

NEW ENGLAND FISHERY MANAGEMENT COUNCIL

**SMALL MESH MULTISPECIES
(WHITING, RED HAKE, OFFSHORE HAKE):
Updated Stock Information**

This document provides updated information about small mesh multispecies (silver hake/whiting, red hake, offshore hake) included in the Northeast Multispecies (Groundfish) FMP. It also updates the status of these stocks relative to their current overfishing definitions.

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1.0 INTRODUCTION – UPDATED SURVEY DATA

For the purposes of updating small mesh multispecies stock status information, the Whiting PDT re-estimated the entire time series of NEFSC fall bottom trawl survey data. The updated time series is presented for each small mesh multispecies stock in this document. In addition, for consistency, overfishing definition reference points were re-calculated when necessary by the Whiting PDT using the updated survey time series that is presented in this document.

Two factors are responsible any differences between the survey indices in this report and those from the 2003 Small Mesh Multispecies SAFE Report:

1. **Shift from the use of arithmetic means to delta-mean survey indices** – When catch data are highly variable, delta distribution estimators can be applied to provide a more precise estimate of the mean and variance compared to those estimated using an arithmetic mean. Silver hake survey biomass indices were estimated based on the delta distribution for the northern stock only during the 17th SARC (NEFSC 1994). The next silver hake assessment, conducted in 2000 (Brodziak *et al.* 2001), applied the delta-distribution to both the northern and southern stocks of silver hake. Survey indices for both red hake and offshore hake have since then been estimated using the delta distribution, so that all survey indices in the small mesh fishery would be estimated consistently. The differences between the two methods are relatively minor for the majority of years in the time series. In addition, the biomass thresholds and targets for each stock have been updated to reflect these changes, thus all comparisons have the same basis.
2. **Improved precision of survey data with a corresponding change to data query software**– During NEFSC bottom trawl research surveys prior to 2001, the total catch weight of each species was recorded to 0.1 kg at each station. Starting in spring 2001, the NEFSC began electronic recording of length and weight measurements at each station during the research surveys. At that same time, the precision of the catch weights was increased by recording the weight to 0.01 kg, and in some cases to 0.001 kg. The increased precision of the catch weights, however, was not incorporated into the software until spring 2005. Any differences in the survey indices presented here compared to previous reports reflect the improved precision and are generally minor.

Given the two factors identified above, updated survey biomass indices for recent years, i.e. 2002 to 2005, changed a previous status determination for the southern stock of silver hake. The three-year moving average survey index for the southern stock of silver hake increased above the biomass target in 2003, at which time the stock would be considered “rebuilt” under the Amendment 12 rebuilding program.

The survey indices and stock status determinations provided in this document have been reviewed by the Whiting PDT and should be considered the best available scientific information at this time.

2.0 SILVER HAKE (WHITING)

The current overfishing definition¹ for silver hake (summarized in Table 1) is as follows:

*Silver hake is overfished when the three-year moving average of the fall survey weight per tow is less than **3.31 kg/tow and 0.89 kg/tow for the northern and southern stocks respectively**, one half of the B_{MSY} proxy (the average observed from 1973 – 1982). If an analytical assessment (e.g. VPA) for silver hake is available, the three-year moving average will be replaced with the terminal year biomass estimate and compared with the mean biomass estimated for 1973 – 1982.*

*Overfishing occurs when fishing mortality, derived from the latest three years of survey data, exceeds $F_{0.1}$ (**0.41 and 0.39 for the northern and southern stocks of silver hake respectively**). If an analytical assessment is available, then the terminal year fishing mortality rate will be compared to $F_{0.1}$.*

Table 1 Current Overfishing Definition Reference Points for Silver Hake

STOCK	THRESHOLDS	TARGETS
Northern Silver Hake	$F_{0.1} = (0.41)$ $B = \frac{1}{2} B_{MSY}$ proxy = 3.31 kg/tow	F below $F_{0.1}$ B = 1973-1982 weight per tow = 6.63 kg/tow
Southern Silver Hake	$F_{0.1} = (0.39)$ $B = \frac{1}{2} B_{MSY}$ proxy = 0.89 kg/tow (See footnote)	F below $F_{0.1}$ B = 1973-1982 weight per tow = 1.78 kg/tow (See footnote)

Silver hake was last assessed as part of the 42nd Stock Assessment Workshop (SAW 42) in November 2005. The materials from this stock assessment should be referenced for more information.

2.1 NORTHERN SILVER HAKE

Table 2 provides updated data from the NEFSC fall bottom trawl survey, updated landings information, and relative exploitation indices for the northern stock of whiting (northern Georges Bank and Gulf of Maine). While the survey data are quite variable over the time series, the fall survey weight per tow for the northern stock of whiting has been trending downward since 2000, when the three-year average reached a record high value for the time series (the highest survey value for the time series occurred in 1998). Survey points for 2004-2006 were particularly low and more consistent with trends observed during the late 1960s and early 1970s. Landings of the northern stock of whiting also declined to the lowest values of the time series during 2004-2006. Reasons for the survey declines in the northern stock area should be investigated further given the relatively stable and low time series of landings and the particularly low landings during the most recent years.

¹ The survey time series was recalculated during SAW 32, which changed the biomass target for the southern stock of whiting from 1.56 to 1.78 and the biomass threshold from 0.78 to 0.89. See the 2001 SAFE Report for Small Mesh Multispecies for a full discussion.

Table 2 Updated NEFSC Fall Survey, Landings, and Relative Exploitation Indices for the Northern Stock of Silver Hake, 1965-2006

Year	Fall Survey (Delta Mean kg/tow)	Fall Survey (3-Year Average)	Landings (1000 mt)	Relative Exploitation Index	Relative Exploitation Index (3-Year Average)
1965	6.52	12.16	45.24	6.94	
1966	4.17	5.08	47.72	11.45	
1967	2.23	4.31	33.37	14.97	11.12
1968	2.06	2.82	41.38	20.07	15.49
1969	2.43	2.24	23.96	9.87	14.97
1970	3.04	2.51	27.53	9.06	13.00
1971	2.47	2.65	36.40	14.73	11.22
1972	6.09	3.86	25.22	4.15	9.31
1973	4.15	4.24	32.08	7.73	8.87
1974	3.76	4.67	20.68	5.49	5.79
1975	8.23	5.38	39.87	4.84	6.02
1976	12.63	8.21	13.63	1.08	3.81
1977	7.59	9.49	12.46	1.64	2.52
1978	7.07	9.10	12.61	1.78	1.50
1979	6.65	7.11	3.42	0.51	1.31
1980	6.66	6.79	4.73	0.71	1.00
1981	4.06	5.79	4.42	1.09	0.77
1982	5.45	5.39	4.66	0.85	0.88
1983	9.21	6.24	5.31	0.58	0.84
1984	3.62	6.09	8.29	2.29	1.24
1985	8.58	7.14	8.30	0.97	1.28
1986	14.19	8.80	8.50	0.60	1.28
1987	9.84	10.87	5.66	0.58	0.71
1988	6.31	10.11	6.77	1.07	0.75
1989	12.55	9.57	4.65	0.37	0.67
1990	15.25	11.37	6.38	0.42	0.62
1991	11.89	13.23	6.05	0.51	0.43
1992	14.25	13.79	5.30	0.37	0.43
1993	8.12	11.42	4.36	0.54	0.47
1994	6.93	9.76	5.72	0.83	0.58
1995	13.16	9.40	3.03	0.23	0.53
1996	7.89	9.32	3.20	0.41	0.49
1997	5.64	8.90	2.59	0.46	0.37
1998	21.97	11.83	2.26	0.10	0.32
1999	11.64	13.08	4.04	0.35	0.30

Table 2 continued. Updated NEFSC Fall Survey, Landings, and Relative Exploitation Indices for the Northern Stock of Silver Hake, 1965-2006

Year	Fall Survey (Delta Mean kg/tow)	Fall Survey (3-Year Average)	Landings (1000 mt)	Relative Exploitation Index	Relative Exploitation Index (3-Year Average)
2000	13.79	15.80	2.42	0.18	0.21
2001	9.52	11.65	3.45	0.36	0.29
2002	10.44	11.25	2.84	0.27	0.27
2003	9.02	9.66	1.73	0.19	0.28
2004	3.39	7.62	0.56	0.16	0.21
2005	1.95	4.79	0.24	0.12	0.16
2006	4.83	3.39	0.58	0.12	0.14

**Landings data are preliminary for 1994-2006.*

Based on the best available information, the northern stock of silver hake is not overfished; however, trawl survey trends in the northern area are declining, and the three-year moving average is very close, only 2.3% higher than the biomass threshold (Table 3, Figure 1). The current fishing mortality rate for the northern stock of whiting is unknown. The Council's Whiting Monitoring Committee (WMC) recommends using a relative exploitation index (total catch / NEFSC fall survey biomass index) as a proxy for fishing mortality when estimates of F are not available. Based on the WMC's recommended exploitation index target and threshold (see Section 2.5 of the 2002 SAFE Report), overfishing is not occurring.

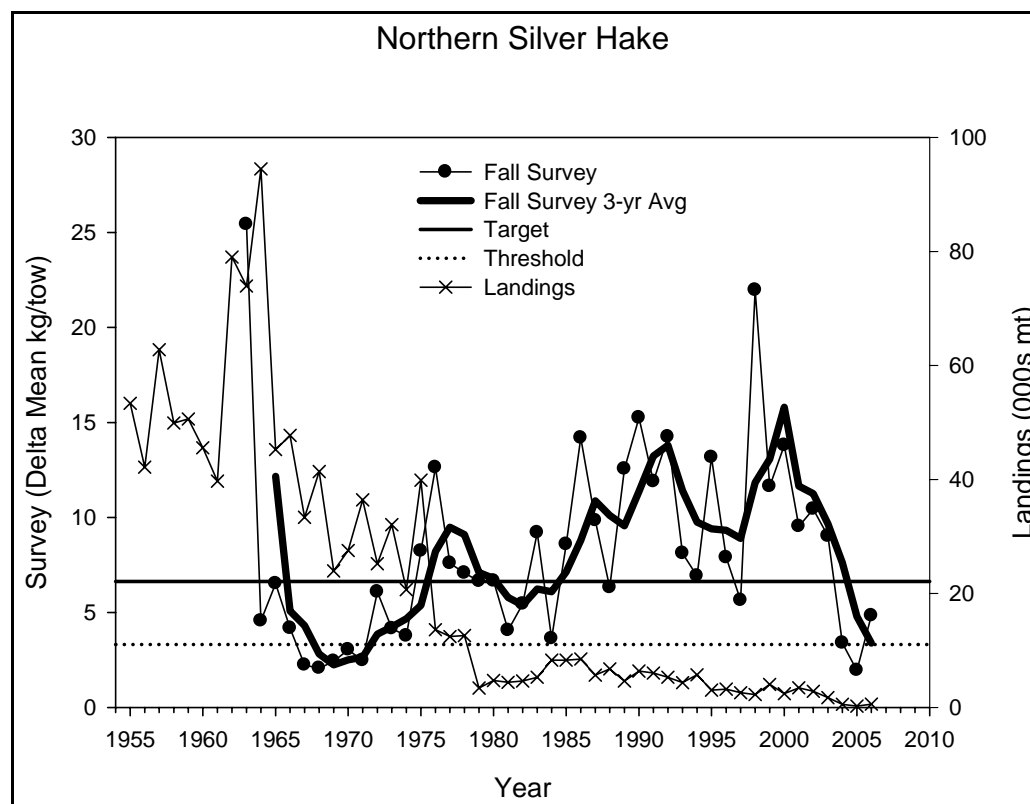
The Whiting PDT is concerned about both the recent low survey values for the northern stock as well as the decline in fishery landings that has occurred over the past several years. Without any increase in fishing effort or landings, it is unclear what may be causing the decline in biomass for this stock. Nevertheless, one or two additional low survey values would likely drop the three-year average weight per tow below the biomass threshold, causing the stock to be considered "overfished." If the northern stock of whiting becomes overfished, it may be difficult to develop management measures for to rebuild this stock without a better understanding about what may be causing the declines.

In particular, there appears to have been a significant decline in older/larger whiting sampled by the survey. During the 42nd Stock Assessment Workshop (SAW 42), scientists identified several possible reasons why trends in abundance of relatively old and large individuals may be decreasing, despite low fishing mortality rates. The SAW 42 Report cites evidence of northward and offshore shifts in average location that may make relatively old and large silver hake less available to bottom trawl surveys. The possibility of increased natural mortality rates due to predation is also an area that requires more research. Without any apparent increase in effort or landings in the directed whiting fishery, bycatch in other fisheries may have an influence as well. The cause(s) for the decline in the survey should be investigated, given the low landings for this stock.

Table 3 Updated Status Determination for the Northern Stock of Silver Hake²

Northern Biomass Target = 6.63 kg/tow Northern Biomass Threshold = 3.31 kg/tow WMC Exploitation Target (F_{MSY} Proxy) = 2.57 WMC Exploitation Threshold (F_{MSY} Proxy) = 2.57								
Year	Fall Survey Index (Kg/Tow)	Fall Index 3-Year Moving Average (Kg/Tow)	3-Year Average Above Biomass Threshold?	3-Year Average Above Biomass Target?	Exploitation Index (Catch/Survey Biomass)	3-Year Average Exploitation Index	Exploitation Index Below Target?	Exploitation Index Below Threshold?
2000	13.79	15.80	YES	YES	0.18	0.21	YES	YES
2001	9.52	11.65	YES	YES	0.36	0.29	YES	YES
2002	10.44	11.25	YES	YES	0.27	0.27	YES	YES
2003	9.02	9.66	YES	YES	0.19	0.28	YES	YES
2004	3.39	7.62	YES	YES	0.16	0.21	YES	YES
2005	1.95	4.79	YES	NO	0.12	0.16	YES	YES
2006	4.83	3.39	YES	NO	0.12	0.14	YES	YES
Stock Status: Not Overfished; Overfishing Not Occurring								

Figure 1 Trends in NEFSC Fall Survey Data and Landings for the Northern Stock of Silver Hake



² Differences from previous reports are due to re-calculation of survey data and use of delta-mean survey indices.

2.2 SOUTHERN SILVER HAKE

Table 4 provides updated data from the NEFSC fall bottom trawl survey, updated landings information, and relative exploitation indices for the southern stock of whiting (southern Georges Bank and the southern New England/Mid-Atlantic region). Overall, survey trends for the southern stock of whiting have improved. Recent survey indices have increased from record low levels since the middle and late 1990s when the stock was considered “overfished” and a rebuilding program was implemented in Amendment 12 to the Multispecies FMP. Landings have also declined since the late 1990s and are at record low levels.

Table 4 Updated NEFSC Fall Survey, Landings, and Relative Exploitation Indices for the Southern Stock of Silver Hake, 1965-2006

Year	Fall Survey (Delta Mean kg/tow)	Fall Survey (3-Year Average)	Landings (1000 mt)	Relative Exploitation Index	Relative Exploitation Index (3-Year Average)
1965	5.59	4.90	307.13	54.95	
1966	2.62	4.21	211.27	80.70	
1967	2.19	3.47	91.25	41.65	59.10
1968	2.69	2.50	58.50	21.72	48.02
1969	1.23	2.04	75.56	61.38	41.58
1970	1.33	1.75	27.51	20.65	34.59
1971	2.20	1.59	71.89	32.65	38.23
1972	2.00	1.84	94.35	47.18	33.49
1973	1.70	1.97	104.59	61.56	47.13
1974	0.86	1.52	109.86	127.45	78.73
1975	1.84	1.47	74.25	40.35	76.46
1976	2.06	1.59	68.74	33.34	67.05
1977	1.77	1.89	59.31	33.45	35.71
1978	2.93	2.26	27.13	9.26	25.35
1979	1.74	2.15	18.38	10.55	17.75
1980	2.12	2.26	13.55	6.38	8.73
1981	1.17	1.68	14.83	12.72	9.88
1982	1.65	1.65	14.56	8.82	9.31
1983	3.20	2.01	12.14	3.79	8.44
1984	1.56	2.14	13.14	8.44	7.02
1985	3.91	2.89	13.16	3.37	5.20
1986	1.39	2.28	10.12	7.29	6.37
1987	1.62	2.30	10.12	6.25	5.64
1988	1.83	1.61	9.20	5.02	6.19
1989	2.12	1.86	13.17	6.21	5.83
1990	1.65	1.87	13.62	8.28	6.50
1991	0.91	1.56	10.09	11.13	8.54
1992	0.98	1.18	10.29	10.52	9.97
1993	1.33	1.07	12.91	9.72	10.45

Table 4 continued. Updated NEFSC Fall Survey, Landings, and Relative Exploitation Indices for the Southern Stock of Silver Hake, 1965-2006

Year	Fall Survey (Delta Mean kg/tow)	Fall Survey (3-Year Average)	Landings (1000 mt)	Relative Exploitation Index	Relative Exploitation Index (3-Year Average)
1994	0.80	1.04	10.33	12.93	11.06
1995	1.64	1.26	11.69	7.13	9.92
1996	0.43	0.96	13.00	30.16	16.74
1997	0.84	0.97	12.99	15.43	17.57
1998	0.62	0.63	12.70	20.49	22.03
1999	0.87	0.78	9.97	11.46	15.79
2000	0.72	0.74	9.76	13.50	15.15
2001	2.41	1.33	8.69	3.62	9.52
2002	1.34	1.49	5.15	3.86	6.99
2003	1.70	1.81	6.92	4.06	3.84
2004	1.38	1.47	7.89	5.71	4.54
2005	1.14	1.41	6.57	5.79	5.19
2006	1.83	1.45	4.26	2.33	4.61

**Landings data are preliminary for 1994-2006.*

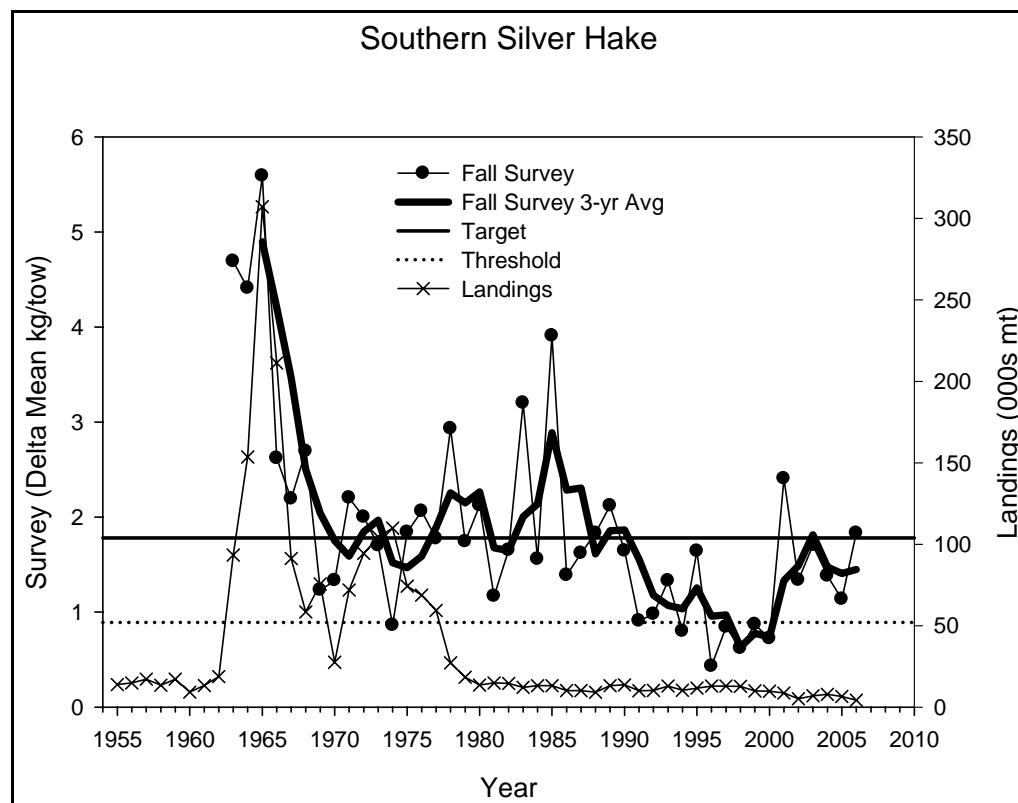
Based on the best available information, the southern stock of silver hake is not overfished (Table 5, Figure 2). The stock actually increased above its target biomass value in 2003, at which point it was considered “*rebuilt*” under the Amendment 12 rebuilding program. This status determination was not reflected in earlier stock updates and SAFE Reports, however, due to changes that occurred in both the survey data (increased precision when measuring at sea since 2000) and the related analysis, which are discussed in Section 1.0 of this document. Improved precision in survey sampling and parameter estimation resulted in revisions to the 2002-2004 survey points that changed the status of this stock for 2003. Based on the updated survey data presented in this document, the stock was considered rebuilt in 2003, i.e., the three-year moving average of the survey index increased above the biomass threshold. Although the survey moving average has declined below the target since 2003, it is still well above the biomass threshold, and the stock is therefore not considered overfished.

The current fishing mortality rate for the southern stock of whiting remains unknown. Based on the WMC’s recommended exploitation index target and threshold (see Section 2.5 of the 2002 SAFE Report), overfishing is not occurring. Landings declined considerably in recent years and were the lowest of the time series in 2006.

Table 5 Updated Status Determination for the Southern Stock of Silver Hake³

Southern Biomass Target = 1.78 kg/tow Southern Biomass Threshold = 0.89 kg/tow WMC Exploitation Threshold (F_{MSY} Proxy) = 20.63 WMC Exploitation Target (60% F_{MSY} Proxy) = 34.39								
Year	Fall Survey Index (Kg/Tow)	Fall Index 3-Year Moving Average (Kg/Tow)	3-Year Average Above Biomass Threshold?	3-Year Average Above Biomass Target?	Exploitation Index (Catch/Survey Biomass)	3-Year Average Exploitation Index	Exploitation Index Below Target?	Exploitation Index Below Threshold?
2000	0.72	0.74	NO	NO	13.50	15.15	YES	YES
2001	2.41	1.33	YES	NO	3.62	9.52	YES	YES
2002	1.34	1.49	YES	NO	3.86	6.99	YES	YES
2003	1.70	1.81	YES	YES	4.06	3.84	YES	YES
2004	1.38	1.47	YES	NO	5.71	4.54	YES	YES
2005	1.14	1.41	YES	NO	5.79	5.19	YES	YES
2006	1.83	1.45	YES	NO	2.33	4.61	YES	YES
Stock Status: Not Overfished, Rebuilt in 2003; Overfishing Not Occurring								

Figure 2 Trends in NEFSC Fall Survey Data and Landings for the Southern Stock of Silver Hake



³ Differences from previous reports are due to re-calculation of survey data and use of delta-mean survey indices.

2.3 SILVER HAKE (WHITING) LANDINGS AND REVENUES

Table 6 presents annual silver hake landings and revenue by area from 1982-2006, updating Table 16 from the 2003 SAFE report. Landings and revenues are also reported for the Cultivator Shoals Whiting Fishery. For the Cultivator Shoals fishery, landings are those reported by participants on their vessel trip reports, while the revenues are calculated using these reported landings and the average annual price for silver hake from dealer reports.

Silver hake landings data from 1994-2006 that did not have a statistical area designation were assigned to the northern or southern stock by proration. Total catches, by market category, were allocated to stock based on a matched subset of trips between the dealer and VTR-logbook databases. Both databases were stratified by calendar quarter, port group and gear group to form a pool of observations from which proportion of catch, by stock, could be allocated to market category with the matched subset. The cross products of the market category by stock proportions derived from the matched subset were employed to compute the total catch by stock, market category, calendar quarter, port group, and gear group in the full dealer database.

Cultivator Shoals silver hake landings and revenue for the period 1981-1993 were calculated using dealer weighout data. For each year, the sum of silver hake landings from statistical area 522 and the revenue from those landings was calculated. Since the statistical area is not reported in dealer data after 1994, letter of authorization records and vessel trip reports were used to identify vessels participating in the Cultivator Shoals Whiting Fishery Exemption program and to calculate the silver hake landings of these vessels when fishing in the Cultivator Shoals Exemption Area. The revenue from these landings is then the reported landings from the vessel trip reports multiplied by the average price for silver hake in that year.

Total landings of silver hake rebounded slightly in 2003 and 2004 from the sharp decline experienced in 2002. However, landings decreased in both 2005 and 2006, and are now at the lowest level of the time series. Though average prices have increased slightly in recent years, revenues are also at the lowest level of the time series. Landings and revenues from the Cultivator Shoal Whiting Fishery are currently about 50% of the levels observed during the 1990s.

Table 6 Annual Silver Hake Landings and Revenues, 1982-2006*

Calendar Year	Northern Landings (mt)	Southern Landings (mt)	Total Landings (mt)	Total Revenue (million \$)	Cultivator Shoals	
					Landings (mt)	Revenue (million \$)
1982	4,660	14,560	19,220	8.6	1,166	0.5
1983	5,310	12,140	17,450	6.6	281	0.1
1984	8,290	13,140	21,430	6.5	765	0.2
1985	8,300	13,160	21,460	8.1	338	0.1
1986	8,500	10,120	18,620	8.6	503	0.2
1987	5,660	10,120	15,780	11.6	102	0.1
1988	6,770	9,200	15,970	8.5	2,466	1.3
1989	4,650	13,170	17,820	9.4	2,446	1.3
1990	6,380	13,620	20,000	11.1	2,975	1.7
1991	6,050	10,090	16,140	10.9	3,504	2.4
1992	5,300	10,290	15,590	10.5	2,995	2.0
1993	4,360	12,910	17,270	13.9	2,494	2.0
1994	5,720	10,330	16,050	13.7	1,317	1.1
1995	3,030	11,690	14,720	14.0	725	0.7
1996	3,200	13,000	16,200	13.6	1,635	1.4
1997	2,590	12,990	15,580	15.1	1,351	1.3
1998	2,260	12,700	14,960	13.3	1,195	1.1
1999	4,040	9,970	14,010	14.2	2,324	2.4
2000	2,420	9,760	12,180	11.5	1,076	1.0
2001	3,450	8,690	12,140	12.4	1,383	1.4
2002	2,840	5,150	7,990	7.5	1,449	1.4
2003	1,730	6,920	8,650	9.3	1,076	1.2
2004	560	7,890	8,450	10.3	449	0.5
2005	240	6,570	6,810	8.2	410	0.5
2006	580	4,260	4,840	6.1	544	0.7

**Landings from 1994 forward are preliminary and are based on a north/south area pro-rata program. These landings will be further investigated and re-calculated in the small mesh multispecies amendment (under development).*

3.0 RED HAKE

3.1 NORTHERN RED HAKE

The current overfishing definition for northern red hake (summarized in Table 7) reads as follows:

*The northern stock of red hake is overfished when the three-year moving average of stock biomass, derived from the fall survey, is below **1.6 kg/tow**. If an analytical assessment is available for northern red hake, then the three-year moving average will be replaced with the terminal year biomass estimate and compared with the biomass reference points.*

*Overfishing occurs when the ratio between catch and survey biomass exceeds **0.61**, the proxy for F_{MSY} . When biomass is less than 3.1 kg/tow (the biomass target), the stock is overfished when fishing mortality is above a rate that declines linearly to zero when biomass equals the minimum biomass threshold (1.6 kg/tow).*

Table 7 Overfishing Definition Reference Points for the Northern Stock of Red Hake*

	THRESHOLD	TARGET
Maximum Sustainable Yield	2,000 MT	Not applicable
Exploitation Index (catch/survey biomass)*	0.61	0.37
Stock Biomass (kg/tow)*	1.6	3.3

**NOTE: The overfishing definition reference points are based on survey data from 1978-1996. For the purposes of consistency, these reference points were re-calculated by the Whiting PDT using the updated survey time series that is presented in this document.*

Long term trends in landings, biomass indices based on NEFSC fall bottom trawl survey data and relative exploitation indices for the northern stock of red hake are presented in Table 8. The fall survey index increased in 2006 after two very low years; the 2006 survey value is consistent with those observed during the 1990s and early 2000s. Landings of the northern stock of red hake have been less than 1,000 mt since 1988 and were particularly low from 2004-2006.

Table 8 Updated Fall Survey, Catch, and Relative Exploitation Indices for the Northern Stock of Red Hake, 1965-2006^{4,5}

Year	Fall Survey (Delta Mean Kg/Tow)	Fall Survey (3-Year Average)	Landings (1000 MT)	Relative Exploitation Index	Relative Exploitation Index (3-Year Average)
1965	1.19	2.41	2.7	2.29	
1966	0.90	1.14	5.6	6.17	
1967	0.48	0.86	1.9	3.90	4.12
1968	0.26	0.55	2.6	10.14	6.74
1969	0.62	0.45	2.0	3.27	5.77
1970	0.56	0.48	1.0	1.85	5.09
1971	1.29	0.82	4.8	3.73	2.95
1972	2.27	1.37	15.0	6.61	4.06
1973	1.49	1.68	15.3	10.28	6.87
1974	0.68	1.48	7.2	10.68	9.19
1975	1.79	1.32	8.7	4.86	8.61
1976	1.81	1.43	6.3	3.50	6.35
1977	3.92	2.51	0.9	0.23	2.86
1978	3.18	2.97	1.2	0.39	1.37
1979	1.97	3.02	1.5	0.77	0.46
1980	3.80	2.98	1.0	0.27	0.48
1981	3.01	2.92	1.2	0.41	0.49
1982	1.67	2.82	1.2	0.73	0.47
1983	4.13	2.94	0.9	0.22	0.45
1984	3.75	3.18	1.1	0.28	0.41
1985	4.67	4.18	1.0	0.21	0.24
1986	2.80	3.74	1.5	0.53	0.34
1987	2.34	3.27	1.0	0.43	0.39
1988	3.09	2.74	0.9	0.28	0.41
1989	6.27	3.90	0.8	0.12	0.28
1990	3.37	4.24	0.9	0.27	0.22
1991	2.66	4.10	0.7	0.26	0.22
1992	2.43	2.82	0.9	0.37	0.30
1993	1.97	2.35	0.7	0.36	0.33
1994	4.73	3.04	0.5	0.11	0.28
1995	3.62	3.44	0.5	0.13	0.20

⁴ Landings may differ slightly from figures in previous SAFE reports. Landings data include a prorated amount of "unspecified hake" as well as a small amount of recreational catch.

⁵ Differences from previous reports are due to re-calculation of survey data and use of delta-mean survey indices.

Table 8 continued. Updated Fall Survey, Catch, and Relative Exploitation Indices for the Northern Stock of Red Hake, 1965-2006

Year	Fall Survey (Delta Mean Kg/Tow)	Fall Survey (3-Year Average)	Landings (1000 MT)	Relative Exploitation Index	Relative Exploitation Index (3-Year Average)
1996	2.64	3.66	0.4	0.15	0.13
1997	3.02	3.09	0.5	0.15	0.14
1998	5.07	3.58	0.5	0.10	0.14
1999	3.32	3.80	0.6	0.19	0.15
2000	6.50	4.96	0.6	0.09	0.13
2001	5.38	5.07	0.7	0.12	0.13
2002	6.47	6.12	0.3	0.05	0.09
2003	3.88	5.24	0.3	0.07	0.08
2004	1.66	4.00	0.2	0.12	0.08
2005	1.27	2.27	0.1	0.10	0.10
2006	3.68	2.20	0.2	0.04	0.09

**Landings data are preliminary.*

Based on the best available information for recent years (Table 9, Figure 3), the northern stock of red hake is not overfished at this time. Overall, the survey indices suggest that stock biomass has increased considerably over time, especially since the stock was at low levels during the late 1960s and early 1970s. However, the fall survey has been trending downward in recent years, and reasons for the decline are unclear given the low levels of landings (similar to silver hake, see additional discussion in Section 2.1 of this document). Bycatch of this stock in other fisheries also should be investigated. The 2006 survey index increased considerably, but additional survey points (2007, 2008) are needed to determine whether the directionality of the trend in the survey indices has changed.

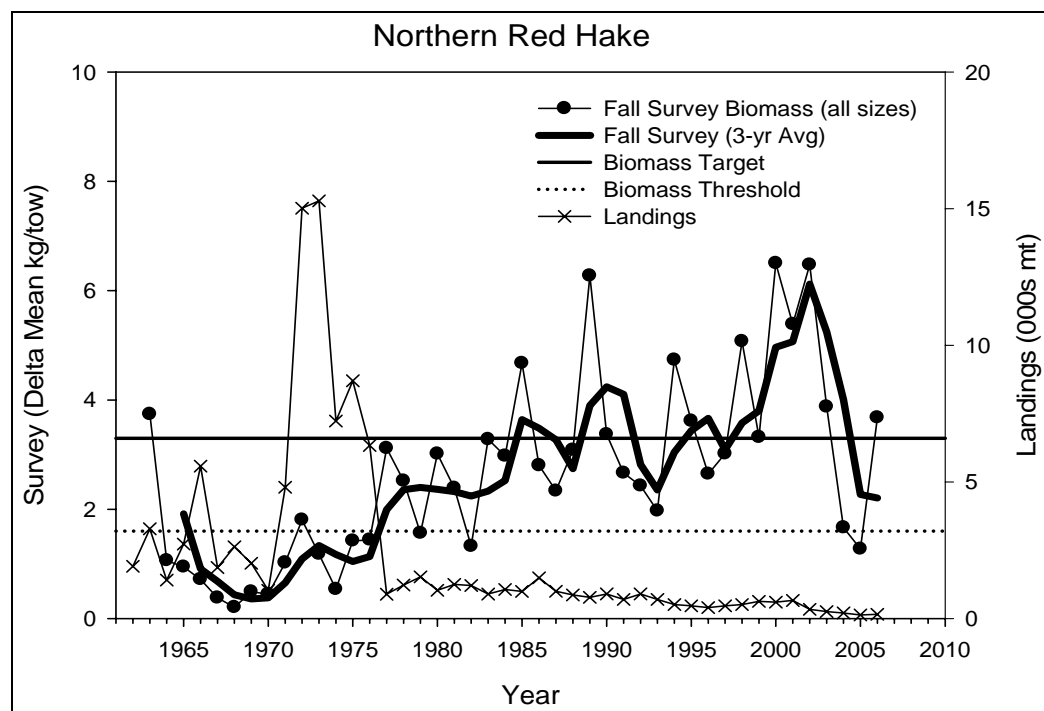
The current fishing mortality rate for the northern stock of red hake remains unknown. The overfishing definition for northern red hake uses a relative exploitation index (total catch / NEFSC fall survey biomass index) as a proxy when estimates of fishing mortality are not available. Overfishing is not considered to be occurring because the current 3-year average exploitation index is well below the target level and threshold levels. Landings of this stock from 2004-2006 were the lowest on record and well below the current MSY value of 2,000 mt (Figure 4).

Table 9 Updated Status Determination for the Northern Stock of Red Hake⁶

Northern Biomass Target = 3.3 kg/tow Northern Biomass Threshold = 1.6 kg/tow Northern Exploitation Target (F_{MSY} Proxy) = 0.37 (when biomass above target level) Northern Exploitation Threshold (F_{MSY} Proxy) = 0.61 (when biomass above target level)								
Year	Fall Survey Index (Kg/Tow)	Fall Index 3-Year Moving Average (Kg/Tow)	3-Year Average Above Biomass Threshold?	3-Year Average Above Biomass Target?	Exploitation Index (Catch/Survey Biomass)	3-Year Average Exploitation Index	Exploitation Index Below Target?	Exploitation Index Below Threshold?
2000	6.50	4.96	YES	YES	0.09	0.13	YES	YES
2001	5.38	5.07	YES	YES	0.12	0.13	YES	YES
2002	6.47	6.12	YES	YES	0.05	0.09	YES	YES
2003	3.88	5.24	YES	YES	0.07	0.08	YES	YES
2004	1.66	4.00	YES	YES	0.12	0.08	YES	YES
2005	1.27	2.27	YES	NO	0.10	0.10	YES	YES
2006	3.68	2.20	YES	NO	0.04	0.09	YES	YES
Stock Status: Not Overfished; Overfishing Not Occurring								

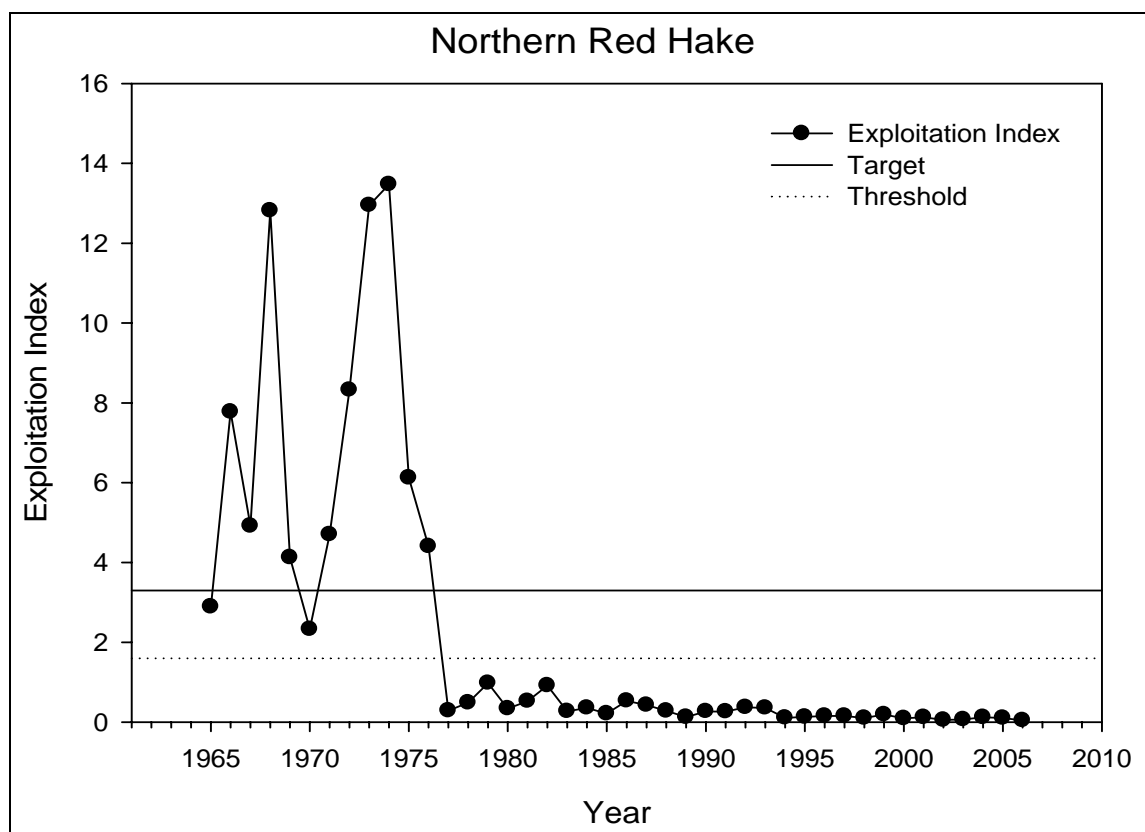
**NOTE: The overfishing definition reference points are based on survey data from 1978-1996. For the purposes of consistency, these reference points were re-calculated by the Whiting PDT using the updated survey time series that is presented in this document.*

Figure 3 NEFSC Fall Survey Data and Landings Data for the Northern Stock of Red Hake



⁶ Differences from previous reports are due to re-calculation of survey data and use of delta-mean survey indices.

Figure 4 Relative Exploitation Index for the Northern Stock of Red Hake



3.2 SOUTHERN RED HAKE

The current overfishing definition for southern red hake (summarized in Table 10) reads as follows:

*The southern stock of red hake is in an overfished condition when the three-year moving average weight per individual in the fall survey falls below the 25th percentile of the average weight per individual from the fall survey time series 1963-1997 (0.12) **AND** when the three-year moving average of the abundance of immature fish less than 25 cm falls below the median value of the 1963-1997 fall survey abundance of fish less than 25 cm (4.07).*

**NOTE: The overfishing definition reference points were re-calculated by the Whiting PDT using the updated survey time series that is presented in this document.*

In previous SAFE Reports, the Whiting Monitoring Committee (WMC) noted problems associated with the overfishing definition for southern red hake. **Although the current definition is intended to identify “overfished” (i.e. low biomass) stock conditions, it is a better indication of “overfishing” (high exploitation rate) conditions.** The WMC recommends that the overfishing definition for the southern stock of red hake be revisited after a benchmark stock assessment is completed. The next stock assessment for red hake has not been scheduled at this time.

Table 10 Overfishing Definition Reference Points for the Southern Stock of Red Hake

	THRESHOLD	TARGET
Maximum Sustainable Yield	Not estimable	
Fishing Mortality (F)	Not specified	Not specified
Stock Biomass (B)	Average weight less than 0.12 kg AND survey abundance for immature fish less than 4.07 per tow	Not specified

**NOTE: The overfishing definition reference points were re-calculated by the Whiting PDT using the updated survey time series that is presented in this document.*

Long-term trends in landings, mean weight, biomass, and recruitment indices based on NEFSC fall bottom trawl survey data and landings for the southern stock of red hake have been updated and are presented in Table 11, Figure 5, and Figure 6. The fall trawl survey index increased in 2005 and 2006, and trends are relatively flat but slightly upwards. **The Council may want to consider evaluating the status of this stock based on a five-year moving average instead of a three-year moving average; this approach may better account for survey variability.**

The current fishing mortality rate for the southern stock of red hake remains unknown. However, landings have decreased below 1,000 mt in every year since 2001 and were the lowest of the time series in 2005. A benchmark stock assessment is needed to thoroughly evaluate the status of this stock and develop a more appropriate overfishing definition.

Table 11 Updated Fall Survey, Recruitment, Mean Survey Fish Weight, and Relative Exploitation Indices for the Southern Stock of Red Hake, 1965-2006^{7,8}

Year	Fall Survey (Delta Mean Kg/Tow)	Fall Survey (3-Year Average)	Fall Survey Recruits (<25 cm, Delta Mean #/tow)	Fall Survey Recruits (3-Year Average)	Mean Fish Weight (kg)	Mean Fish Weight (3-Year Average)	Landings (1000 MT)	Relative Exploitation Index	Relative Exploitation Index (3-Year Average)
1965	5.79	6.96	6.80		0.18		93.62	16.17	
1966	3.08	4.40	12.23		0.12		108.02	35.10	
1967	1.67	3.51	1.33	6.79	0.21	0.17	58.95	35.40	28.89
1968	3.53	2.76	2.44	5.34	0.21	0.18	18.71	5.30	25.27
1969	3.57	2.92	5.21	3.00	0.20	0.21	53.42	14.95	18.55
1970	2.46	3.19	7.09	4.91	0.15	0.19	11.86	4.83	8.36
1971	2.54	2.86	6.61	6.30	0.15	0.17	35.42	13.97	11.25
1972	4.51	3.17	10.07	7.93	0.15	0.15	61.37	13.62	10.81
1973	2.74	3.26	8.07	8.25	0.12	0.14	51.68	18.87	15.49
1974	0.85	2.70	19.55	12.56	0.04	0.10	26.83	31.61	21.37
1975	5.26	2.95	12.40	13.34	0.14	0.10	20.03	3.81	18.10
1976	3.46	3.19	5.44	12.46	0.17	0.12	23.11	6.69	14.03
1977	2.70	3.81	2.01	6.62	0.20	0.17	7.81	2.89	4.46
1978	1.86	2.67	3.05	3.50	0.16	0.18	5.40	2.90	4.16
1979	2.95	2.51	4.07	3.04	0.14	0.17	7.85	2.66	2.81
1980	3.51	2.78	10.59	5.90	0.13	0.14	4.23	1.20	2.25
1981	2.64	3.03	7.36	7.34	0.12	0.13	2.58	0.98	1.61
1982	3.01	3.05	1.66	6.54	0.20	0.15	3.17	1.05	1.08
1983	7.61	4.42	2.36	3.79	0.21	0.18	1.57	0.21	0.75
1984	0.98	3.87	3.24	2.42	0.16	0.19	2.74	2.79	1.35
1985	1.96	3.52	36.27	13.96	0.05	0.14	0.93	0.47	1.16
1986	0.97	1.30	2.37	13.96	0.13	0.11	1.10	1.14	1.47
1987	0.73	1.22	2.01	13.55	0.14	0.11	1.86	2.56	1.39
1988	0.75	0.81	5.09	3.15	0.10	0.12	0.90	1.20	1.63
1989	1.24	0.91	1.74	2.95	0.12	0.12	0.78	0.63	1.46
1990	1.35	1.11	1.95	2.93	0.12	0.11	1.00	0.74	0.86
1991	3.27	1.95	2.84	2.18	0.14	0.13	1.10	0.34	0.57
1992	0.62	1.75	2.20	2.33	0.14	0.13	1.30	2.09	1.06
1993	0.89	1.59	3.85	2.96	0.09	0.12	0.90	1.01	1.15

⁷ Landings may differ slightly from figures in previous SAFE reports. Landings data include a prorated amount of "unspecified hake" as well as a small amount of recreational catch.

⁸ Differences from previous reports are due to re-calculation of survey data and use of delta-mean survey indices.

Table 11 continued. Updated Fall Survey, Recruitment, Mean Survey Fish Weight, and Relative Exploitation Indices for the Southern Stock of Red Hake, 1965-2006

Year	Fall Survey (Delta Mean Kg/Tow)	Fall Survey (3-Year Average)	Fall Survey Recruits (<25 cm, Delta Mean #/tow)	Fall Survey Recruits (3-Year Average)	Mean Fish Weight (kg)	Mean Fish Weight (3-Year Average)	Landings (1000 MT)	Relative Exploitation Index	Relative Exploitation Index (3-Year Average)
1994	0.76	0.76	5.87	3.97	0.08	0.10	1.19	1.56	1.56
1995	0.48	0.71	8.80	6.17	0.05	0.07	1.14	2.35	1.64
1996	0.36	0.53	1.42	5.36	0.12	0.08	0.70	1.96	1.96
1997	0.57	0.47	1.39	3.87	0.15	0.11	0.86	1.51	1.94
1998	0.53	0.48	1.88	1.56	0.13	0.13	0.83	1.58	1.68
1999	0.59	0.56	14.83	6.03	0.03	0.10	0.88	1.50	1.53
2000	0.42	0.51	0.75	5.82	0.18	0.11	0.98	2.33	1.80
2001	1.79	0.93	10.18	8.58	0.05	0.09	1.03	0.57	1.47
2002	0.83	1.02	5.71	5.54	0.07	0.10	0.59	0.71	1.21
2003	0.67	1.10	4.45	6.78	0.08	0.07	0.55	0.83	0.71
2004	0.42	0.64	4.78	4.98	0.06	0.07	0.47	1.14	0.89
2005	0.78	0.62	7.60	5.61	0.06	0.07	0.19	0.24	0.74
2006	1.34	0.85	5.63	6.00	0.08	0.07	0.22	0.17	0.51

**Landings data are preliminary for 1994-2006.*

Figure 5 NEFSC Fall Survey Data (with 3-year averages) for the Southern Stock of Red Hake

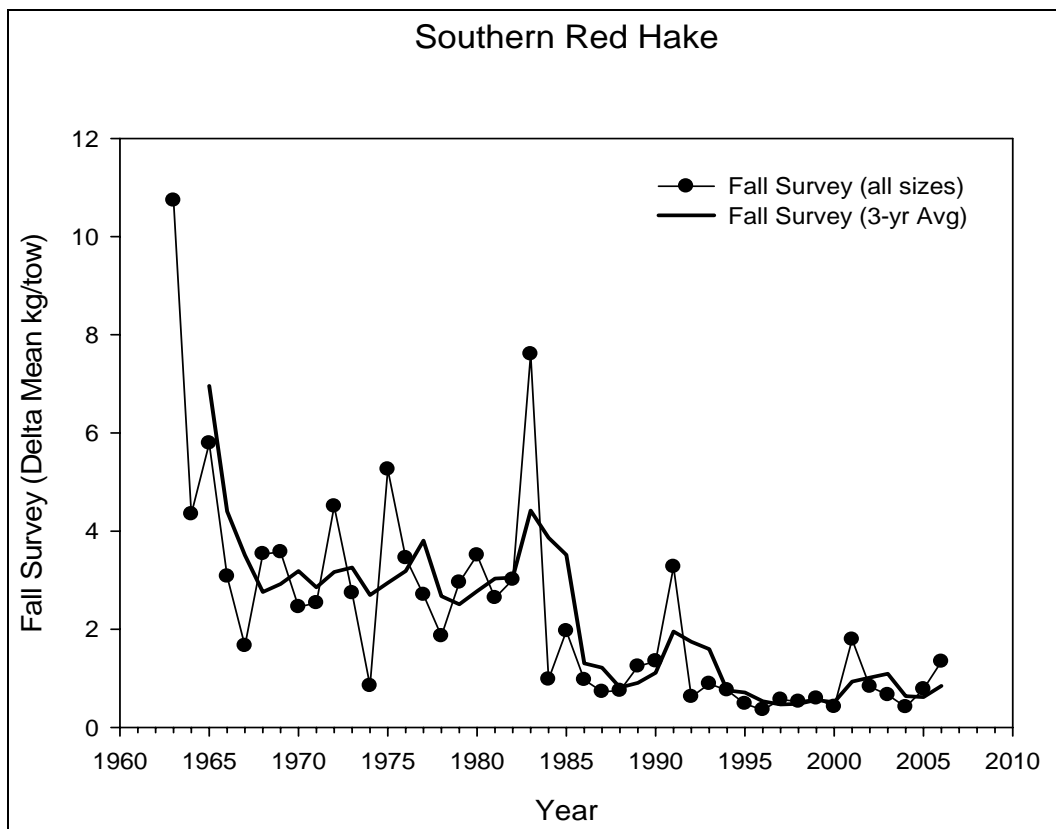
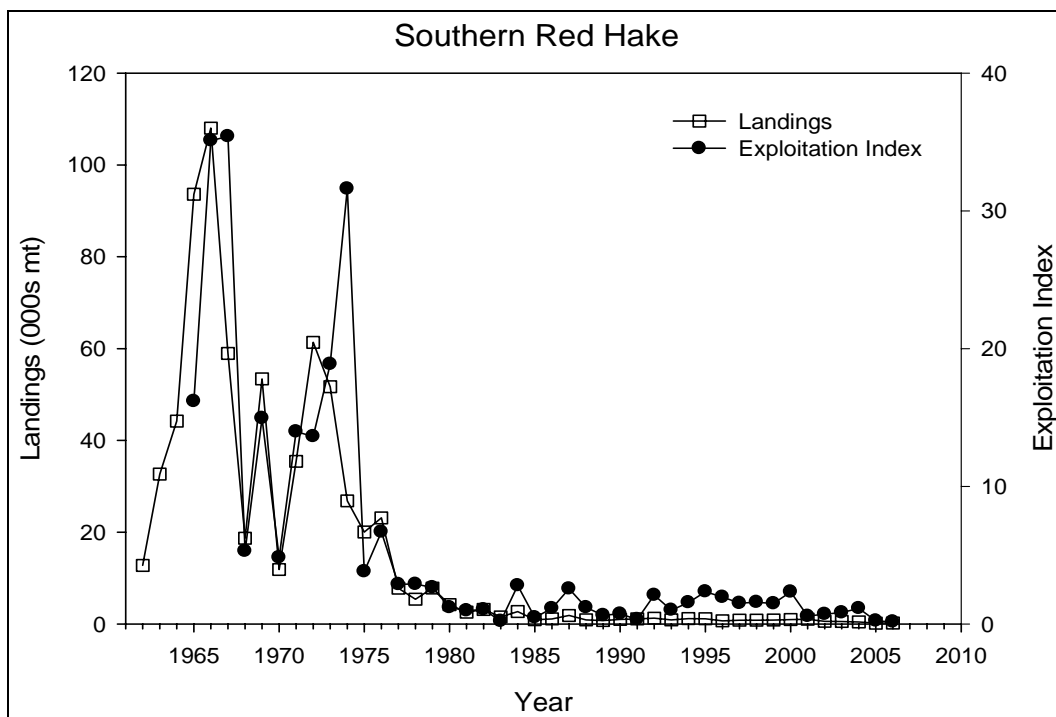


Figure 6 Landings Data and Relative Exploitation Index for the Southern Stock of Red Hake



Based on the best available information (Table 12, Figure 7), the southern stock of red hake is not overfished. Overfishing is not occurring (the WMC notes that the current overfishing definition more appropriately characterizes exploitation and not biomass conditions). A benchmark stock assessment is needed to fully evaluate the status of this stock and develop a more appropriate and useful overfishing definition.

Table 12 Updated Status Determination for the Southern Stock of Red Hake⁹

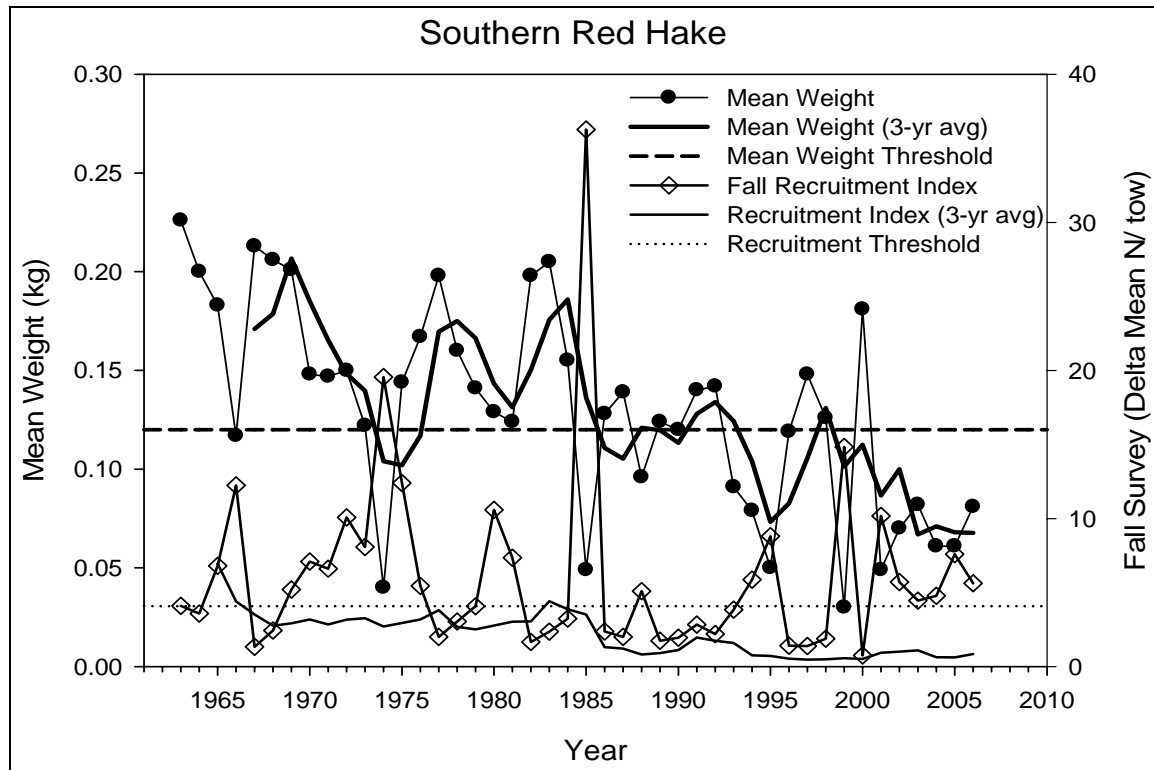
Southern Red Hake Stock Overfishing Threshold: survey mean weight = 0.12 kg and survey recruitment index = 4.07 fish						
YEAR	Mean Fish Weight (kg)	3-Year Average Mean Fish Weight	Recruitment Index (< 25 cm, Delta Mean #/Tow)	Recruitment Index (3-Year Average)	3-Year Average Weight Above 0.12 kg?	3-Year Average Recruitment Above 4.07 Fish?
1998	0.13	0.13	1.88	1.56	YES	NO
1999	0.03	0.10	14.83	6.03	NO	YES
2000	0.18	0.11	0.75	5.82	NO	YES
2001	0.05	0.09	10.18	8.58	NO	YES
2002	0.07	0.10	5.71	5.54	NO	YES
2003	0.08	0.07	4.45	6.78	NO	YES
2004	0.06	0.07	4.78	4.98	NO	YES
2005	0.06	0.07	7.60	5.61	NO	YES
2006	0.08	0.07	5.63	6.00	NO	YES
Stock Status: Not Overfished/Overfishing						

**Landings data are preliminary for 1994-2006.*

**NOTE: The overfishing definition reference points were re-calculated by the Whiting PDT using the updated survey time series that is presented in this document.*

⁹ Differences from previous reports are due to re-calculation of survey data and use of delta-mean survey indices.

Figure 7 Trends in NEFSC Fall Survey Mean Weights and Survey Recruitment Index for the Southern Stock of Red Hake



3.3 RED HAKE LANDINGS AND REVENUES

Table 13 presents annual red hake landings and revenue by area from 1982-2006, updating Table 17 from the 2003 SAFE report. While landings increased slightly in 2006 from 2005 levels, they remain near the low point of the time series, with total revenue at its low point.

Red Hake landings data from 1994-2006 that did not have a statistical area designation were prorated to stock area based on the 1991-1993 average proportion of landings from the northern and southern stocks.

Cultivator Shoals silver hake landings and revenue for the period 1981-1993 were calculated using dealer weighout data. For each year, the sum of silver hake landings from statistical area 522 and the revenue from those landings was calculated. Since the statistical area is not reported in dealer data after 1994, letter of authorization records and vessel trip reports were used to identify vessels participating in the Cultivator Shoals Whiting Fishery Exemption program and to calculate the silver hake landings of these vessels when fishing in the Cultivator Shoals Exemption Area. The revenue from these landings is then the reported landings from the vessel trip reports multiplied by the average price for silver hake in that year.

Table 13 Annual Red Hake Landings and Revenues, 1982-2006

Calendar Year	Northern Landings (mt)	Southern Landings (mt)	Total Landings (mt)	Total Revenue (million \$)	Cultivator Shoals	
					Landings (mt)	Revenue (million \$)
1982	1,210	3,170	4,380	1.4	5	0.0016
1983	900	1,570	2,470	0.6	3	0.0007
1984	1,060	2,740	3,800	0.8	2	0.0004
1985	990	930	1,920	0.5	1	0.0003
1986	1,490	1,100	2,590	0.8	1	0.0003
1987	1,000	1,860	2,860	1.2	4	0.0017
1988	860	900	1,760	0.6	58	0.0206
1989	770	780	1,550	0.6	109	0.0442
1990	900	1,000	1,900	0.7	105	0.0403
1991	700	1,100	1,800	0.9	41	0.0201
1992	900	1,300	2,200	1.1	86	0.0422
1993	700	900	1,600	0.9	63	0.0345
1994	510	1,190	1,700	0.9	59	0.0325
1995	460	1,140	1,600	1.0	23	0.0140
1996	400	700	1,100	0.7	5	0.0032
1997	470	860	1,330	0.8	25	0.0149
1998	510	830	1,340	0.8	57	0.0328
1999	630	880	1,510	0.9	68	0.0402
2000	600	980	1,580	0.9	53	0.0304
2001	660	1,030	1,690	0.9	49	0.0269
2002	330	590	920	0.7	60	0.0443
2003	260	550	810	0.6	81	0.0557
2004	200	470	670	0.5	27	0.0222
2005	130	190	320	0.4	14	0.0157
2006	150	220	370	0.3	63	0.0510

4.0 OFFSHORE HAKE

The current overfishing definition for offshore hake (summarized in Table 14) reads as follows:

Offshore hake is in an overfished condition when the three year moving average weight per individual in the fall survey falls below the 25th percentile of the average weight per individual from the fall survey time series 1963-1997 (0.22) AND when the three year moving average of the abundance of immature fish less than 30 cm falls below the median value of the 1963-1997 fall survey abundance of fish less than 30 cm (0.27).

**NOTE: The overfishing definition reference points were re-calculated by the Whiting PDT using the updated survey time series that is presented in this document.*

In previous SAFE Reports, the WMC noted problems associated with the overfishing definition for offshore hake. **Although the current definition is intended to identify “overfished” (i.e. low biomass) stock conditions, it is a better indication of “overfishing” (high exploitation rate) conditions.** The WMC recommends that the overfishing definition for offshore hake be revisited after a benchmark stock assessment is completed.

Table 14 Overfishing Definition Reference Points for Offshore Hake

	THRESHOLD	TARGET
Maximum Sustainable Yield	Not estimable	
Fishing Mortality (F)	Not specified	Not specified
Stock Biomass (B)	Average weight less than 0.22 kg AND survey abundance for immature fish (<30 cm) less than 0.27 per tow	Not specified

**NOTE: The overfishing definition reference points were re-calculated by the Whiting PDT using the updated survey time series that is presented in this document.*

Long-term trends in landings, mean weight, biomass, and recruitment indices based on NEFSC fall bottom trawl survey data and landings for offshore hake have been updated and are presented in Table 15 and Figure 8. Figure 9 illustrates the variability associated with the survey data for offshore hake; survey weights, recruitment numbers, and mean fish weight are quite variable over the time series, and no trends are readily apparent. **The Council may want to consider evaluating the status of this stock based on a five-year moving average instead of a three-year moving average; this approach may better account for survey variability.**

Offshore hake is usually landed in small amounts in combination with silver hake, and the fishing mortality rate for offshore hake remains unknown. A benchmark stock assessment is needed to thoroughly evaluate the status of this stock, investigate reasons for fluctuations in recruitment and mean fish weight, and develop a more appropriate overfishing definition.

Table 15 Updated Fall Survey, Recruitment, and Mean Survey Fish Weight for Offshore Hake, 1965-2006^{10,11}

Year	Fall Survey (Delta Mean kg/tow)	Fall Survey (3-Year Average)	Fall Survey Recruits (<30 cm, Delta Mean #/tow)	Fall Survey Recruits (3-Year Average)	Mean Fish Weight (kg)	Mean Fish Weight (3-Year Average)
1965	0.26	0.22	0.03	0.01	0.64	0.57
1966	1.42	0.59	0.00	0.01	0.68	0.57
1967	0.06	0.58	0.15	0.06	0.17	0.50
1968	0.18	0.56	0.30	0.15	0.29	0.38
1969	0.13	0.13	0.37	0.27	0.23	0.23
1970	0.10	0.14	0.31	0.33	0.18	0.23
1971	0.05	0.09	0.12	0.27	0.15	0.19
1972	0.68	0.27	1.55	0.66	0.22	0.18
1973	0.09	0.27	0.20	0.63	0.21	0.19
1974	0.20	0.32	0.62	0.79	0.19	0.20
1975	0.26	0.18	0.40	0.41	0.28	0.23
1976	0.61	0.36	0.32	0.44	0.42	0.29
1977	0.35	0.41	0.41	0.38	0.28	0.32
1978	0.54	0.50	1.08	0.60	0.25	0.31
1979	0.23	0.37	0.08	0.52	0.32	0.28
1980	0.33	0.37	0.32	0.49	0.37	0.31
1981	1.42	0.66	0.48	0.29	0.58	0.42
1982	0.04	0.59	0.03	0.28	0.32	0.42
1983	0.14	0.53	0.53	0.35	0.19	0.36
1984	0.12	0.10	0.04	0.20	0.30	0.27
1985	0.49	0.25	0.27	0.28	0.40	0.30
1986	0.26	0.29	0.51	0.27	0.26	0.32
1987	0.19	0.31	0.37	0.38	0.28	0.31
1988	0.12	0.19	0.05	0.31	0.65	0.39
1989	0.20	0.17	0.29	0.24	0.27	0.40
1990	0.39	0.24	1.29	0.54	0.18	0.36
1991	0.14	0.24	0.05	0.54	0.29	0.25
1992	0.15	0.23	0.06	0.47	0.33	0.27
1993	0.11	0.13	0.05	0.06	0.33	0.32
1994	0.01	0.09	0.09	0.07	0.15	0.27
1995	0.14	0.09	0.35	0.16	0.22	0.23
1996	0.11	0.09	0.01	0.15	0.33	0.24

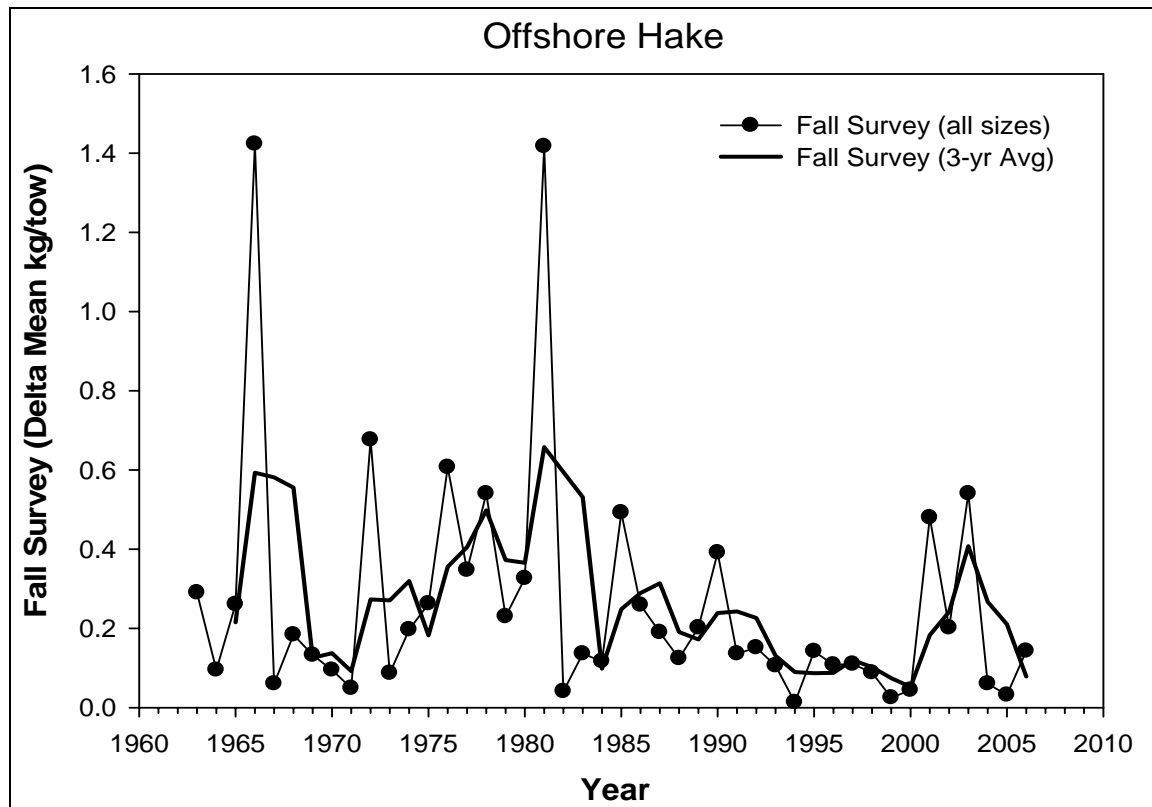
¹⁰ Landings believed negligible.

¹¹ Differences from previous reports are due to re-calculation of survey data and use of delta-mean survey indices.

Table 15 continued. Updated Fall Survey, Recruitment, and Mean Survey Fish Weight for Offshore Hake, 1965-2006

Year	Fall Survey (Delta Mean kg/tow)	Fall Survey (3-Year Average)	Fall Survey Recruits (<30 cm, Delta Mean #/tow)	Fall Survey Recruits (3-Year Average)	Mean Fish Weight (kg)	Mean Fish Weight (3-Year Average)
1997	0.11	0.12	0.08	0.15	0.38	0.31
1998	0.09	0.10	0.56	0.22	0.14	0.28
1999	0.03	0.07	0.13	0.26	0.13	0.22
2000	0.04	0.05	0.06	0.25	0.21	0.16
2001	0.48	0.18	1.86	0.68	0.18	0.18
2002	0.20	0.24	0.36	0.76	0.22	0.21
2003	0.54	0.41	0.55	0.92	0.32	0.24
2004	0.06	0.27	0.27	0.39	0.15	0.23
2005	0.03	0.21	0.01	0.28	0.27	0.25
2006	0.14	0.08	0.71	0.33	0.16	0.19

Figure 8 NEFSC Fall Survey Data (with 3-year averages) for Offshore Hake

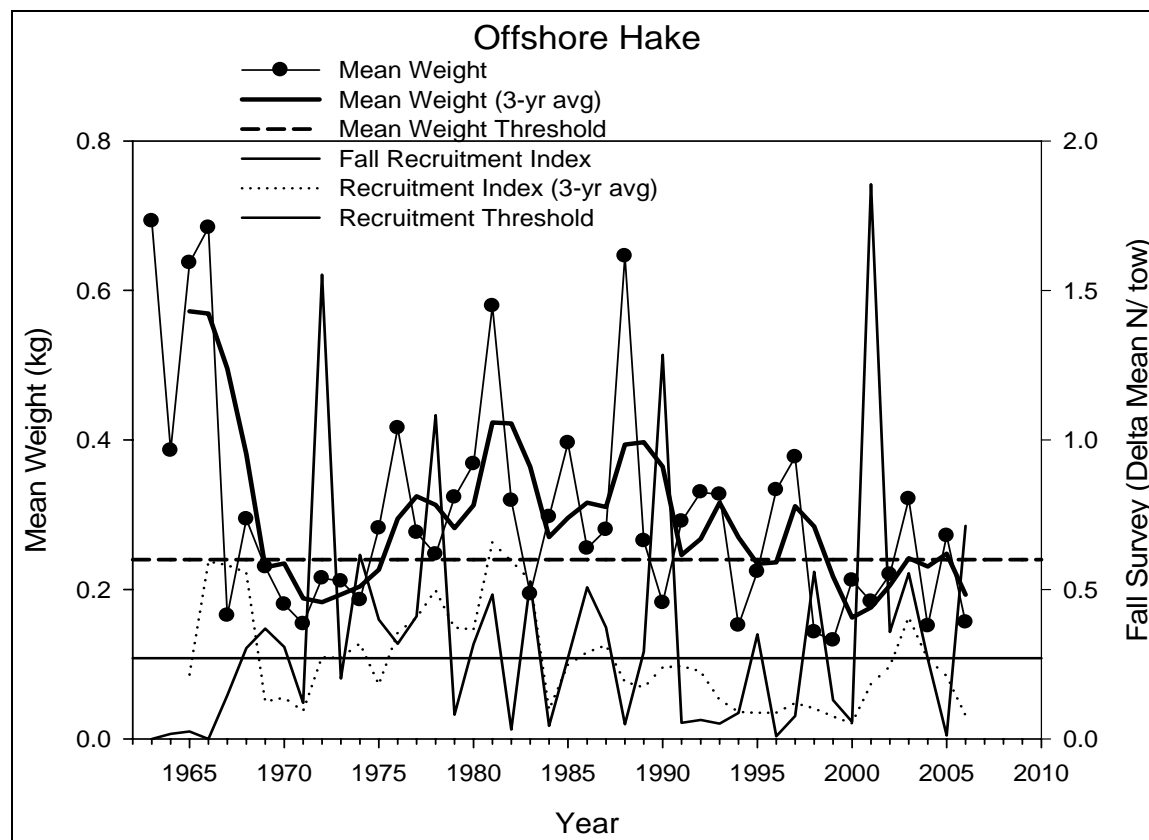


Based on the best available information (Table 16, Figure 9), the offshore hake stock is not overfished. Overfishing is not occurring (the WMC notes that the current overfishing definition more appropriately characterizes exploitation and not biomass conditions). However, it should be noted that the survey averages are just at the threshold level for a “not overfished/overfishing” determination. In 2006, the three-year average mean fish weight is below the threshold value, and the three-year average recruitment index is just at the threshold level. The recruitment average, however, includes an extremely low value for 2005, which may be the result of survey variability (also apparent throughout the recruitment time series in Figure 9). A benchmark stock assessment is needed to thoroughly evaluate the status of this stock, investigate reasons for fluctuations in recruitment and mean fish weight, and develop a more appropriate and useful overfishing definition.

Table 16 Whiting PDT Updated Status Determination for Offshore Hake

Offshore Hake Overfishing Threshold: survey mean weight = 0.24 kg and survey recruitment index = 0.33 fish/tow						
YEAR	Mean Fish Weight (kg)	3-Year Average Mean Fish Weight	Recruitment Index (# of fish < 30 cm)	3-Year Average Recruitment Index	3-Year Average Weight Above 0.22 kg?	3-Year Average Recruitment Above 0.27 Fish?
1998	0.14	0.28	0.56	0.22	YES	NO
1999	0.13	0.22	0.13	0.26	AT	NO
2000	0.21	0.16	0.06	0.25	NO	NO
2001	0.18	0.18	1.86	0.68	NO	YES
2002	0.22	0.21	0.36	0.76	NO	YES
2003	0.32	0.24	0.55	0.92	YES	YES
2004	0.15	0.23	0.27	0.39	YES	YES
2005	0.27	0.25	0.01	0.28	YES	YES
2006	0.16	0.19	0.71	0.33	NO	YES
Stock Status: Not Overfished/Overfishing						

Figure 9 Trends in NEFSC Fall Survey Mean Weights and Survey Recruitment Index for Offshore Hake



5.0 REFERENCES

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