

# **Status and Future Prospects for the Pacific Ocean Perch Resource in Waters off Washington and Oregon as Assessed in 2007**

by

Owen S. Hamel

*DRAFT May 18, 2005*

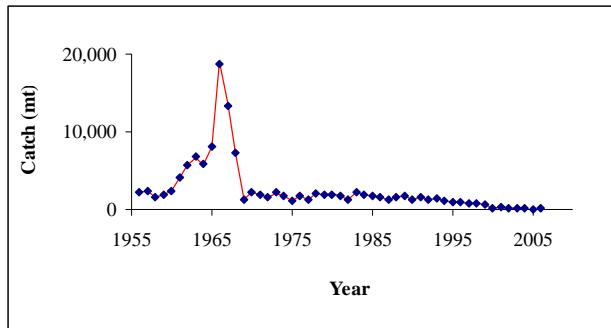
*This information is distributed solely for the purpose of pre-dissemination peer review under applicable information quality guidelines. It has not been formally disseminated by NOAA Fisheries. It does not represent and should not be construed to represent any agency determination or policy.*

Northwest Fisheries Science Center  
U. S. Department of Commerce  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
2725 Montlake Blvd East  
Seattle, Washington 98112-2097

# Status and Future Prospects for the Pacific Ocean Perch Resource in Waters off Washington and Oregon as Assessed in 2007

This assessment update applies to the Pacific ocean perch (*Sebastes alutus*) (POP) species of rockfish for the combined US Vancouver and Columbia INPFC areas. Catches are characterized by large removals of between 5,000 and 20,000 mt during the mid-1960's, primarily by foreign vessels. The fishery proceeded with more moderate removals of between 1,100 and 2,200 metric tons per year from 1969 through 1994, with the foreign fishery ending in 1977. Management measures further reduced landings to below 900 metric tons by 1995, with subsequent landings falling steadily until reaching between 60 and 150 metric tons per year from 2002 through 2006.

Catch history from 1956-2006



Catch estimates for past 10 years including discard

Year	Catch
1997	751
1998	739
1999	593
2000	171
2001	307
2002	179
2003	151
2004	146
2005	75
2006	83

This assessment is an update and uses the same model as in the 2003 and 2005 assessments, a forward projection age-structured model (Hamel 2005, Hamel et al. 2003).

New data and changes to the data used in the previous assessment are as follows. Catch data for 2003 and 2004 were updated, and new catch data were added for 2005 and 2006. Fishery age compositions from 1999-2004 were updated, with new 2005 and 2006 age compositions added. The 1999-2004 NWFSC slope survey biomass indices and age compositions were recalculated based upon changes in stratum area estimates and any updates in the database, with the 2005 and 2006 NWFSC slope survey biomass indices and age compositions added.

A number of sources of uncertainty are explicitly included in this assessment. For example, allowance is made for uncertainty in natural mortality, the parameters of the stock-recruitment relationship, and the survey catchability coefficients. However, sensitivity analyses based upon alternative model structures / data set choices in the 2003 and 2005 assessments suggest that the overall uncertainty may be greater than that predicted by a single model specification. There are also other sources of uncertainty that are not included in the current model. These include the degree of connection between the stocks of Pacific ocean perch off British Columbia and those in PFMC waters; the effect of the PDO, ENSO and other climatic variables on recruitment, growth and survival of Pacific ocean perch; gender differences in growth and survival; a possible non-linear relationship between individual spawner biomass and effective spawning output and a more complicated relationship between age and maturity.

A reference case was selected which adequately captures the range for those sources of uncertainty considered in the model. Bayesian posterior distributions based on the reference case were estimated for key management and rebuilding variables. These distributions best reflect the uncertainty in this analysis, and are suitable for probabilistic decision making.

***Retrospective of past 10 years***

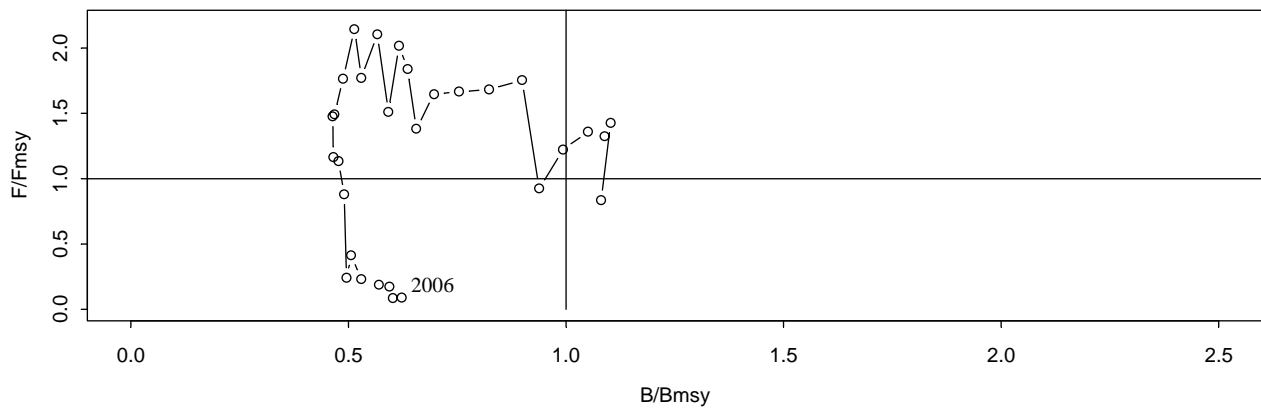
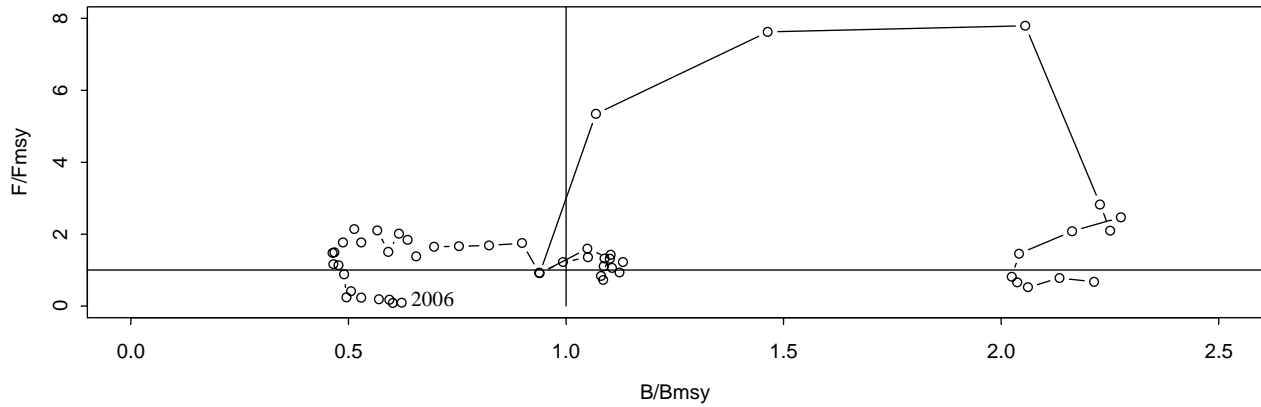
<i>Year</i>	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
<i>Total Catch</i>	751	739	593	171	307	179	151	146	75	83	
<i>Discards</i>	120	118	95	27	49	29	24	24	12	13	
<i>Landings</i>	631	621	498	144	258	150	127	122	63	70	
<i>ABC</i>			695	713	1541	640	689	980	988	733	765
<i>OY (HG)</i>	(750)	(750)	595	270	303	350	377	444	447	366	382
<i>F</i>	0.0445	0.0434	0.0336	0.0093	0.0158	0.0089	0.0072	0.0067	0.0033	0.0035	
<i>Expl. Rate</i>	0.0420	0.0407	0.0327	0.0094	0.0163	0.0087	0.0068	0.0062	0.0030	0.0032	
<i>3+ Biomass</i>	17809	18214	18178	18231	18760	20582	22142	23508	24618	25658	26544
<i>Biom. sd</i>	2326	2452	2519	2583	2663	3008	3314	3599	3847	4080	4310
<i>Biom. cv</i>	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.16	0.16	0.16
<i>Sp Biomass</i>	6882	7055	7249	7331	7489	7826	8428	8791	8910	9210	10168
<i>Sp Bio. sd</i>	907	954	1006	1038	1055	1107	1194	1251	1273	1325	1506
<i>Sp Bio. cv</i>	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.15
<i>Recruitment</i>	5.07	3.69	0.53	0.82	1.69	10.47	5.35	3.13	1.61	1.48	
<i>Rec. sd</i>	1.15	0.96	0.32	0.39	0.67	2.75	2.05	1.53	1.27	1.33	
<i>Rec. cv</i>	0.23	0.26	0.61	0.47	0.39	0.26	0.38	0.49	0.79	0.90	
<i>Depletion</i>	0.186	0.191	0.196	0.198	0.202	0.212	0.228	0.238	0.241	0.249	0.275
<i>Depl. sd</i>	0.031	0.032	0.034	0.035	0.035	0.037	0.040	0.042	0.043	0.045	0.051
<i>Depl. cv</i>	0.17	0.17	0.17	0.17	0.17	0.18	0.18	0.18	0.18	0.18	0.19

The point estimate (maximum of the posterior density function, MPD) for the depletion of the spawning biomass at the start of 2007 is 27.5%. The ABC for 2007 based on the MPD point estimate is 1009 mt. The OY for 2007 based upon the 40-10 rule is 588 mt (The ABC and OY for 2007 in the above table are based on current management and the 2005 assessment). For West Coast rockfish, a stock is considered overfished when it is below 25% of virgin spawning biomass, and recovered when it reaches 40% of virgin spawning biomass. Overfishing for POP is considered to be occurring when F is above  $F_{msy} = 0.0382$  according to the current assessment base model. Based on this assessment, POP on the West Coast are recovering, and overfishing is not occurring.

POP are essentially managed on a regional basis, as they occur almost exclusively off of Oregon and Washington for the West Coast. Management and assessment of stock status might be improved through greater cooperation with British Columbia, as the stock extends northward into Canadian waters.

***Major quantities from assessment***

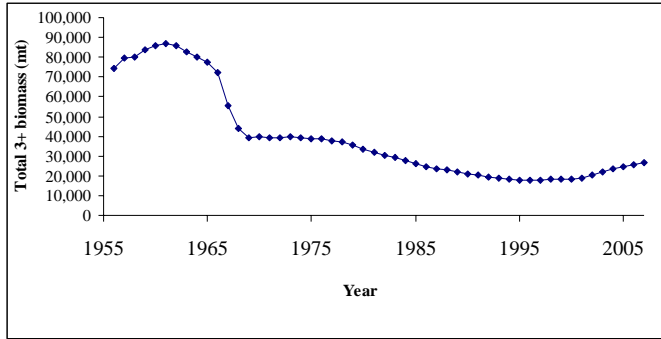
	<i>Value</i>	<i>sd</i>	<i>cv</i>
$SB_0$	36,983	4,863	0.13
$B_0$	82,052	11,001	0.13
$R_0$	4.97	0.97	0.20
$SB_{msy}$	14,793	2,462	0.17
$F_{msy}$	0.0382	0.0123	0.32
<i>Basis for above</i>	F at equilibrium 40% biomass with S-R curve		
<i>Exploitation rate at MSY</i>	0.0388	0.0107	0.28
$MSY$	1411	348	0.25



***F/F<sub>msy</sub> versus B/B<sub>msy</sub> for all years of catch data and the last 30 years***

The point estimates of summary (age 3+) biomass show an upward trend over the past ten years, increasing by nearly 50% in that time.

**3+ Biomass Levels from 1956 to 2007**



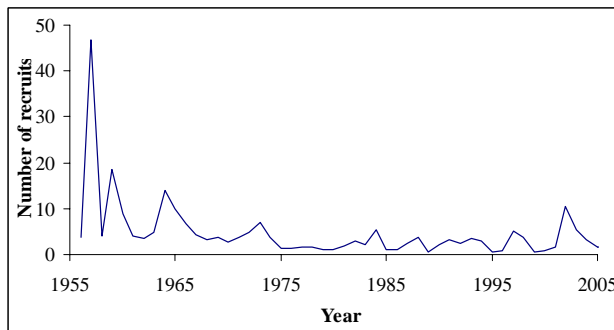
**Biomass estimates for the past 10 years**

<i>Year</i>	<i>Total 3+ biomass(mt)</i>
1998	18,214
1999	18,178
2000	18,231
2001	18,760
2002	20,582
2003	22,142
2004	23,508
2005	24,618
2006	25,658
2007	26,544

The recruitment pattern for POP is similar to that of many rockfish species. Recent decades have provided rather poor year-classes compared with the 1950s and 1960s, although the 1999 year class (the 2002 recruitment year ) appears to be larger than has occurred since the 1960's, and the 2000 year class appears to be relatively large as well.

The first year for which there are age-composition data to support an estimate of recruitment is 1956, which also happens to be the first year for which catch data are available. The estimates of recruitment for the years prior to 1956 are close to the equilibrium estimate from the stock-recruitment relationship. The first few years with recruitment estimates that are informed by data are, however, still highly uncertain. The extremely large recruitment for 1957 may therefore partly reflect slightly higher average recruitment over the years 1935-56. Only by the early to mid-1960's are the estimates of recruitment reliable. Recent (1997-2006 in the table below) estimates of recruitment are highly variable by year, and lower on average than those for 1960-74, though higher on average than those for 1975-1994. The estimate of recruitment for 2006 is based on very limited information.

**Recruitment estimates (1935-2006)**



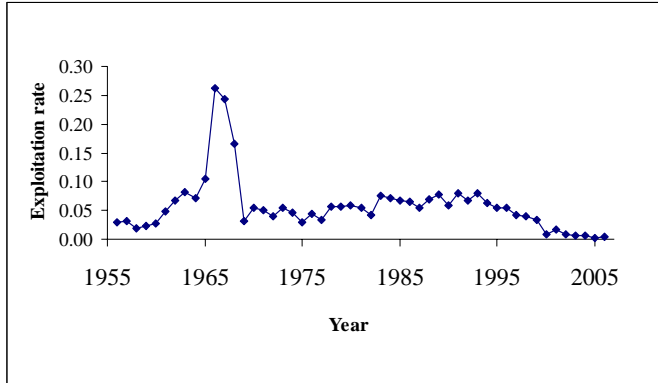
**Recruitment estimates for the past 10 years  
(millions of age-3 recruits)**

<i>Year</i>	<i>Recruitment</i>
1997	5.07
1998	3.69
1999	0.53
2000	0.82
2001	1.69
2002	10.47
2003	5.35
2004	3.13
2005	1.61
2006	1.48

The exploitation rate (percent of biomass taken) on fully-selected animals peaked near 25% in the mid-1960's when foreign fishing was intensive. The exploitation rate dropped by the late 1960's, but increased slowly and steadily from 1975 to the early 1990's, due to decreasing exploitable biomass. Over the past 10 years the exploitation rate has fallen from over 4% to under 0.5%.

**Exploitation rate estimates (1956-2007)**

**Exploitation estimates for the past 10 years**



Year	Exploitation rate
1997	0.0420
1998	0.0407
1999	0.0327
2000	0.0094
2001	0.0163
2002	0.0087
2003	0.0068
2004	0.0062
2005	0.0030
2006	0.0032

Near term projections show a slow monotonic increase in exploitable biomass. These were calculated with a new module within the assessment model using fishing mortality rates of 0.01 and 0.02. This module projects recruitment from the estimated spawner recruit curve.

**Catch, Spawning Biomass and Depletion MPD projections with  $F = 0.01$  and  $0.02$**

Year	F=0.01			F=0.02		
	Catch	Sp. Bio.	Depletion	Catch	Sp. Bio.	Depletion
2007	257	10168	0.275	510	10168	0.275
2008	272	11399	0.308	535	11273	0.305
2009	295	12218	0.330	573	11961	0.323
2010	320	12612	0.341	615	12217	0.330
2011	334	12781	0.346	635	12244	0.331
2012	340	13007	0.352	640	12329	0.333
2013	342	13367	0.361	638	12554	0.339
2014	349	13765	0.372	644	12824	0.347
2015	359	14175	0.383	658	13110	0.354
2016	371	14595	0.395	675	13408	0.363
2017	382	15023	0.406	691	13715	0.371
2018	393	15455	0.418	707	14025	0.379

To create three different possible states of nature for the two fishing mortality rates, we took the medians of the lowest 25%, the middle 50% and the highest 25% for each quantity and year from the 2400 saved model runs from the MCMC analysis. These projections are based upon the estimated spawner recruit curve and current spawning biomass and age composition estimates. A more thorough analysis will be done for the rebuilding analysis, upon which management actions will be based, which will likely result in different projections than those seen here.

**Catch, Spawning Biomass and Depletion MCMC projections with  $F = 0.01$**

Catch (mt)	Spawning biomass	Depletion
------------	------------------	-----------

	0-25%	25-75%	75-100%	0-25%	25-75%	75-100%	0-25%	25-75%	75-100%
2007	225	271	328	8936	10778	13133	0.245	0.312	0.395
2008	239	288	352	9999	12166	15022	0.275	0.353	0.450
2009	256	312	384	10686	13107	16334	0.294	0.380	0.488
2010	274	337	420	10986	13556	16966	0.303	0.393	0.507
2011	286	354	445	11102	13771	17281	0.306	0.400	0.516
2012	293	364	458	11269	14024	17613	0.311	0.407	0.525
2013	296	369	463	11555	14382	18031	0.319	0.418	0.537
2014	301	375	470	11872	14763	18462	0.328	0.429	0.549
2015	309	384	480	12191	15147	18891	0.336	0.441	0.560
2016	317	395	492	12513	15538	19318	0.345	0.453	0.571
2017	326	405	503	12841	15932	19741	0.354	0.465	0.582
2018	334	415	513	13168	16326	20160	0.364	0.476	0.593

*Catch, Spawning Biomass and Depletion MCMC projections with  $F = 0.02$*

	Catch (mt)			Spawning biomass			Depletion		
	0-25%	25-75%	75-100%	0-25%	25-75%	75-100%	0-25%	25-75%	75-100%
2007	447	538	653	8936	10778	13133	0.245	0.312	0.395
2008	469	566	691	9889	12033	14863	0.272	0.349	0.445
2009	497	606	748	10460	12836	16006	0.288	0.373	0.478
2010	527	647	808	10640	13139	16462	0.293	0.381	0.492
2011	544	673	847	10634	13206	16592	0.293	0.383	0.495
2012	551	686	863	10680	13311	16740	0.295	0.386	0.499
2013	551	688	865	10852	13524	16977	0.300	0.393	0.505
2014	556	694	870	11059	13769	17237	0.305	0.400	0.512
2015	566	705	881	11273	14023	17504	0.311	0.408	0.519
2016	577	718	895	11493	14286	17774	0.317	0.416	0.525
2017	589	732	909	11717	14556	18045	0.324	0.425	0.532
2018	600	745	922	11938	14827	18318	0.330	0.433	0.538

Research and data needs for future assessments include information on the relationship of individual female age and biomass to maturity, fecundity and survival of offspring; information on the accuracy of POP ageing; information on the relative density of POP in trawlable and untrawlable areas and difference in age and/or length compositions between those areas; and information on the status of the British Columbia stock of POP and its relationship to that off of Oregon and Washington.