Deriving estimates of OFL for species in the "Other Fish" complex or potential alternative complexes

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The current "Other Fish" complex and proposed alternatives include a number of species for which estimates of OFL contributions are not available from stock assessments or data-poor methods. Four of the species had OFL contributions for the 2013–2014 management cycle calculated by applying approximate MSY harvest rates to estimates of stock biomass from the NWFSC West Coast Bottom Trawl Survey (Bradburn et al., 2012). This approach is described in detail in Cope et al. (2012). This document expands the set of species to those associated with proposed alternatives to the Other Fish complex described in Agenda Item H.4.b, GMT Report, November 2013 and updates those species previously considered to account for more recent biomass estimates. Species for which OFL estimates were available from other methods or for which the survey did not have adequate coverage of their depth range were not included in the calculations presented here.

This survey-based approach to setting OFLs is based on the calculation

$$OFL = F_{MSY} B_w$$

where F_{MSY} is the fishing mortality rate that maximizes long-term yield, and B_w is an inverse-variance weighted average of recent survey biomass estimates. To account for uncertainty in this OFL estimates, one million samples of F_{MSY} and B_w were drawn from assumed distributions for these quantities (Table 1, Figure 2) and the median of the products of these values is presented here as the estimated OFL (Table 3, Figure 2). In general, the estimated OFL values are similar to the 2014 OFL based Cope et al. (2012) for the four species that had the same methods applied (Table 1).

Following Cope et al. (2012), the most recent 3 years of the survey were used in the calculation of B_w. For most species, a longer, 6-year average was found to be very similar to the recent years (Table 1, Figure 1). For long-lived, but infrequently encountered species, a longer range would likely be a better estimate of abundance. Aleutian skate only occur in an average of only 2 survey tows per year (out of an average of 645 tows per year over the past 10 years), so their survey estimate are more variable than the other species considered here. In this case, a preferable option might be grouping Aleutian skate with "all other skates" to reduce the sampling variability associated with this contribution to a complex that included skates.

The F_{MSY} values are based on the product of values for natural mortality (M) and the ratio F_{MSY} / M. The estimates of M were obtained from a variety of published sources (listed in Table 1) or in some cases assumed to be the same as those estimated for similar species (all grenadiers were assumed to have the same M). Two values for F_{MSY} / M were used based on the estimates in Zhou et al. (2012). Samples of these two quantities were generated from assumed distributions and multiplied together to get a distribution of F_{MSY} values. For two species, roughtail/black skate and ratfish, two estimates of M were available. In Cope et al. (2012), the M values for ratfish were drawn from a uniform distribution bounded by the two values. However, using the uniform distribution resulted in less uncertainty for these species with multiple estimates than the distributions assumed for those species with a single estimate. To avoid this contradiction, the previously applied methods were extended so that samples from the uniform distribution were used as the expected values for a second stage of sampling from a lognormal distribution. The resulting distributions are compared in Figure 2. In all cases, the lognormal distributions for M were assumed to have a log-scale standard deviation of 0.4 (CV = 0.417; Dick and MacCall, 2011).

These methods depend on the both the accuracy of the parameters contributing to F_{MSY} as well as a large set of assumptions about the survey. The population is assumed to not have significant trends in abundance and the survey is assumed to have catchability equal to 1.0. Furthermore, survey selectivity and fishery selectivity are assumed to be equal. In benchmark stock assessments, these assumptions are typically not met. In the future, meta-analytic methods could be considered to refine the values presented here by estimating the relationship between this survey-based estimation of biomass and OFL with values developed in benchmark assessments.

OFL estimates from other sources

Cartilaginous Fish

Among the cartilaginous fish, leopard shark and soupfin shark have 2014 OFL estimates based on DB-SRA and DCAC, respectively, which may be used again in 2015–2016. Spiny dogfish has a benchmark assessment conducted in 2011 which has been used to derived OFL values for 2015–2016.

Shallow Water Roundfish

The NWFSC West Coast Bottom Trawl Survey does not sample depths shallower than 55 meters (30 fathoms). This prevents it from being a good sampling method for any of the species that might be considered in a Shallow Water Roundfish group, including kelp greenling, all other greenlings, or cabezon (WA). Kelp greenling in California has an OFL estimate from DB-SRA but additional analyses would be needed to get estimates for Oregon and Washington. All other greenlings and cabezon off Washington could have OFL estimates based on recent average catch or some other data poor method, but such calculations are not included in this document.

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Table 1. Description of distributions used for M, F_{MSY}/M, and survey biomass, and resulting OFL estimate (highlighted in gray).

Stock	Natural Mortality, M yr-1				FMSY / M			Survey biomass (mt)		Ave. positive tows / year	OFL estimate	2014 OFL
	Dist.	Expected Value	CV	M source	Dist.	Expected Value	CV	3-year average	6-year average			
Skates												
Big skate	lognormal	0.162	0.417	Max. age 26 (McFarlane and King, 2006)	lognormal	0.41	0.55	10,376	8,662	109	540.8	458.0
California skate	lognormal	0.162	0.417	borrowed from Big Skate	lognormal	0.41	0.55	2,487	1,807	148	129.6	86.0
Aleutian skate	lognormal	0.176	0.417	M=k*1.6; k (Haas, 2011)	lognormal	0.41	0.55	72	NA	2	3.6	NA
Roughtail/ black skate	uniform/ lognormal	U(0.06-0.12)	0.417	Barnett et al. (2013)	lognormal	0.41	0.55	6,497	6,552	102	184.8	NA
Bering/ sandpaper skate	lognormal	0.096	0.417	M=k*1.6; k from Ainsley 2009	lognormal	0.41	0.55	5,727	5,760	229	177.4	NA
All other skates	lognormal	0.1	0.417	M used in AFSC other skate category	lognormal	0.41	0.55	785	810	36	24.9	NA
Sharks and Ratfish												
Ratfish	uniform/ lognormal	U(0.17, 0.26)	0.417	Barnett (2008)	lognormal	0.41	0.55	18,577	19,846	357	1,272.4	1,441.0
Brown cat shark	lognormal	0.1	0.417	Assumed	lognormal	0.41	0.55	9,918	9,629	240	320.0	NA
Deep water Roundfish												
Finescale codling/ Pacific flatnose	lognormal	0.15	0.417	FishBase	lognormal	0.87	0.55	3,091	3,553	60	316.0	NA
Pacific grenadier	lognormal	0.053	0.417	Max. age 73 (Andrews et al., 1999)	lognormal	0.87	0.55	38,344	38,547	133	1,386.0	1,519.0
Giant grenadier	lognormal	0.053	0.417	borrowed from P. grenadier	lognormal	0.87	0.55	17,634	17,969	121	638.6	NA
All other grenadiers	lognormal	0.053	0.417	borrowed from P. grenadier	lognormal	0.87	0.55	1,108	1,139	75	40.1	NA
California slickhead	lognormal	0.35	0.417	FishBase	lognormal	0.87	0.55	26,118	26,564	148	6,248.8	NA

Table 2. Summary statistics for distributions of estimated biomass (mt).

Species	Quantiles					Mean	Point estimate
	2.5%	25%	50%	75%	97.5%		
Skates							
Big skate	8,776	9,771	10,340	10,941	12,187	10,377	10,376
California skate	2,102	2,342	2,478	2,623	2,926	2,488	2,487
Aleutian skate	25	45	62	87	174	72	72
Roughtail / black skate	5,501	6,121	6,473	6,847	7,618	6,496	6,497
Bering / sandpaper skate	5,154	5,518	5,719	5,928	6,348	5,728	5,727
All other skates	534	678	770	875	1,123	785	785
Sharks and Ratfish							
Ratfish	15,047	17,210	18,470	19,823	22,693	18,574	18,577
Brown cat shark	8,834	9,519	9,900	10,295	11,094	9,917	9,918
Deep water Roundfish							
Finescale codling/ Pacific flatnose	2,510	2,864	3,072	3,297	3,777	3,091	3,091
Pacific grenadier	30,812	35,423	38,114	41,016	47,169	38,345	38,344
Giant grenadier	15,002	16,637	17,572	18,562	20,624	17,634	17,634
All other grenadiers	902	1,028	1,102	1,181	1,348	1,108	1,108
California slickhead	22,410	24,725	26,037	27,414	30,253	26,112	26,118

Table 3. Summary statistics for distributions of OFL (mt) based on distributions of survey biomass and MSY harvest rates.

Species	Quantiles					Mean	Point estimate
	2.5%	25%	50%	75%	97.5%		
Skates							
Big skate	138.2	338.4	540.8	865.1	2,114.8	688.8	689.2
California skate	33.2	81.1	129.6	207.5	506.9	165.1	165.2
Aleutian skate	0.7	2.0	3.6	6.3	19.2	5.2	5.2
Roughtail / black skate	44.6	113.4	184.8	300.8	764.1	239.8	239.7
Bering / sandpaper skate	45.7	111.2	177.4	283.1	688.0	225.4	225.4
All other skates	6.1	15.4	24.9	40.3	101.4	32.1	32.2
Sharks and Ratfish							
Ratfish	318.3	789.5	1,272.4	2,054.0	5,100.9	1,639.8	1,637.5
Brown cat shark	82.4	200.4	320.0	510.5	1,245.1	406.5	406.6
Deep water Roundfish							
Finescale codling/ Pacific flatnose	80.5	197.5	316.0	505.9	1,237.6	403.0	403.3
Pacific grenadier	351.5	864.0	1,386.0	2,221.9	5,454.1	1,767.8	1,768.1
Giant grenadier	163.6	399.3	638.6	1,021.3	2,504.5	812.2	813.1
All other grenadiers	10.2	25.0	40.1	64.2	157.1	51.1	51.1
California slickhead	1,603.8	3,909.8	6,248.8	9,983.6	24,406.1	7,961.2	7,953.0

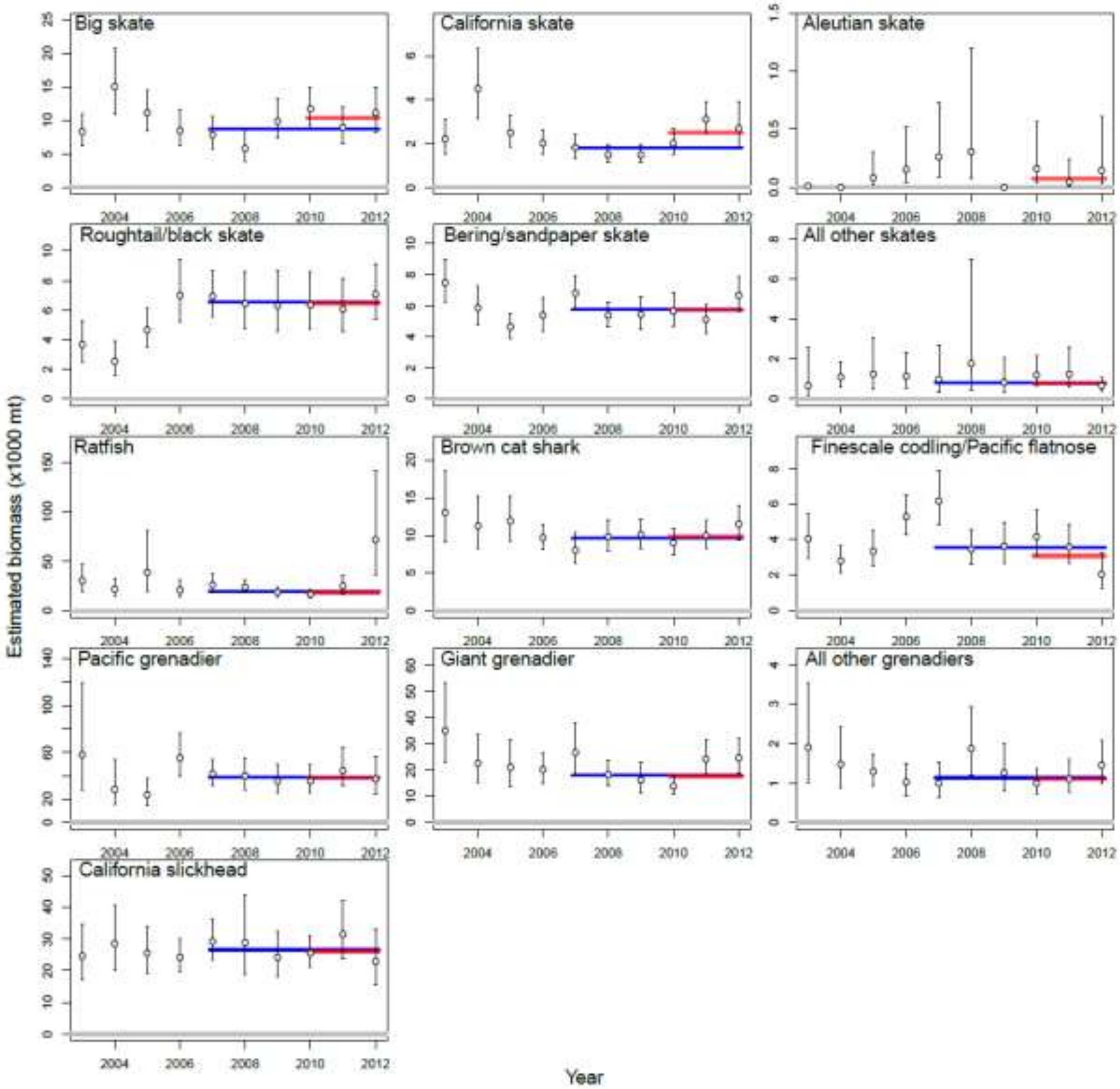

Figure 1. Time series of estimated survey biomass (mt), 2003-2012, with estimated 95% confidence intervals. Horizontal lines indicate weighted average value over most recent 6-year and 3-year periods. No 6-year average for Aleutian skate is reported because they were not encountered in the 2009 survey.

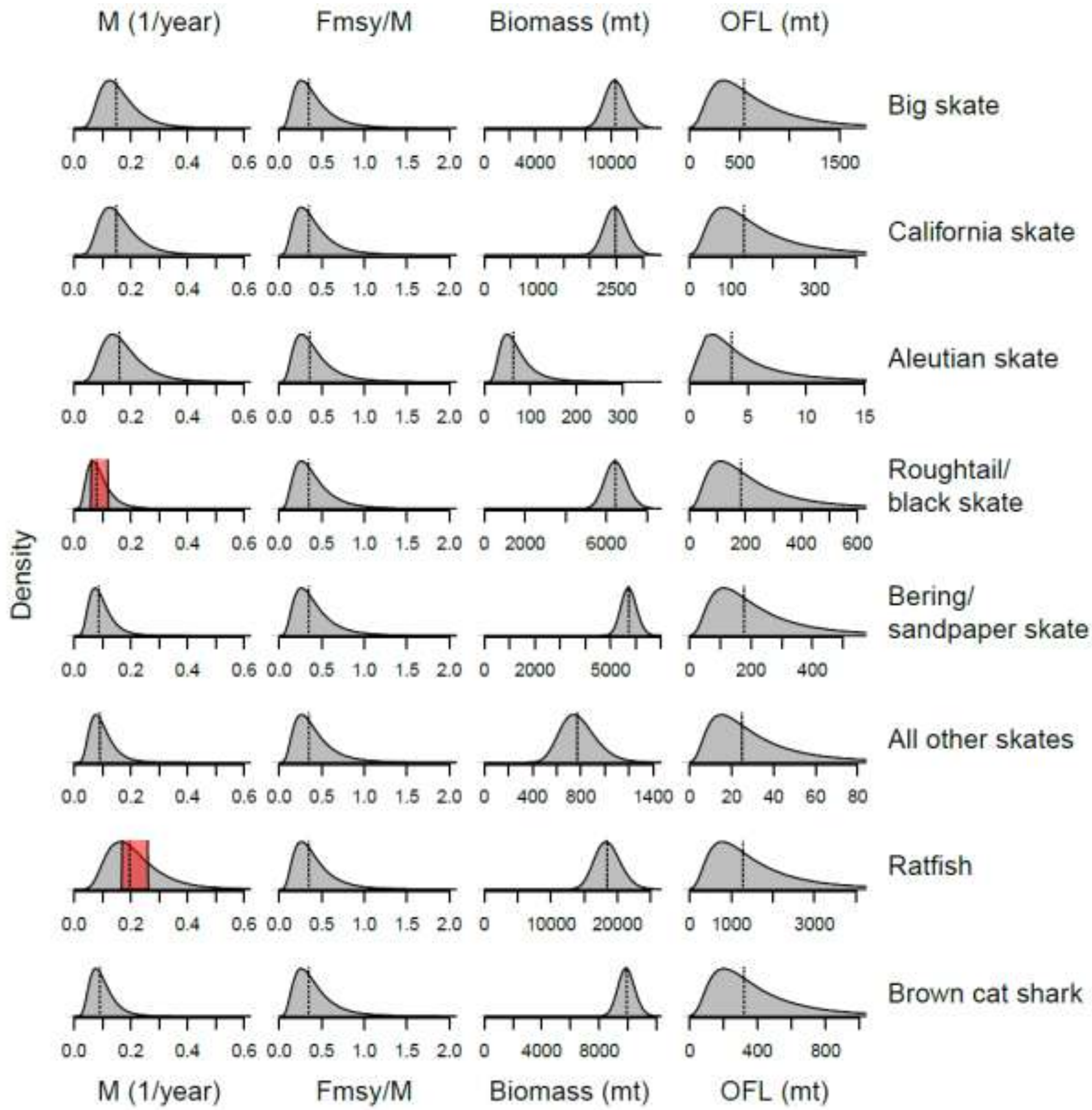

Figure 2a. Assumed distributions for M (first column) and F_{MSY}/M (second column), weighted average survey biomass for the years 2010–2012 (third column) and resulting OFL (fourth column) for 8 species of cartilaginous fish. Vertical lines indicate medians of each distribution. Shaded boxes in the first column for roughtail/black skate and Bering/sandpaper skate indicate the uniform distribution of M values used as expected values in sampling from lognormal distributions for these species.

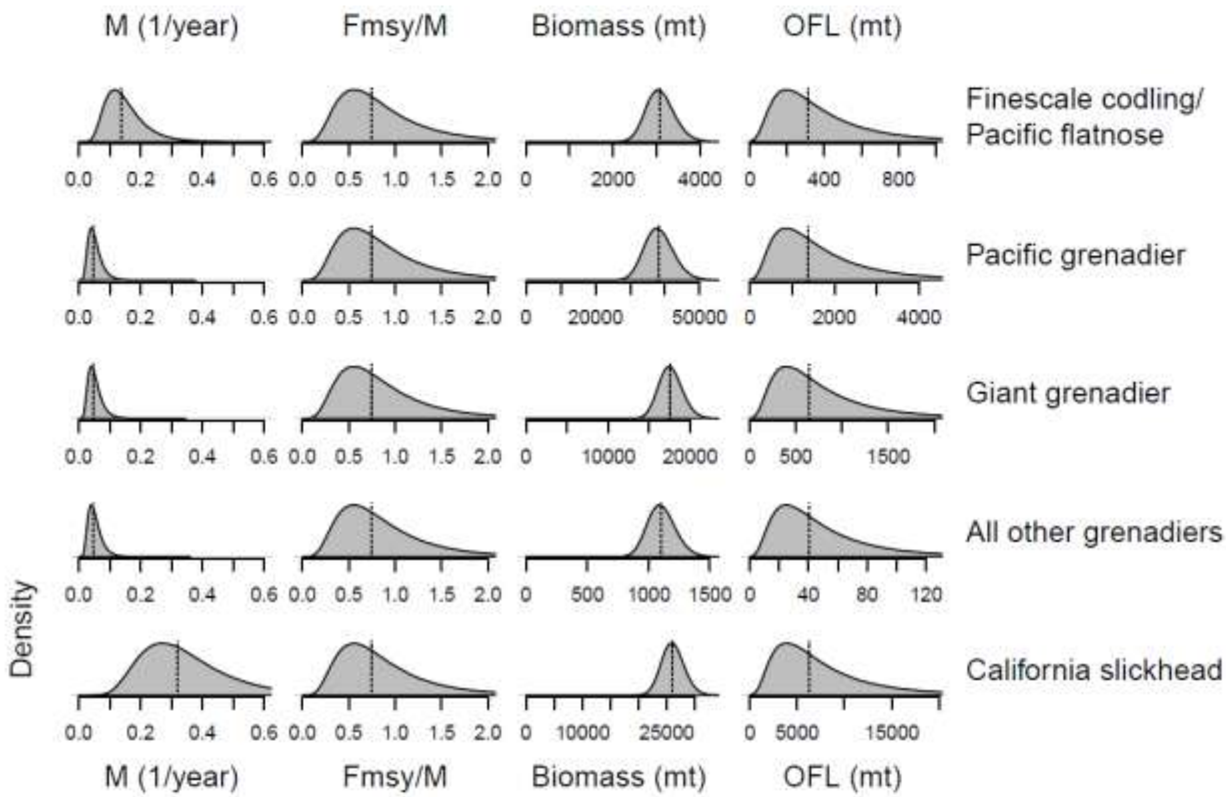

Figure 2b. Assumed distributions for M and F_{MSY}/M (left two columns), weighted average survey biomass (third column 2010–2012) and resulting OFL (fourth column) for 5 species of round fish.