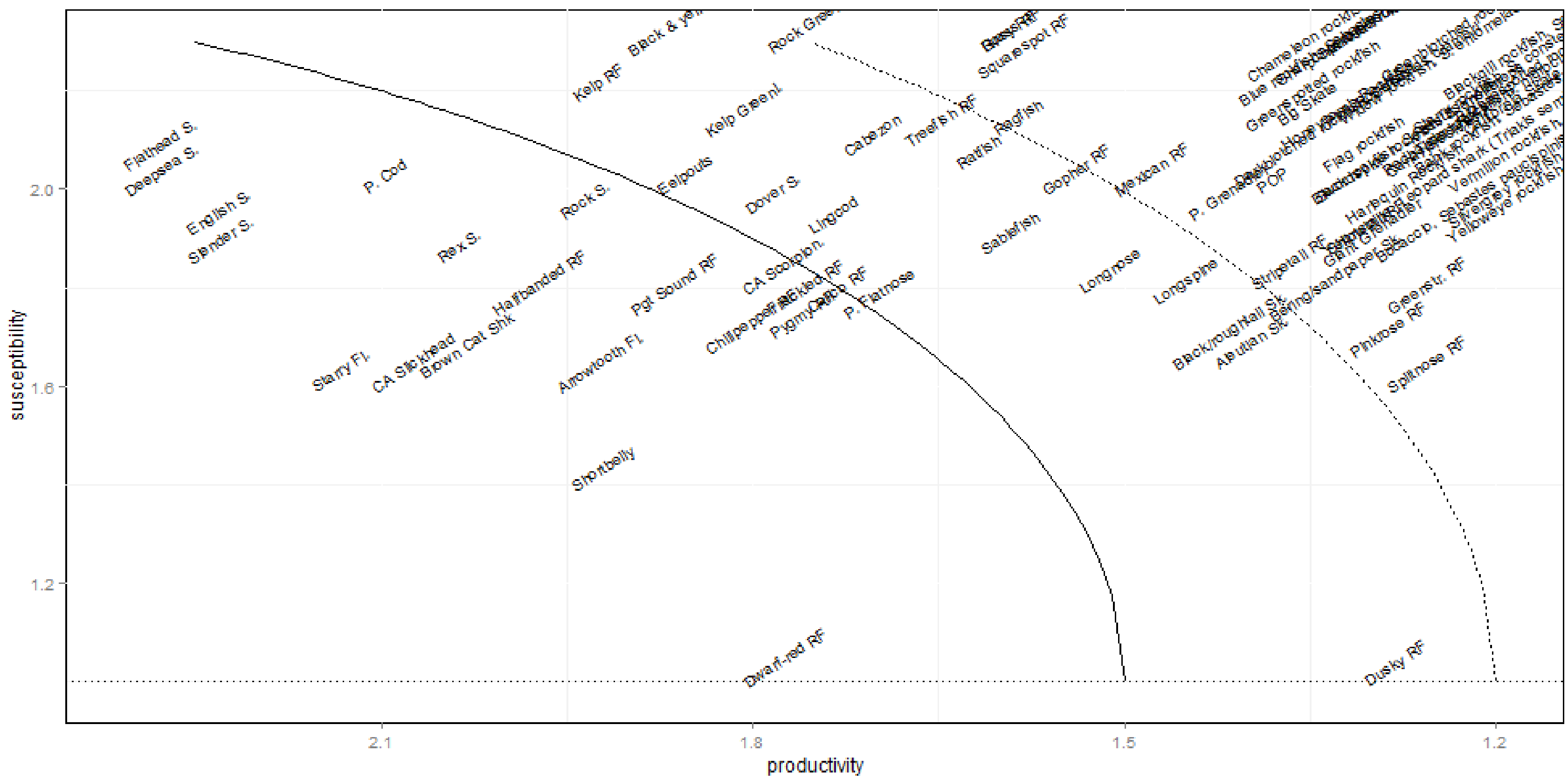

Figure 4. Same as previous Figure but zoomed and labeled to highlight the stocks falling near PSA vulnerabilities of 1.5 and 1.8. Labels are jittered to reduce overlap. Specific PSA scores for these stocks are listed in the table below.

Table 3. FMP and Non-FMP stocks with PSA Vulnerability scores of 1.90 and lower.

Stock	P-score	S-score	Vulnerability	Stock	P-score	S-score	Vulnerability
1. Grass rockfish	1.61	2.29	1.89	30. Kelp rockfish	1.94	2.19	1.59
2. Rosy Rockfish	1.61	2.29	1.89	31. Lingcod	1.75	1.92	1.55
3. Greenstriped rockfish	1.28	1.76	1.88	32. Dover Sole	1.80	1.96	1.54
4. Shortspine thornyhead	1.33	1.88	1.88	33. Eelpouts spp.	1.87	2.00	1.51
5. Yellowtail rockfish	1.33	1.88	1.88	34. Finescale codling	1.72	1.75	1.48
6. Giant grenadier	1.33	1.86	1.87	35. Calico rockfish	1.75	1.76	1.46
7. Olive rockfish	1.69	2.33	1.87	36. Freckled rockfish	1.78	1.76	1.44
8. Squarespot rockfish	1.61	2.24	1.86	37. Pygmy rockfish	1.78	1.71	1.42
9. Pacific grenadier	1.44	1.95	1.82	38. Rock sole	1.95	1.95	1.42
10. Pinkrose rockfish	1.31	1.67	1.82	39. California scorpionfish	1.80	1.80	1.40
11. Splitnose rockfish	1.28	1.60	1.82	40. Chilipepper	1.83	1.68	1.35
12. Bering/sandpaper skate	1.37	1.75	1.80	41. Puget Sound rockfish	1.89	1.76	1.35
13. Mexican rockfish	1.50	2.00	1.80	42. Pacifc cod	2.11	2.00	1.34
14. Ragfish	1.60	2.12	1.80	43. Rex sole	2.05	1.86	1.28
15. Stripetail rockfish	1.39	1.81	1.80	44. Flathead sole	2.30	2.05	1.26
16. Rock greenling	1.78	2.29	1.77	45. Halfbanded rockfish	2.00	1.76	1.26
17. Gopher rockfish	1.56	2.00	1.76	46. Pacific sanddab	2.40	2.10	1.25
18. Treefish rockfish	1.67	2.10	1.73	47. Curlfin Sole	2.45	2.10	1.23
19. Ratfish	1.63	2.05	1.72	48. Sand sole	2.35	2.05	1.23
20. Aleutian skate	1.42	1.65	1.71	49. Deepsea sole	2.30	2.00	1.22
21. Longspine Thornyhead	1.47	1.78	1.71	50. Arrowtooth Flounder	1.95	1.60	1.21
22. Black-and-yellow rockfish	1.89	2.29	1.70	51. Dwarf-red rockfish	1.80	1.00	1.20
23. Dusky rockfish	1.30	1.00	1.70	52. English Sole	2.25	1.92	1.19
24. Pacific whiting	2.00	2.36	1.69	53. Butter Sole	2.45	2.05	1.18
25. Black/roughtail skate	1.45	1.65	1.68	54. Brown cat shark	2.06	1.63	1.14
26. Cabezon	1.72	2.08	1.68	55. Slender sole	2.25	1.86	1.14
27. Longnose skate	1.53	1.80	1.68	56. Shortbelly rockfish	1.94	1.40	1.13
28. Sablefish	1.61	1.88	1.64	57. California slickhead	2.10	1.60	1.10
29. Kelp greenling	1.83	2.12	1.62	58. Starry flounder	2.15	1.60	1.04

Appendix – Supplemental Tables

Table 4. Invertebrate species and species categories excluded from the analysis. Only species with an average catch greater than 1 mt across all sectors in the dataset are displayed.

Average Catch (mt) 2007-2011					
Crustaceons	**FMP Sectors**	**All Sectors**	**Cephalopods**	**FMP Sectors**	**All Sectors**
1. Dungeness Crab	1,693	22,331	1. Humboldt Squid	1,596	1,596
2. Pink Shrimp	0	18,132	2. Squid Unid	443	490
3. Red Rock Crab	21	597	3. Octopus Unid	10	13
4. Shrimp Unid.	1	409	**Mollusks and Other Invertebrates**	**FMP Sectors**	**All Sectors**
5. Tanneri Tanner Crab	405	405	1. Red Sea Urchin	0	5,343
6. California Spiny Lobster	6	325	2. Sea Cucumber Unid.	3	305
7. Spotted Prawn	5	168	3. Razor Clam	0	113
8. Ridgeback Prawn	0	157	4. Jellyfish Unid.	2	89
9. Bait Shrimp Unid.	0	118	5. Basket Cockle	0	77
10. Crab Unid.	2	38	6. Mollusks Unid.	4	73
11. Tanner Crab Unid.	36	36	7. Urchin Unid.	7	9
12. Ghost Shrimp	0	21	8. Butter Clam	0	8
13. Sheep Crab	0	4	9. Gaper Clam	0	5
14. Graceful Crab	0	3	10. Sea Urchin Unid.	0	2
15. Brown Box Crab	2	2	11. Bivalves Unid.	1	1
16. Armored Box Crab	1	2	12. Manila Clam	0	1
17. Yellow Rock Crab	0	1	13. Echinoderm Unid.	0	1
18. Scarlet King Crab	1	1			
19. Pacific Rock Crab	1	1			
20. Mud Shrimp	0	1			

Table 5. Non-FMP species in the catch dataset that were excluded from the analysis because they are managed under another FMP or state or international management or expected to be found mainly in state and nearshore waters. Only species with an average catch greater than 1 mt across all sectors in the dataset are displayed. Species are sorted by the average annual catch across all sectors, in descending order.

Average Catch (mt), 2007-2011								
Species	FMP Sectors	All Sectors	Species	FMP Sectors	All Sectors	Species	FMP Sectors	All Sectors
1. Market Squid	2	86,620	26. Thresher Shark	56	56	52. Shortfin Mako Shark	6	6
2. Pacific Sardine	39	78,636	27. White Seabass	55	55	53. Sargo	6	6
3. Albacore Tuna	283	11,712	28. Striped Bass	54	54	54. Pink (Humpback) Salmon	5	6
4. Northern Anchovy	2	6,541	29. Blue Shark	47	49	55. Whitebait Smelt	0	6
5. Pacific Mackerel	1	3,580	30. White Croaker	21	48	56. Bigeye Tuna	0	6
6. Hagfish Unid..	1	1,776	31. Yellowfin Tuna	25	48	57. White Sturgeon	5	5
7. King (Chinook) Salmon	471	1,043	32. Yellowtail (Amberjack)	40	46	58. Striped Seaperch	5	5
8. Pacific Bonito	71	728	33. American Shad	22	40	59. Bigeye Thresher Shark	0	4
9. Pacific Herring	11	727	34. Red (Sockeye) Salmon	30	30	60. Blacksmith	4	4
10. Pacific Halibut	583	701	35. Bonito (Shortfin Mako) Shark	1	29	61. California Corbina	4	4
11. Swordfish	0	469	36. Spotfin Croaker	25	25	62. Shiner Surfperch	3	3
12. Silver (Coho) Salmon	411	459	37. Yellowfin Croaker	21	21	63. Rubberlip Surfperch	3	3
13. California Halibut	192	393	38. Ocean Whitefish	19	19	64. Giant Sea Bass	0	3
14. Jack Mackerel	29	314	39. Black Surfperch	19	19	65. Dog (Chum) Salmon	3	3
15. White Sea Bass	0	247	40. Eulachon	0	13	66. Skipjack Tuna	1	2
16. Chub (Pacific) Mackerel	240	240	41. Redtail Surfperch	12	12	67. Poacher Unid.	0	2
17. Pacific Barracuda	143	173	42. Opaleye	12	12	68. California Lizardfish	2	2
18. Smelt Unid.	0	157	43. Mackerel Unid.	1	11	69. Monkeyface Prickleback	2	2
19. Common Thresher Shark	1	126	44. Surf Smelt	10	10	70. Pacific Hagfish	0	1
20. Barred Sand Bass	115	116	45. Halfmoon	10	10	71. White Seaperch	1	1
21. Bluefin Tuna	0	116	46. Walleye Surfperch	9	9	72. Green Sturgeon	0	1
22. Kelp Bass	97	97	47. Surfperch Unid.	0	8	73. Dorado	0	1
23. Jack Smelt	78	78	48. Spotted Sandbass	8	8	74. Wolf-eel	1	1
24. California Sheephead	76	77	49. Top Smelt	8	8	75. Pacific Staghorn Sculpin	1	1
25. Bat Ray	26	75	50. Queenfish	7	7	76. Silver Surfperch	1	1
26. Barred Surfperch	61	61	51. Sculpin Unid.	4	6	77. Pile Surfperch	1	1

Table 6. List of the PSA productivity attributes with bin definitions and score weightings for different species groups and those with and without Council-approved assessments. Default weights for all attributes are 2.

	Bins			Weight (0 - 4)			
Productivity Attributes	High (3)	Moderate (2)	Low (1)	Elasmobranchs	Flatfish	Rockfishes & other fishes	non-FMP
r	>0.5	0.5-0.16	<0.16	2	2	2	Different weights used depending on available information
Maximum Age	< 10 years	10 - 30 years	> 30 years	2	2	2	
Maximum Size	< 60 cm	60-150 cm	> 150 cm	1	2	1	
von Bertalanffy Growth Coefficient (k)	> 0.25	0.15-0.25	< 0.15	2	2	2	
Estimated Natural Mortality	> 0.40	0.20-0.40	< 0.20	2	2	2	
Measured Fecundity	> 10e4	10e2-10e3	< 10e2	2	2	1	
Breeding Strategy	0	between 1 and 3	≥4	2	2	2	
Recruitment Pattern	highly frequent recruitment success (> 8 per decade)	moderately frequent recruitment success (>1 & <8 per decade)	infrequent recruitment success (< 1 per decade)	2	2	2	
Age at Maturity	< 2 years	2-4 years	> 4 years	2	2	2	
Mean Trophic Level	<2.5	2.5-3.5	>3.5	2	2	2	

Table 7. List of the PSA fishery susceptibility attributes and score weightings for all species scored in this analysis. As explained in the text, the management related attributes were given zero weight.

Susceptibility Attributes	Low (1)	Moderate (2)	High (3)	Weight (0-4)
Management Strategy	Proactive management; sort requirements; individual specification; discard monitoring; biological data; representative fishery-independent indices	Reactive management; decent catch records; some assessment data; weak spatial knowledge; weakly informed indices	High catch uncertainty; low assessment data; no sorting; inadequate discard monitoring; low confidence in control rule	0
Areal Overlap	< 25% of stock occurs in the area fished	Between 25% and 50% of the stock occurs in the area fished	> 50% of stock occurs in the area fished	2
Geographic Concentration	stock is distributed in > 50% of its total range	stock is distributed in 25% to 50% of its total range	stock is distributed in < 25% of its total range	2
Vertical Overlap	< 25% of stock occurs in the depths fished	Between 25% and 50% of the stock occurs in the depths fished	> 50% of stock occurs in the depths fished	2
F relative to M	<0.5	0.5 - 1.0	>1	0
Relative Spawning Biomass	B is > 40% of B0 (or maximum observed from time series of biomass estimates)	B is between 25% and 40% of B0 (or maximum observed from time series of biomass estimates)	B is < 25% of B0 (or maximum observed from time series of biomass estimates)	0
Seasonal Migrations	Seasonal migrations decrease overlap with the fishery	Seasonal migrations do not substantially affect the overlap with the fishery	Seasonal migrations increase overlap with the fishery	2
Schooling/Aggregation and Other Behavioral Responses	Behavioral responses decrease the catchability of the gear	Behavioral responses do not substantially affect the catchability of the gear	Behavioral responses (e.g. schooling) increase the catchability of the gear	2
Morphology Affecting Capture	Species shows low selectivity to the fishing gear.	Species shows moderate selectivity to the fishing gear.	Species shows high selectivity to the fishing gear.	2
Survival After Capture and Release	Survival probability > 67%	33% < survival probability < 67%	Survival probability < 33%	2
Desirability/Value of the Fishery	stock is not highly valued or desired by the fishery	stock is moderately valued or desired by the fishery	stock is highly valued or desired by the fishery	2
Fishery Impact to EFH or Habitat in General for Non-targets	Adverse effects absent, minimal or temporary	Adverse effects more than minimal or temporary but are mitigated	Adverse effects more than minimal or temporary and are not mitigated	0

Productivity Attribute	*Score*	*Weight*	*Reasons*
r	2	2	FishBase estimats a minimum population doubling time of 4.5-14 years for Blackbelly and Bigfin (doubling time ≈ Ln 2 / r)
Maximum Age	2	2	Love (2011) reports a Bigfin 7-8 years old at 75 percent of max size.
Maximum Size	3	1	Fishbase Bigfin, Wattled
von Bertalanffy Growth Coefficient (k)	1.5	2	Love (2011) reports k = 0.13 for Fish Doctor, FishBase has k= 0.31 for Blackbelly
Estimated Natural Mortality	2	0	no data
Measured Fecundity	1.5	1	Love (2001) reports some species with less than 100 eggs and others with 1000s of eggs. Ferry Graham et al. (2007) lab work reports less than 100 eggs and questions higher estimates.
Breeding Strategy	2	2	Nests and some egg guarding, long hatching times (Love 2011 and Ferry Graham et al. 2007)
Recruitment Pattern	2	0	no data
Age at Maturity	2	2	Love (2011) reports Blackbelly Eelpout mature at 2-3 years.
Mean Trophic Level	1.5	2	FishBase estimates for Bigfin, Blackbelly, Twoline (3.3-3.6).

Table 8. PSA scoring, attribute weights, and reasoning for Eelpouts (Family Zoarcidae).

Productivity Attribute	*Score*	*Weight*	*Reasons*
r	2	2	FishBase estimats a minimum population doubling time of 4.5-14 years for Blackbelly and Bigfin (doubling time ≈ Ln 2 / r)
Maximum Age	2	2	Love (2011) reports a Bigfin 7-8 years old at 75 percent of max size.
Maximum Size	3	1	Fishbase Bigfin, Wattled, others don't get bigger than 60 cm.
von Bertalanffy Growth Coefficient (k)	1.5	2	Love (2011) reports k = 0.13 for Fish Doctor, FishBase has k= 0.31 for Blackbelly
Estimated Natural Mortality	--	0	no data
Measured Fecundity	1.5	1	Love (2001) reports some species with less than 100 eggs and others with 1000s of eggs. Ferry Graham et al. (2007) lab work reports less than 100 eggs and questions higher estimates.
Breeding Strategy	2	2	Nests and guarding, long hatching times, some birth live young (Love 2011 and Ferry Graham et al. 2007)
Recruitment Pattern	--	0	no data
Age at Maturity	2	2	Love (2011) reports Blackbelly Eelpout mature at 2-3 years.
Mean Trophic Level	1.5	2	FishBase estimates for Bigfin, Blackbelly, Twoline (3.3-3.6).

Susceptibility Attributes	*Score*	*Weight*	*Reasons*
Management Strategy	--	0	not scored in this analysis
Areal Overlap	3	2	Focusing just on CA Current area, their range has high overlap with fisheries
Geographic Concentration	2	2	Appear to be evenly distributed in trawl survey area, un-trawlable habitats unknown.
Vertical Overlap	3	2	They're found in trawlable habitats and depths.
F relative to M	--	0	not scored in this analysis
Relative Spawning Biomass	--	0	not scored in this analysis
Seasonal Migrations	2	2	no suggestion of migrations or movements that would change overlap.
Schooling/Aggregation and Other Behavioral Responses	2	2	Unknown. Many species burrow, which would suggest reduced exposure, yet they could be attracted to trawl activity (e.g. stirred up prey).
Morphology Affecting Capture	2	2	Nothing stands out as affecting their catchability either way except small size.
Survival After Capture and Release	2	2	Unknown. Moderate score seems reasonable assumption.
Desirability/Value of the Fishery	1	2	Not marketed.
Fishery Impact to EFH or Habitat in General for Non-targets	--	0	not scored in this analysis

Main References Consulted

Bradburn, M.J., A.A. Keller, and B.H. Horness. 2011. The 2003 to 2008 U.S. West Coast bottom trawl surveys of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, length, and age composition. NOAA Tech. Memo. NMFS-NWFSC-114.

Ferry-Graham, Lara A., Jeffrey C. Drazen, and Veronica Franklin. 2007. Laboratory observations of reproduction in the deep-water zoarcids Lycodes cortezianus and Lycodapus mandibularis (Teleostei: Zoarcidae)." Pacific science 61(1): 129-139.

Table 9. PSA scoring, attribute weights, and reasoning for the ragfish (*Icosteus aenigmaticus*).

Productivity Attribute	*Score*	*Weight*	*Reasons*
r	2	2	FishBase estimate of population doubling time is 4.5 - 14 years corresponding to an r of 0.15-0.05 (doubling time ≈ Ln 2 / r)
Maximum Age	--	0	Allen (2001) reports they are difficult to age.
Maximum Size	1	1	FishBase (Fitch and Lavenberg 1968) and Allen (2001) report max size 200 cm
von Bertalanffy Growth Coefficient (k)	1	1	FishBase (Fitch and Lavenberg 1968) reports k = 0.13
Estimated Natural Mortality	--	0	no data.
Measured Fecundity	3	2	Allen (2001) reports fecundity of 144,000-552,000 eggs.
Breeding Strategy	1	2	Allen (2001):eggs in icthyoplankton
Recruitment Pattern	--	0	no data
Age at Maturity	--	0	No age data.
Mean Trophic Level	1	2	FishBase estimates TL of 4.5; Allen (2001) notes shortspine in stomach of one speciman.

Susceptibility Attributes	*Score*	*Weight*	*Reasons*
Management Strategy	--	0	not scored in this analysis
Areal Overlap	2.5	2	They are found out to 600 fm in the NWFSC Trawl Survey yet are rarely seen. Allen(2001) reports use of canyons and shelf.
Geographic Concentration	1.5	2	Best guess is an even, sparse distribution throughout the range yet Allen (2001) note some clustering of where specimens were taken.
Vertical Overlap	3	2	Caught in bottom trawl and midwater whiting - suggests high overlap.
F relative to M	--	0	not scored in this analysis
Relative Spawning Biomass	--	0	not scored in this analysis
Seasonal Migrations	2	2	They may move onto the shelf to spawn yet overlap probably not affected..
Schooling/Aggregation and Other Behavioral Responses	2	2	Sparse in the NWFSC Trawl survey (2003-08) so schooling, if any, would be off the bottom or in non-trawlable habitats.
Morphology Affecting Capture	2	2	They get pretty large so modeate selectivity and Allen (2001) reports specimens taken by multiple gears.
Survival After Capture and Release	3	2	No data, score of 2 assumed.
Desirability/Value of the Fishery	1	2	Not marketed.
Fishery Impact to EFH or Habitat in General for Non-targets	--	0	not scored in this analysis

Main References Consulted

Allen, G. H. (2001). The Ragfish, *Icosteus aenigmaticus* Lockington, 1880: A Synthesis of Historical and Recent Records From the North Pacific Ocean and the Bering Sea. Marine Fisheries Review, 63(4): 1-31.

Bradburn, M.J., A.A. Keller, and B.H. Horness. 2011. The 2003 to 2008 U.S. West Coast bottom trawl surveys of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, length, and age composition. NOAA Tech. Memo. NMFS-NWFSC-114.

Froese, R. and D. Pauly. Editors. 2013. FishBase. World Wide Web electronic publication. www.fishbase.org, version

Love, Milton S. 2011. Certainly More Than You Want to Know about the Fishes of the Pacific Coast: A Postmodern Experience.