

# Reevaluation of the OY range for groundfish in the Gulf of Alaska using single-species MSY estimates

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September 22, 2022

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# Key definitions in the Fisheries Management Plan for Groundfish in the Gulf of Alaska

Maximum sustainable yield (MSY) is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions, fishery technological characteristics (e.g., gear selectivity), and distribution of catch among fleets.

Optimum yield (OY) is the amount of fish which—

a) will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems;

b) is prescribed as such on the basis of the MSY from the fishery, as reduced by any relevant economic, social, or ecological factor; and

c) in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the MSY in such fishery.

Maximum fishing mortality threshold (MFMT, also called the “OFL control rule”) is the level of fishing mortality (F), on an annual basis, used to compute the smallest annual level of catch that would constitute overfishing. Overfishing occurs whenever a stock or stock complex is subjected to a level of fishing mortality or annual total catch that jeopardizes the capacity of a stock or stock complex to produce MSY on a continuing basis.

Overfishing limit (OFL) is the annual amount of catch that results from applying the MFMT to a stock or stock complex’s abundance. The OFL is the catch level above which overfishing is occurring.

# Recap of earlier OY specification for groundfish in the GOA

- Established by Amendment 15 to the GOA FMP in 1987.
- OY is specified for groundfish in aggregate as a range
- Lower end of the range is 116,000 t, lowest aggregate groundfish catch during 1965-1985.
- Upper end of range is based on the sum of single species MSY estimates
- Aggregate MSY in 1983 to 1987 ranged from 804,950 mt in 1983 to 1,137,750 mt for the 1987 fishing year.
- Average MSY over the five-year period was 873,070.
- Upper end of range set to 800,000 t with rationale for the 8% reduction is that it provides some allowance to ensure OY does not exceed MSY

From the FMP:

“Magnuson-Stevens Act requires Councils to “review on a continuing basis, and revise as appropriate, the assessments and specifications made ... with respect to the optimum yield.” In particular, OY may need to be respecified in the future if major changes occur in the estimate of MSY for the groundfish complex.”

# Groundfish Tiers 3-6

3) Information available: *Reliable point estimates of  $B$ ,  $B_{40\%}$ ,  $F_{35\%}$ , and  $F_{40\%}$ .*

3a) *Stock status:  $B/B_{40\%} > 1$*

$$F_{OFL} = F_{35\%}$$

$$F_{ABC} \leq F_{40\%}$$

3b) *Stock status:  $\alpha < B/B_{40\%} \leq 1$*

$$F_{OFL} = F_{35\%} \times (B/B_{40\%} - \alpha)/(1 - \alpha)$$

$$F_{ABC} \leq F_{40\%} \times (B/B_{40\%} - \alpha)/(1 - \alpha)$$

3c) *Stock status:  $B/B_{40\%} \leq \alpha$*

$$F_{OFL} = 0$$

$$F_{ABC} = 0$$

4) Information available: *Reliable point estimates of  $B$ ,  $F_{35\%}$ , and  $F_{40\%}$ .*

$$F_{OFL} = F_{35\%}$$

$$F_{ABC} \leq F_{40\%}$$

5) Information available: *Reliable point estimates of  $B$  and natural mortality rate  $M$ .*

$$F_{OFL} = M$$

$$F_{ABC} \leq 0.75 \times M$$

6) Information available: *Reliable catch history from 1978 through 1995.*

*OFL = the average catch from 1978 through 1995, unless an alternative value is established by the SSC on the basis of the best available scientific information*

$$ABC \leq 0.75 \times OFL$$

# Tier 3 approach

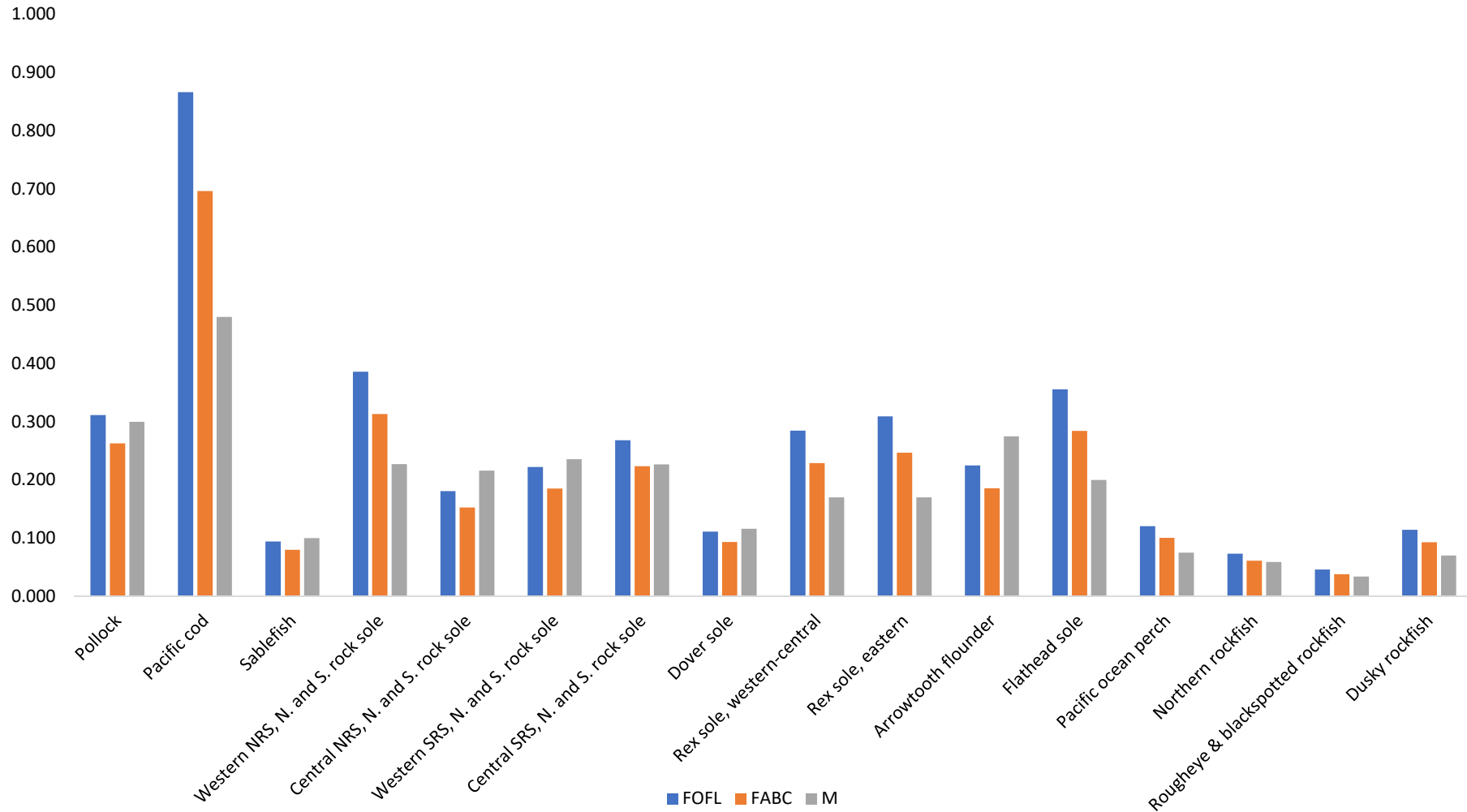
- For tier three stocks, the equilibrium yield at the FMSY proxy of F35% was used as an estimate of MSY.
- Produced routinely by the PROJ model used to project the OFL and the ABC for all Tier 3 assessments.
- Output files were obtained from the lead assessment author for each of the most recent Tier 3 assessments.

# Tier 3 approach

Stock	2021 Assessment status	Tier	COFL	CABC	FOFL	FABC	B35%	B40%	M	
Pollock	Full		3	187127	171728	0.311	0.263	150089	171530	0.300
Pacific cod	Full		3	77533	72056	0.866	0.696	56849	64970	0.480
Sablefish	Full		3	16122	15103	0.094	0.080	74687	85356	0.100
Western NRS, N. and S. rock sole	Full		3	4320	3978	0.386	0.313	10046	11481	0.227
Central NRS, N. and S. rock sole	Full		3	2936	2731	0.181	0.153	7320	8365	0.216
Western SRS, N. and S. rock sole	Full		3	6142	5658	0.222	0.185	15326	17515	0.236
Central SRS, N. and S. rock sole	Full		3	8184	7554	0.268	0.224	18704	21376	0.227
Dover sole	Partial		3	2443	2235	0.111	0.093	6661	7613	0.116
Rex sole, western-central	Full		3	7417	6844	0.285	0.229	16369	18707	0.170
Rex sole, eastern	Full		3	1683	1546	0.309	0.247	3149	3599	0.170
Arrowtooth flounder	Full		3	84788	79182	0.225	0.185	356544	407478	0.275
Flathead sole	Partial		3	17619	16228	0.356	0.284	32043	36620	0.200
Pacific ocean perch	Full		3	26455	24717	0.120	0.100	116171	132767	0.075
Northern rockfish	Partial		3	5273	4931	0.073	0.061	29691	33933	0.059
Rougheye & blackspotted rockfish	Full		3	615	574	0.046	0.038	5172	5911	0.034
Dusky rockfish	Partial		3	4668	4362	0.114	0.093	21299	24342	0.070
Tier 3 total				453326	419427					

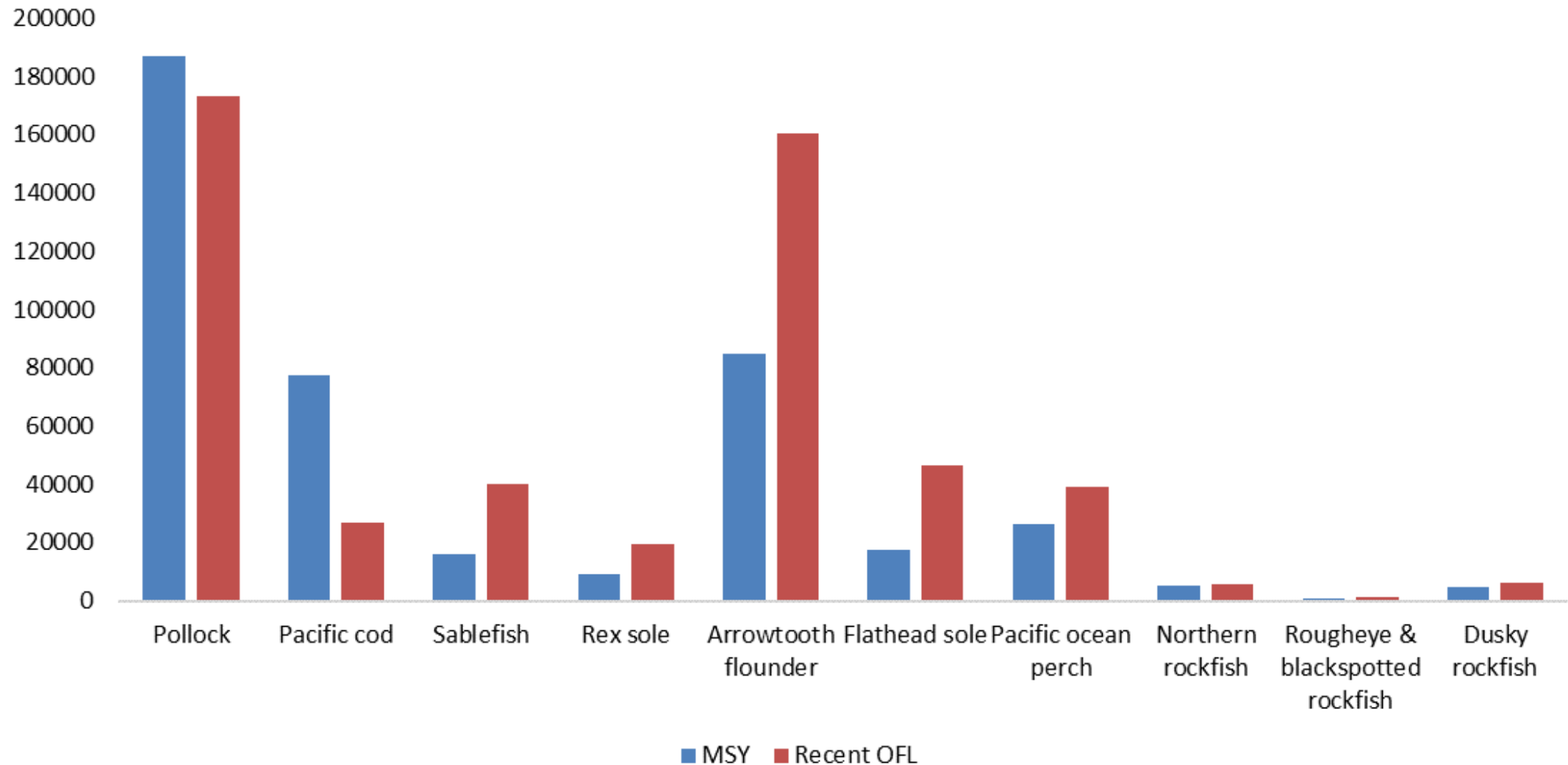
# Tier 3 approach

Natural mortality vs F reference points





# Tier 3 approach—MSY relative to recent OFL

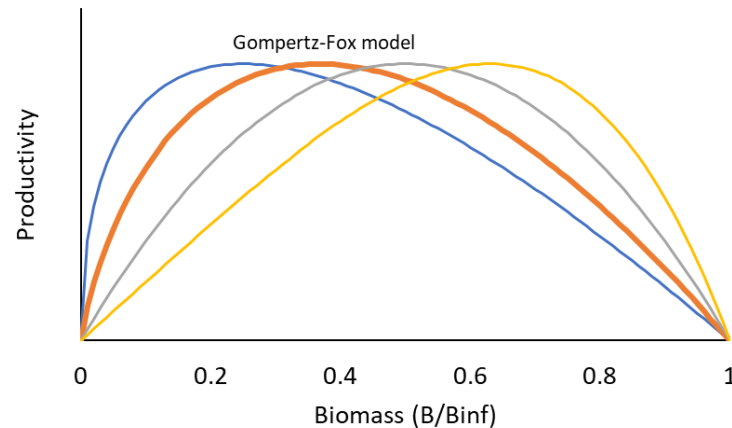


# Tier 4-5 approach

- For stocks in tiers 4 and 5, the OFL is obtained by multiplying current stock size by the either the natural mortality rate or the F35% fishing mortality rate.
- Many of the tier 4 and 5 stocks have historically been lightly exploited, consequently their abundance may be closer to unfished levels than the  $B_{MSY}$  stock size
- Simply considering OFL values from recent assessment as estimates of MSY has the potential to substantially overestimate MSY.

# Tier 4-5 approach

- Approach is based on the Gompertz-Fox surplus production model (Fox 1970), which can be considered a special case of the more general Pella-Tomlinson surplus production model (Quinn and Deriso 1988)



- For the Gompertz-Fox production model, stock size at maximum productivity, i.e., MSY stock size, occurs at  $1/e = 0.368$  of unfished abundance
- Approximately consistent with the tier 3 assumption of B35% as proxy for the biomass at MSY.

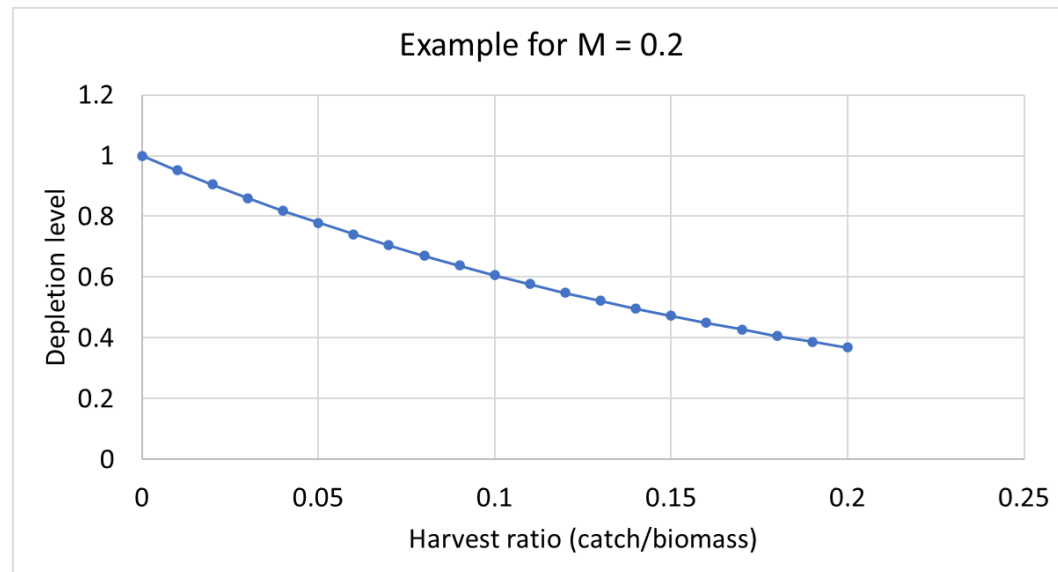
# Tier 4-5 approach

Equilibrium yield for the Gompertz-Fox production model is given by

$$Y_e = k_{max} B_e [\ln(B_{inf}) - \ln(B_e)]$$

- Assume  $F_{MSY} = F_{35\%} = M = k_{max}$
- Assume  $B_{inf} = 1$ , so that  $B_e$  represents stock size relative to unfished
- Assume the stock in equilibrium.
- Define  $h = Y_e / B_e =$  average catch/ average biomass.
- Rearranging and simplifying gives

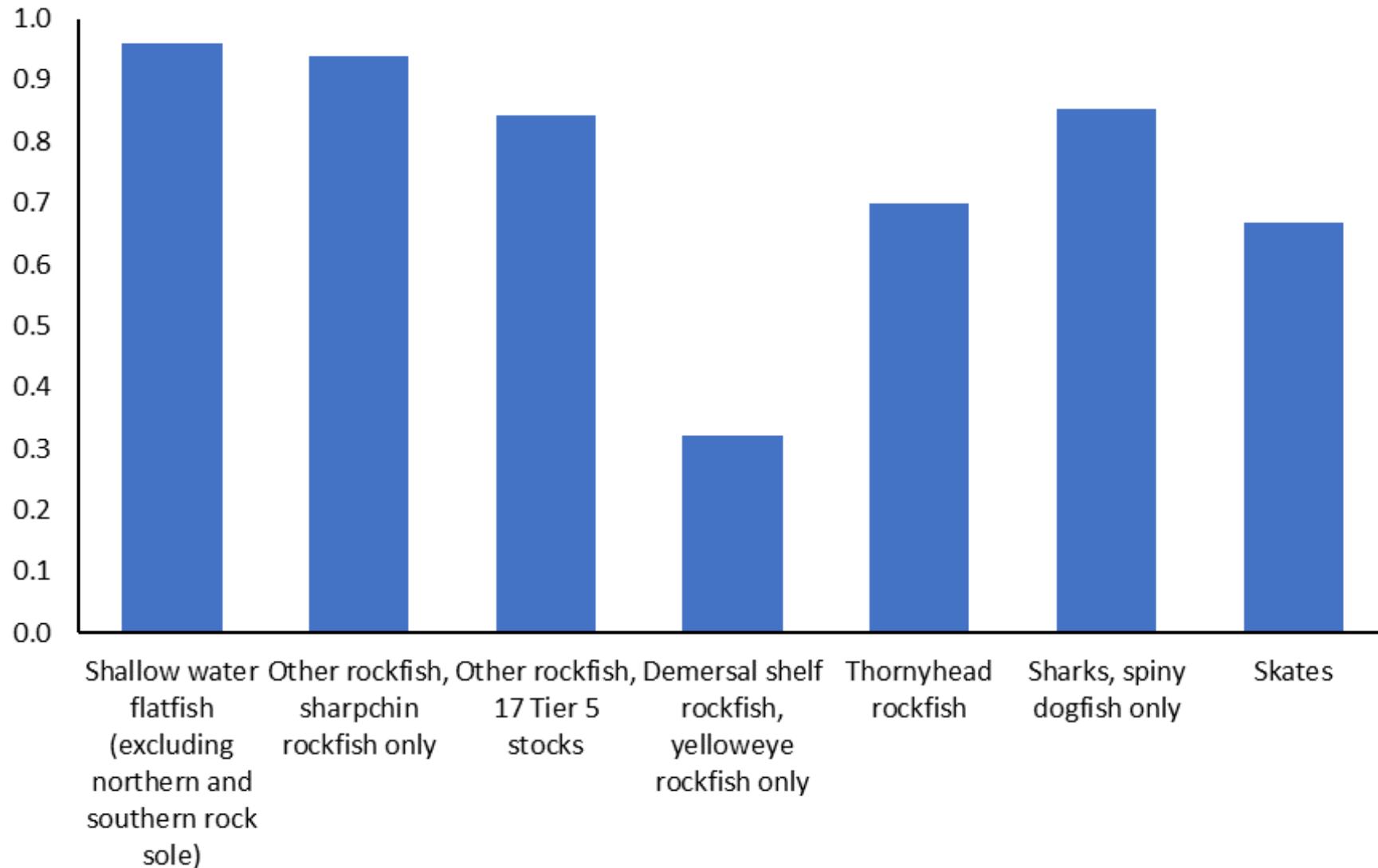
$$Depletion(B_e) = \exp\left(-h/M\right)$$



# Tier 4-5 approach

Stock/Stock complex	2021 Assessment status	Tier	M or FMSY	Average Biomass	Average Harvest	MSY (no B35% correction)	Stock depletion	MSY (Corrected to B35%)
Shallow water flatfish (excluding northern and southern rock sole)	Full	5	0.200	123149	1029	24630	0.9591	8988
Other rockfish, sharpchin rockfish only	Full	4	0.079	20167	101	1593	0.9384	594
Other rockfish, 17 Tier 5 stocks	Full	5	0.055	66552	632	3660	0.8414	1523
Demersal shelf rockfish, yelloweye rockfish only	Full	4	0.032	11,062	403	354	0.3206	386
Thornyhead rockfish	None	5	0.030	77394	830	2322	0.6993	1162
Sharks, spiny dogfish only	None	5	0.040	222474	1412	8899	0.8533	3650
Skates	Full	5	0.100	95178	3853	9518	0.6671	4994
			Total			50976		21297

# Tier 4-5 approach, stock depletion



# Tier 6 approach

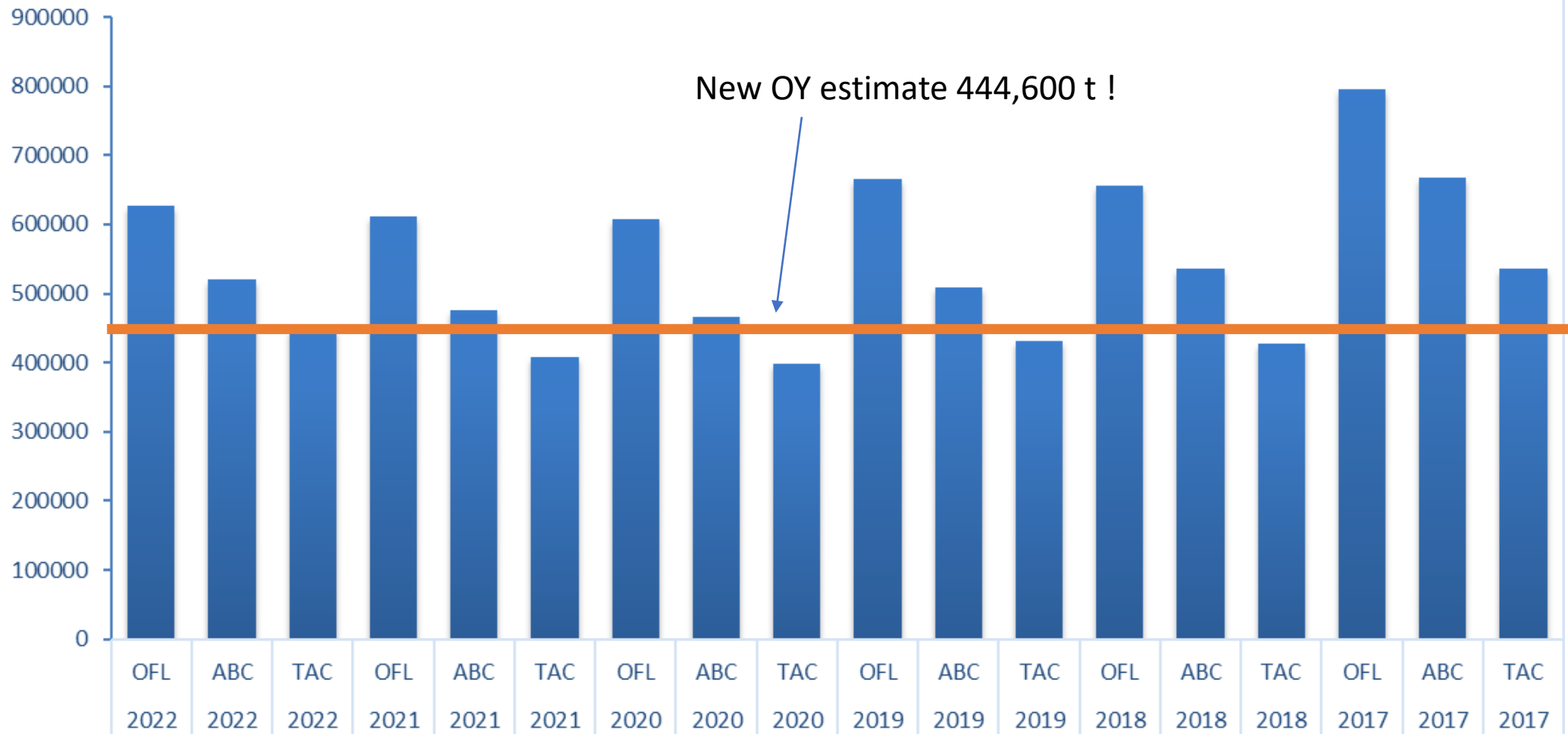
- For tier 6 stocks, the default OFL is based on average catch during the period 1978-1995.
- Since this OFL is a constant value, it was considered an appropriate proxy for MSY.
- Tier 6 stocks account for less than 2% of the aggregate MSY for groundfish

# Tier 6 approach

Stock/Stock complex	2021 Assessment status	Tier	OFL
Deepwater flatfish, except Dover sole	Partial	6	313
Other rockfish, Tier 6 only	Full	6	236
Demersal shelf rockfish, except yelloweye rockfish	Full	6	26
Atka mackerel	Full	6	6200
Octopus	Full	6	1307
Sharks, except spiny dogfish	None	6	570
		Total	8652



## Total OFL, ABC, and TAC



# Takeaways

- Repeating the OY estimation procedure gave an aggregate OY of 444,600 t compared to the original estimate of 800,000 t.
- Recent aggregate ABCs have been slightly higher new estimate of OY, but the aggregate TACs have been surprisingly similar
- The aggregate groundfish OY will be evaluated using other approaches as a part GOA-CLIM