DRAFT - Status of the Pacific Hake (whiting) stock in U.S. and Canadian waters in 2015

Joint Technical Committee of the Pacific Hake/Whiting Agreement
Between the Governments of the United States and Canada

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EXECUTIVE SUMMARY

STOCK

This assessment reports the status of the coastal Pacific Hake (or Pacific Whiting, *Merluccius Productus*) resource off the west coast of the United States and Canada. This stock exhibits seasonal migratory behavior, ranging from offshore and generally southern waters during the winter spawning season to coastal areas between northern California and northern British Columbia during the spring, summer and fall when the fishery is conducted. In years with warmer water temperatures the stock tends to move farther to the North during the summer and older hake tend to migrate farther than younger fish in all years with catches in the Canadian zone typically consisting of fish greater than four years old. Separate, and much smaller, populations of hake occurring in the major inlets of the northeast Pacific Ocean, including the Strait of Georgia, Puget Sound, and the Gulf of California, are not included in this analysis.

CATCHES

Coast-wide fishery Pacific Hake landings averaged 224,364 t from 1966 to 2015, with a low of 89,930 t in 1980 and a peak of 363,135 t in 2005. Prior to 1966, total removals were negligible compared to the modern fishery. Over the early period, 1966–1990, most removals were from foreign or joint-venture fisheries. Over all years, the fishery in U.S. waters averaged 168,983 t, or 75.3% of the average total landings, while catch from Canadian waters averaged 55,381 t. Over the last 10 years, 2006–2015, the total average catch is 265,646 with U.S. and Canadian catches averaging 206,859 t and 58,786 t, respectively.

In this stock assessment, the terms catch and landings are used interchangeably. Estimates of discard within the target fishery are included, but discarding of Pacific Hake in non-target fisheries is not. Discard from all fisheries is estimated to be less than 1% of landings in recent years. Recent coast-wide landings from 2010–2014 have been above the long term average of 224,364 t.

Landings between 2001 and 2008 were predominantly comprised of fish from the very large 1999 year class, with the cumulative removal from that cohort exceeding 1.2 million t.

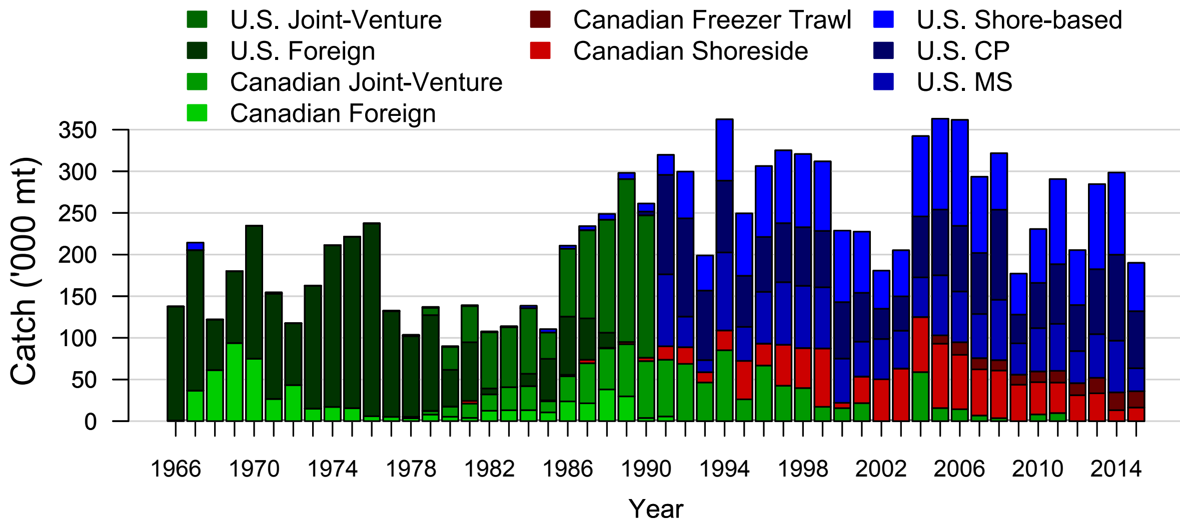

Figure 1. Total Pacific Hake catch used in the assessment by sector, 1966 – 2015. U.S. tribal catches are included in the sectors where they are represented.

Table 1. Recent commercial fishery catch (1,000's t). Tribal catches are included where applicable.

Year	US Mother-ship	US Catcher-Processor	US Shore-based	US Research	US Total	CAN Joint Venture	CAN Shore-side	CAN Freezer-Trawler	CAN Total	Total
2006	60,926	78,864	127,165	0	266,955	14,319	65,289	15,136	94,744	361,699
2007	52,977	73,263	91,441	0	217,682	6,780	55,390	13,537	75,707	293,389
2008	72,440	108,195	67,760	0	248,395	3,592	57,197	12,517	73,306	321,701
2009	37,550	34,552	49,223	0	121,325	0	43,774	12,073	55,847	177,172
2010	52,022	54,284	64,654	0	170,961	8,081	38,780	12,850	59,712	230,672
2011	56,394	71,678	102,147	1,042	231,262	9,717	36,632	14,060	60,409	291,671
2012	38,512	55,264	65,920	448	160,145	0	31,164	14,478	45,642	205,787
2013	52,470	77,950	102,143	1,018	233,581	0	33,451	18,583	52,033	285,614
2014	62,102	103,203	98,638	197	264,139	0	13,184	21,380	34,563	298,703
2015	27,658	68,484	58,009	0	154,152	0	16,364	19,532	35,896	190,047

DATA AND ASSESSMENT

The biomass estimate from the acoustic survey conducted in 2015 has been added to the model survey time series. The only other new data included in 2015 are the 2015 fishery age compositions and total catch. Various other data types, including data on maturity, have been explored since the 2014 stock assessment, but are not included in the base model for this year.

The Joint Technical Committee (JTC) assessment depends primarily on the fishery landings (1966 – 2015), acoustic survey biomass estimates and age-composition (1995 – 2015; Figure 2), as well as fishery age-composition. While the 2011 survey index value was the lowest in the time-series, the index increased steadily over the four surveys conducted in 2011, 2012, 2013, and 2015. Age-composition data from the aggregated fisheries (1975–2014) and the acoustic survey contribute to the assessment model<U+0092>s ability to resolve strong and weak cohorts.

The assessment uses a Bayesian estimation approach, sensitivity analyses, and closed-loop simulations to evaluate the potential consequences of parameter uncertainty, alternative structural models, and management system performance, respectively. The Bayesian approach combines prior knowledge about natural mortality, stock-recruitment steepness (a parameter for stock productivity), and several other parameters with likelihoods for acoustic survey biomass indices and age-composition, as well as fishery age composition data. Integrating the joint posterior distribution over model parameters (via Markov Chain Monte Carlo simulation) provides probabilistic inferences about uncertain model parameters and forecasts derived from those parameters. Sensitivity analyses are used to identify alternative structural models that may also be consistent with the data. Finally, the closed-loop simulations provide an assessment of how alternative combinations of survey frequency, assessment model selectivity assumptions, and harvest control rules affect expected management outcomes given repeated application of these procedures over the long-term.

This 2015 assessment retains the structural form of the base assessment model from 2014. The model retains many of the previous elements as configured in Stock Synthesis (SS). Analyses conducted in 2014 showed that the time-varying selectivity assessment model reduced the magnitude of extreme cohort strength estimates. In closed-loop simulations, management based upon assessment models with time-varying fishery selectivity led to higher median average catch, lower risk of falling below 10% of unfished biomass (B_0), smaller probability of fishery closures, and lower inter-annual variability in catch compared to assessment models with time-invariant fishery selectivity. It was found that even a small degree of flexibility in the assessment model fishery selectivity could reduce the effects of errors caused by assuming selectivity is constant over time.

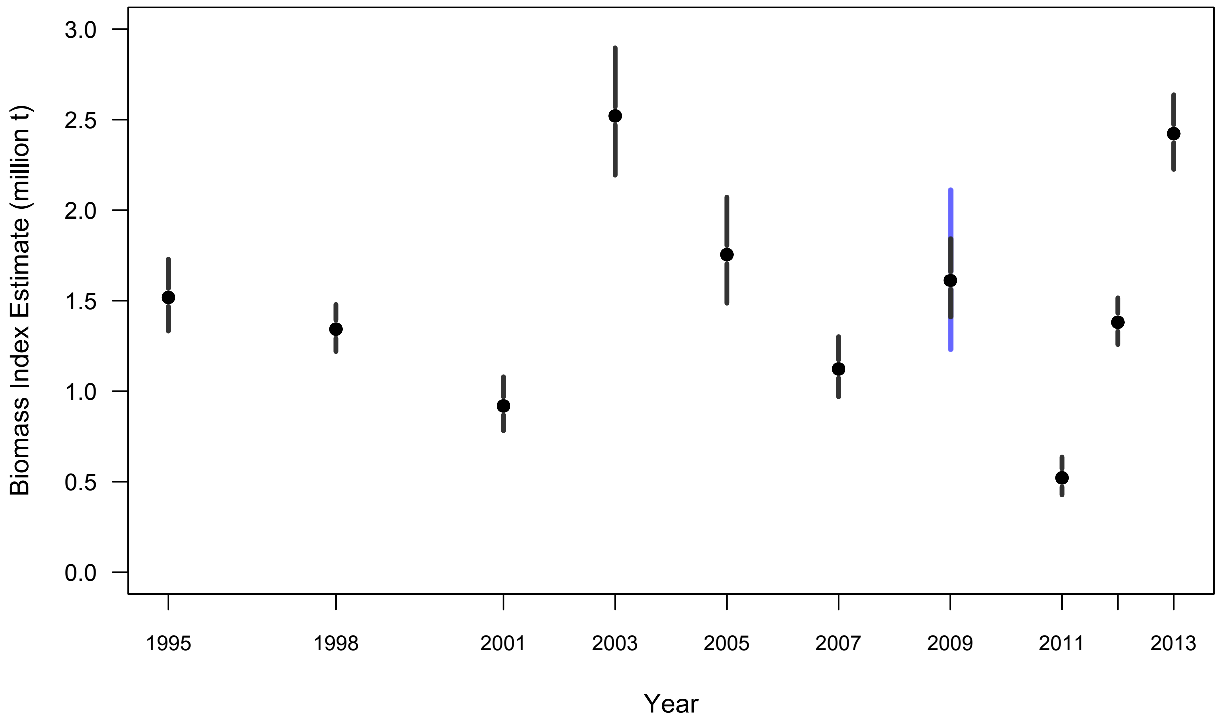

Figure 2. Acoustic survey biomass index (millions of metric tons). Approximate 95% confidence intervals are based on only sampling variability (1995–2007, 2011–2015) in addition to squid/hake apportionment uncertainty (2009, in blue).

STOCK BIOMASS

The base stock assessment model indicates that since the 1960s, Pacific Hake female spawning biomass has ranged from well below to near unfished equilibrium. The model estimates that it was below the unfished equilibrium in the 1960s and 1970s due to lower than average recruitment. The stock is estimated to have increased rapidly to near unfished equilibrium after two or more large recruitments in the early 1980s, and then declined steadily after a peak in the mid- to late-1980s to a low in 2000. This long period of decline was followed by a brief increase to a peak in 2003 as the large 1999 year class matured. The 1999 year class largely supported the fishery for several years due to relatively small recruitments between 2000 and 2007 entering the fishery to replace catches being removed during this period. With the aging 1999 year class, median female spawning biomass declined throughout the late 2000s, reaching a time-series low of