

Assessment of Lingcod
(Ophiodon elongatus)

for the

Pacific Fishery Management Council

in 2005

by

Thomas H. Jagielo and Farron R. Wallace

Washington Department of Fish and Wildlife
48 Devonshire Road.
Montesano, Washington 98563

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Executive Summary

Stock

This assessment applies to lingcod (*Ophiodon elongatus*) in the full Pacific Fishery Management Council (PFMC) management zone (the US-Vancouver, Columbia, Eureka, Monterey, and Conception INPFC areas). Separate assessment models were constructed to describe population trends in the northern (LCN: US-Vancouver, Columbia) and southern (LCS: Eureka, Monterey, Conception) areas.

Catches

Commercial Landings

Commercial lingcod catch history in California waters is available beginning 1916 (personal communication Brenda Erwin, PSMFC) and averaged 428 mt between 1916 and 1955 (Table 4). Commercial lingcod landings in Oregon were first reported in 1950 (Mark Freeman, personal communication) and averaged 264 mt between 1950 and 1953. Washington commercial lingcod landings were first reported in 1937 (anonymous, 1956, WDFW report) and averaged 106 mt until 1955.

Catch data were compiled from agency reports and personal communication for all years preceding 1981 (Table 5). The PacFIN database was queried for catch information in subsequent years and catch detail is presented by gear and INPFC area in Table 6.

Commercial landings peaked in 1985 at 3,129 mt in northern waters (Columbia and Vancouver INPFC areas) and in 1974 at 1,735 mt in southern waters (Eureka, Monterey and Conception INPFC Areas)(Table 5). Average catch between 1990-1997 declined 40 % and 35% since the 1980's in northern and southern waters, respectively. Under rebuilding management, commercial fishery restrictions in recent years (1998-present) reduced coastwide catches to an annual average of less than 225 mt (Figure 3).

From 1981-1997, trawl gear has made up the majority of commercial landings for the northern (83%) and southern (63%) coast. In recent years (1998-2004), commercial fishery restrictions constrained the trawl portion of the commercial catch to 65% and 40% for the northern and southern coast, respectively. In 2004, coastwide commercial landings totaled 174 mt and were distributed as follows by INPFC area: U.S.-Vancouver (41.7 mt), Columbia (44.6 mt), Eureka (39.5 mt), Monterey (33.2 mt), Conception (14.8 mt).

Recreational Landings

Recreational fishers in California have targeted lingcod since the early 1940's. Catch averaged 65.3 mt annually between 1947-1954 (Leet et al., 1992). Recreational lingcod catch information is not available until 1977 for Oregon waters and averaged 52.3 mt annually between 1977 and 1979. Recreational lingcod catch in Washington was first estimated in 1967 to be 25.3 mt and annual catch estimates have been provided since 1975.

Recreational catch estimates were extracted from the RecFIN database for years 1980–1989 and 1993 to present for California waters. California recreational catch estimates for all other years

were previously compiled in the 2000 lingcod assessment (Jagiello et al., 2000). Oregon recreational catch data were provided by ODFW (Don Bodenmiller personal communication). The recreational catch in Washington was provided by the WDFW Ocean Sampling Program.

Recreational catch in southern waters has declined since catch peaked in 1980 at 2,226 mt (Table 5, Figure 4). In contrast, recreational catch in northern waters peaked at 236 mt in 1994. Estimated coastwide recreational landings averaged 500 mt. from 1998-2004 and were 1175 mt. and 316 mt. in 2003 and 2004, respectively.

Historically, recreational landings have comprised a larger proportion of the total landings for the southern area, compared to the northern area. In recent years, the recreational portion of the total landings has increased substantially in both the southern and northern areas. In 2004 recreational fisheries harvested 65% of the total lingcod catch coastwide (Figure 5).

Data and Assessment

Present Modeling Approach and Assessment Program

The present assessment updates the previous coastwide assessment (Jagiello et al. 2003) and is implemented in Stock Synthesis II using the executable code SS2 version 1.19d (Methot 2005).

As in the previous assessment, separate age structured models were constructed to analyze stock dynamics for the northern (LCN: US-Vancouver, Columbia) and southern (LCS: Eureka, Monterey, Conception) areas.

The LCN model incorporated the following likelihood components, which are described mathematically in Methot 2005). Input data sources are specified by Table number in the body of the 2003 assessment document which follows:

- 1) Commercial Catch-At-Age: 1979-2004 (Table 9, Table 15).
 - 2) Recreational Catch-At-Age: 1980, 1986-2004 (Table 10, Table 15).
 - 3) Commercial Catch-At-Length: 1975-1978 (Table 13).
 - 4) Recreational Catch-At-Length: 1981-1983 (Table 13).
 - 5) NMFS Trawl Survey Catch-At-Age: 1992, 1995, 1998, 2001, and 2004 (Table 11).
 - 6) NMFS Trawl Survey Catch-At-Length: 1986 and 1989 (Table 12).
 - 7) WDFW Tag Survey Catch-At-Age: 1994-1997 (Table 11).
 - 8) WDFW Tag Survey Catch-At-Length: 1986-1993 (Table 12).
 - 9) NMFS Trawl Survey Biomass (mt): 1977, 1980, 1983, 1986, 1989, 1992, 1995, 1998, 2001 (Table 20) and 2004 (Table 21).
 - 10) WDFW Tag Survey Abundance (Numbers of Fish): 1986-1992 (Table 22).
- NOTE: THIS DATASET WAS OMITTED IN FINAL BASE MODEL AT THE REQUEST OF THE STAR PANEL CONDUCTED AUGUST 15-19, 2005.**
- 11) Trawl Fishery Logbook CPUE Index: Washington and Oregon lingcod CPUE estimates (lbs/hr) derived from a Delta GLM analysis of trawl logbook information, 1976-1997 (Table 24).

The LCS model incorporated the following likelihood components:

- 1) Commercial Catch-At-Age: 1992-1998, 2000-2004 (Table 14, Table 15).
- 2) Recreational Catch-At-Age: 1992-1998, 2000-2004 (Table 14, Table 15).
- 3) NMFS Trawl Survey Catch-At-Age: 1995, 1998, 2001, and 2004 (Table 14, Table 15).
- 4) NMFS Trawl Survey Biomass (mt): 1977, 1980, 1983, 1986, 1989, 1992, 1995, 1998, 2001 (Table 20) and 2004 (Table 20, Table 21).
- 5) Trawl Fishery Logbook CPUE Index: Oregon and California lingcod CPUE estimates (lbs/hr) derived from a Delta GLM analysis of trawl logbook information, 1978-1997 (Table 25).

Unresolved Problems and Major Uncertainties

At the STAR Panel review (August 15-19, 2005) concern was raised regarding the apparent lack of evidence in the data for the northern (LCN) model estimates of high 1999 and 2000 year class strength. In particular, doubts were raised concerning the reliability of the 2001 and 2004 NMFS triennial survey estimates, in which these two year classes were abundant. Furthermore, the STAR Panel did not find compelling evidence from the fishery age composition data to corroborate the high year classes seen in those two surveys. As a result of these uncertainties, the lingcod assessment was recommended for further review at the follow-up STAR Panel meeting (September 26-30, 2005).

At the follow-up STAR Panel meeting, additional analyses and information were provided to document the LCN model estimates of high 1999 and 2000 year class strength. Additional model runs with sequential removal of the 2001 and 2004 NMFS trawl surveys, and age compositions from the commercial and recreational fisheries from 2000-2004 indicated that both survey and commercial data supported the two strong year classes. As a result, the STAT Team recommended and the STAR Panel approved the base LCN model for management.

The STAT team very much appreciated the constructive August 15-19, 2005 and September 26-30 STAR Panel reviews, which resulted in improved LCN and LCS models for fisheries management.

The STAT team additionally notes that:

- 1) Uncertainty regarding stock status is higher for the southern area relative to the northern area, primarily because historical data from the southern area were sparse relative to the northern area. The time series of fishery age data available for the southern (LCS) model is short and samples sizes are small, resulting in greater uncertainty in the estimation of assessment parameters and stock productivity for the southern area. Age data for the NMFS trawl survey were sparse for both regions in early years, but particularly for the southern region. Recreational fishery catch at age data were not available for the southern region in 2003.
- 2) Management-implemented minimum size limits have resulted in limiting the utility of fishery information for estimation of recent stock recruitment in both regions, and fishery trip limits have compromised the utility of recent fishery CPUE data as viable indices of abundance.

Management Reference Points

Management reference points derived from the 2005 lingcod stock assessment are summarized in Table ES-1. The estimates of unfished spawning biomass (B_{zero}) were determined as the product of mean recruitment from 1956-2005 and the estimated Spawners Per Recruit. On a coastwide basis the lingcod population is fully rebuilt; estimated spawning biomass was 34,017 mt in 2005, which is 0.60 of the unfished spawning biomass estimate (52,850 mt). The estimated ratio of 2005 spawning biomass to unfished spawning biomass is higher in the north (0.87) compared to the south (0.24).

Spawning Stock Biomass

SS2 estimates of the coastwide female spawning stock biomass declined from 60,106 mt in 1956 to 6,004 mt in 1994, and subsequently increased to 34,017 mt in 2005 (Table ES-2, Figure ES1-Top). Female spawning biomass depletion (B_0/B_t) fell to 0.11 in 1994 and subsequently increased to 0.64 in 2005 (Table ES-2, Figure ES1-Bottom).

Recruitment

The model estimate of virgin recruitment was higher for the northern area (3750 thousand age 0 fish) compared to the southern area (2503 thousand age 0 fish). Recruitments were generally similar in magnitude in both the north and south from 1972-1992, averaging 2008 in the north, and 2071 in the south (Table ES-2, Figure ES-1, bottom). Subsequently, from 1993-2005, recruitments tended to be higher in the north, and averaged 4503 compared to 1309 for the same period in the south. Recent, historically strong, 1999 and 2000 year classes were estimated in the north.

Exploitation Status

In the northern area, the exploitation rate (catch/available biomass) peaked at 0.20 in 1991 and averaged 0.03 from 1956-1980, 0.12 from 1981-1997, and 0.02 from 1998-2005 (Table ES-3). Exploitation rates were generally higher in the southern area, peaking at 0.26 in 1989 and averaging 0.05 from 1956-1980, 0.20 from 1981-1997, and 0.10 from 1998-2005.

Management Performance

The first lingcod ABC's based on a quantitative assessment were implemented in 1995. A comparison of reported landings and ABC values shows good correspondence through 2001, when landings were typically at or below the target ABC values (Figure ES2). In 2002, landings exceeded the coastwide ABC by 17% and the coastwide OY was exceeded by 51%.

Forecasts and Decision Table

Projected yield was forecasted using the SS2 software for the northern (LCN) and southern (LCS) base models (Table ES-4). Coastwide yield forecasts (sum of LCN and LCS) are summarized in Table ES-5. Forecasts were run with and without the 40:10 adjustment option. These forecasts assumed that fishery removals in 2005 and 2006 were taken at the level projected by the Groundfish Management Team for 2005 (970mt) (John Devore, Personal Communication).

Additional model forecast runs were made for a set of alternative conditions to establish decision tables. For LCN, the decision table was constructed with the base model and one alternate model in which both: 1) the NMFS 2001 and 2004 shelf triennial trawl survey data were omitted, and 2) the age composition data for the recreational and commercial fishery were omitted for the years 2000 through 2004 (Table ES-6). For LCS, the decision table was constructed with the base model and two alternate models (Table ES-7). The first “low” alternate model assumed that spawning biomass in 2005 was approximately 1.25 standard deviations below the base model estimate of spawning biomass in 2005 (3375 mt); the second “high” alternate model assumed that spawning biomass in 2005 was approximately 1.25 standard deviations above the base model estimate of spawning biomass in 2005 (5827 mt).

In both decision tables (Table ES-6 and Table ES-7), the base case model using the base case catch projection is highlighted with a bold outline. The additional cells in the decision tables contrast the results obtained when the models are run with catch projections from the alternate (State of Nature) models. For instance, in the northern area, when base model projected catches are used with the alternate State of Nature model, a depletion level of 0.27 is predicted in the year 2016 (Table ES-6). In the southern area, the predicted depletion level of 0.39 in the year 2016 results when the “high” ending biomass model catches are applied to the “low” ending biomass State of Nature model (Table ES-7).

Recommendations: Research and Data Collection Needs

Emphasis should be placed on improving fishery age structure sampling size and geographical coverage in both regions. More frequent and synoptic fishery independent surveys should be conducted in both regions to aid in determination of stock status and recent recruitment.

Table ES1. Management reference points derived from the 2005 lingcod stock assessment.

Northern (LCN)	Base model
B2005 (mt)	29416
Rinit (Thousands)	3750
Spawners Per Recruit	10.52
Rmean56-05 (Thousands)	3207
Bzero (mt)	33749
Depletion	0.87
Southern (LCS)	
Base model	
B2005 (mt)	4601
Rinit (Thousands)	2503
Spawners Per Recruit	9.43
Rmean56-05 (Thousands)	2025
Bzero (mt)	19101
Depletion	0.24
Coastwide	
Base models-Pooled	
B2005 (mt)	34017
Bzero (Thousands)	52850
Depletion	0.64

Table ES2. Estimates of lingcod spawning biomass, depletion, and recruitment (1956-2005), derived from the 2005 lingcod stock assessment.

Bzero: Year	Spawning Biomass (mt)			Depletion			Recruitment-Age 0 (Thousands)		
	LCN	LCS	Coastwide	LCN	LCS	Coastwide	LCN	LCS	Coastwide
1956	38357	21749	60106	1.14	1.14	1.14	3747	2497	6244
1957	37696	21500	59196	1.12	1.13	1.12	3745	2496	6241
1958	36979	20998	57977	1.10	1.10	1.10	3743	2494	6237
1959	36181	20480	56660	1.07	1.07	1.07	3740	2493	6233
1960	34816	20046	54862	1.03	1.05	1.04	3736	2491	6227
1961	33381	19675	53057	0.99	1.03	1.00	3731	2489	6220
1962	32166	19304	51470	0.95	1.01	0.97	3726	2488	6214
1963	31513	19065	50578	0.93	1.00	0.96	3724	2487	6210
1964	31280	18854	50134	0.93	0.99	0.95	3723	2486	6208
1965	30866	18781	49647	0.91	0.98	0.94	3721	2485	6206
1966	30281	18737	49018	0.90	0.98	0.93	3719	2485	6204
1967	29522	18700	48221	0.87	0.98	0.91	3715	2485	6200
1968	29283	18639	47922	0.87	0.98	0.91	3714	2485	6199
1969	28785	18539	47324	0.85	0.97	0.90	3712	2484	6196
1970	28723	18458	47181	0.85	0.97	0.89	3711	2484	6195
1971	28946	18228	47174	0.86	0.95	0.89	3712	2483	6195
1972	29065	17758	46823	0.86	0.93	0.89	3375	2480	5855
1973	29236	16829	46065	0.87	0.88	0.87	1176	2475	3652
1974	29073	15671	44744	0.86	0.82	0.85	2706	2468	5174
1975	28628	14435	43063	0.85	0.76	0.81	1515	2460	3975
1976	27545	13407	40952	0.82	0.70	0.77	1326	3967	5293
1977	26402	12480	38882	0.78	0.65	0.74	2318	1099	3417
1978	24918	12195	37113	0.74	0.64	0.70	2477	1227	3704
1979	23504	11994	35498	0.70	0.63	0.67	6619	5522	12141
1980	21260	11539	32800	0.63	0.60	0.62	1539	1403	2942
1981	19384	9664	29049	0.57	0.51	0.55	955	586	1541
1982	18112	8393	26505	0.54	0.44	0.50	1442	483	1925
1983	17140	7626	24766	0.51	0.40	0.47	1244	928	2172
1984	15700	7063	22763	0.47	0.37	0.43	1972	5487	7459
1985	13790	6212	20002	0.41	0.33	0.38	1298	1124	2422
1986	11454	5108	16562	0.34	0.27	0.31	2576	4621	7198
1987	10562	4512	15074	0.31	0.24	0.29	282	514	796
1988	9524	4384	13908	0.28	0.23	0.26	986	578	1563
1989	8615	4270	12885	0.26	0.22	0.24	1610	1581	3191
1990	7296	3934	11230	0.22	0.21	0.21	1357	1664	3021
1991	6328	3397	9725	0.19	0.18	0.18	2589	2015	4604
1992	4796	2720	7515	0.14	0.14	0.14	2806	800	3605
1993	4266	2255	6522	0.13	0.12	0.12	1120	1500	2620
1994	3864	2141	6004	0.11	0.11	0.11	3841	1067	4908
1995	3924	2226	6150	0.12	0.12	0.12	3607	985	4592
1996	4449	2215	6664	0.13	0.12	0.13	1694	2606	4300
1997	5034	2145	7179	0.15	0.11	0.14	1666	314	1979
1998	5886	2075	7961	0.17	0.11	0.15	4601	860	5462
1999	7245	2331	9576	0.21	0.12	0.18	11733	2016	13750
2000	8675	2630	11306	0.26	0.14	0.21	12945	1587	14532
2001	10702	3099	13801	0.32	0.16	0.26	3320	1750	5070
2002	13758	3558	17316	0.41	0.19	0.33	3552	1106	4658
2003	18370	3859	22229	0.54	0.20	0.42	3434	788	4221
2004	24077	3919	27996	0.71	0.21	0.53	3318	1075	4393
2005	29416	4601	34017	0.87	0.24	0.64	3715	1362	5076

Table ES3. Estimates of exploitation rate derived from the 2005 lingcod stock assessment.

Year	LCN Exploitation Rate	LCS Exploitation Rate
1956	0.016	0.018
1957	0.018	0.029
1958	0.021	0.029
1959	0.035	0.026
1960	0.039	0.024
1961	0.037	0.026
1962	0.027	0.021
1963	0.020	0.022
1964	0.027	0.017
1965	0.033	0.018
1966	0.039	0.019
1967	0.028	0.021
1968	0.036	0.023
1969	0.026	0.023
1970	0.020	0.031
1971	0.023	0.043
1972	0.022	0.068
1973	0.031	0.083
1974	0.037	0.093
1975	0.050	0.088
1976	0.043	0.090
1977	0.046	0.055
1978	0.040	0.066
1979	0.065	0.092
1980	0.063	0.193
1981	0.064	0.164
1982	0.079	0.178
1983	0.115	0.151
1984	0.128	0.139
1985	0.149	0.171
1986	0.074	0.152
1987	0.098	0.195
1988	0.109	0.226
1989	0.161	0.262
1990	0.146	0.261
1991	0.204	0.252
1992	0.130	0.256
1993	0.156	0.233
1994	0.131	0.191
1995	0.092	0.198
1996	0.097	0.198
1997	0.085	0.206
1998	0.049	0.125
1999	0.037	0.131
2000	0.011	0.062
2001	0.009	0.057
2002	0.009	0.103
2003	0.006	0.158
2004	0.008	0.039

Table ES4. Projected yield for the LCN Base Model (Top) and LCS Base Model (Bottom).

LCN Base Model						
FORECAST: _Without_40:10						
year	4010	bio-all	SpawnBio	recruit-0	Yield	ABC
2007	1	56321	36250	3741	5830	5830
2008	1	52212	34135	3734	5025	5025
2009	1	48734	31802	3725	4473	4473
2010	1	45743	29533	3715	4058	4058
2011	1	43170	27454	3705	3741	3741
2012	1	40976	25614	3694	3484	3484
2013	1	39145	24046	3684	3259	3259
2014	1	37670	22768	3675	3059	3059
2015	1	36525	21776	3667	2903	2903
2016	1	35653	21023	3661	2810	2810
FORECAST: _with_40:10						
year	4010	bio-all	SpawnBio	recruit-0	Yield	ABC
2007	1	56321	36250	3741	5830	5830
2008	1	52212	34135	3734	5025	5025
2009	1	48734	31802	3725	4473	4473
2010	1	45743	29533	3715	4058	4058
2011	1	43170	27454	3705	3741	3741
2012	1	40976	25614	3694	3484	3484
2013	1	39145	24046	3684	3259	3259
2014	1	37670	22768	3675	3059	3059
2015	1	36525	21776	3667	2903	2903
2016	1	35653	21023	3661	2810	2810

LCS Base Model						
FORECAST: _Without_40:10						
year	4010	bio-all	SpawnBio	recruit-0	Yield	ABC
2007	1	9123	5451	1390	876	876
2008	1	9260	5398	2289	828	828
2009	1	9524	5374	2287	805	805
2010	1	10013	5419	2290	771	771
2011	1	10715	5609	2298	794	794
2012	1	11519	5973	2313	907	907
2013	1	12279	6429	2330	1025	1025
2014	1	12945	6884	2345	1134	1134
2015	1	13503	7291	2357	1218	1218
2016	1	13966	7643	2366	1275	1275
FORECAST: _with_40:10						
year	4010	bio-all	SpawnBio	recruit-0	Yield	ABC
2007	0.756	9123	5451	1390	662	876
2008	0.767	9475	5558	2296	658	857
2009	0.778	9906	5667	2301	664	853
2010	0.792	10529	5819	2307	656	828
2011	0.817	11332	6091	2318	698	855
2012	0.85	12214	6517	2333	824	969
2013	0.885	13035	7022	2349	965	1090
2014	0.914	13736	7509	2362	1097	1200
2015	0.936	14299	7928	2373	1200	1282
2016	0.953	14743	8273	2381	1269	1332

Table ES-5. Projected coastwide yield (Sum of LCN and LCS).

Coastwide-Pooled (Sum of LCN and LCS)					
FORECAST: _Without_40:10					
year	bio-all	SpawnBio	recruit-0	Yield	ABC
2007	65445	41701	5130	6706	6706
2008	61471	39533	6022	5853	5853
2009	58257	37175	6012	5278	5278
2010	55756	34952	6005	4829	4829
2011	53885	33062	6003	4535	4535
2012	52495	31587	6008	4390	4390
2013	51424	30474	6014	4284	4284
2014	50615	29652	6020	4193	4193
2015	50028	29067	6024	4121	4121
2016	49619	28665	6026	4085	4085
FORECAST: __with_40:10					
year	bio-all	SpawnBio	recruit-0	Yield	ABC
2007	65445	41701	5130	6493	6706
2008	61686	39693	6030	5683	5883
2009	58640	37468	6026	5136	5326
2010	56271	35352	6022	4714	4886
2011	54502	33544	6023	4440	4597
2012	53190	32131	6027	4308	4453
2013	52181	31067	6033	4224	4349
2014	51405	30277	6037	4156	4259
2015	50824	29704	6040	4103	4184
2016	50396	29295	6041	4080	4142

Table ES6. Decision table for the northern (LCN) area.

LCN	B0:	33749	Year	Catch	State of Nature			
					Base Case		Alternate Case	
Management Decision					SSB	Depletion	SSB	Depletion
Base Case Catch (With 40:10) Full Model					RUN BB		RUN AB	
			2007	5830	36250	1.07	20327	0.60
			2008	5025	34135	1.01	17713	0.52
			2009	4473	31802	0.94	15461	0.46
			2010	4058	29533	0.88	13614	0.40
			2011	3741	27454	0.81	12167	0.36
			2012	3484	25614	0.76	11067	0.33
			2013	3259	24046	0.71	10257	0.30
			2014	3059	22768	0.67	9695	0.29
			2015	2903	21776	0.65	9346	0.28
			2016	2810	21023	0.62	9159	0.27
Alternate Case Catch (With 40:10) Delete: 2001, 2004 Survey 2000-2004 Fishery Age Comps.					RUN BA		RUN AA	
			2007	3267	36250	1.07	20327	0.60
			2008	3042	36057	1.07	19584	0.58
			2009	2869	35277	1.05	18845	0.56
			2010	2729	34157	1.01	18170	0.54
			2011	2625	32927	0.98	17594	0.52
			2012	2555	31650	0.94	17116	0.51
			2013	2500	30396	0.90	16720	0.50
			2014	2456	29224	0.87	16396	0.49
			2015	2424	28171	0.83	16139	0.48
			2016	2402	27238	0.81	15933	0.47

Table ES7. Decision table for the southern (LCS) area.

LCS		19101		Base Case		Alternate Case-Low		Alternate Case-High	
B0:	Year	Catch	SSB	Depletion	SSB	Depletion	SSB	Depletion	
Management Decision									
Base Case Catch (With 40:10)									
Full Model	2007	662	5451	0.29	4251	0.22	6568	0.34	
	2008	658	5558	0.29	4420	0.23	6653	0.35	
	2009	664	5667	0.30	4607	0.24	6713	0.35	
	2010	656	5819	0.30	4839	0.25	6796	0.36	
	2011	698	6091	0.32	5189	0.27	6988	0.37	
	2012	824	6517	0.34	5694	0.30	7325	0.38	
	2013	965	7022	0.37	6280	0.33	7739	0.41	
	2014	1097	7509	0.39	6850	0.36	8135	0.43	
	2015	1200	7928	0.42	7354	0.38	8464	0.44	
	2016	1269	8273	0.43	7784	0.41	8722	0.46	
Alternate Case Catch (With 40:10)									
Ending Biomass-Low									
	2007	414	5451	0.29	4251	0.22	6568	0.34	
	2008	491	5745	0.30	4600	0.24	6840	0.36	
	2009	557	5984	0.31	4920	0.26	7031	0.37	
	2010	602	6218	0.33	5237	0.27	7195	0.38	
	2011	672	6525	0.34	5627	0.29	7421	0.39	
	2012	808	6959	0.36	6144	0.32	7764	0.41	
	2013	956	7459	0.39	6732	0.35	8171	0.43	
	2014	1096	7936	0.42	7297	0.38	8554	0.45	
	2015	1203	8337	0.44	7788	0.41	8862	0.46	
	2016	1280	8660	0.45	8201	0.43	9095	0.48	
Alternate Case Catch (With 40:10)									
Ending Biomass-High									
	2007	853	5451	0.29	4251	0.22	6568	0.34	
	2008	799	5415	0.28	4280	0.22	6509	0.34	
	2009	761	5412	0.28	4357	0.23	6458	0.34	
	2010	706	5490	0.29	4512	0.24	6467	0.34	
	2011	740	5727	0.30	4823	0.25	6626	0.35	
	2012	849	6131	0.32	5302	0.28	6943	0.36	
	2013	979	6628	0.35	5874	0.31	7351	0.38	
	2014	1101	7116	0.37	6441	0.34	7752	0.41	
	2015	1195	7545	0.39	6949	0.36	8094	0.42	
	2016	1258	7908	0.41	7393	0.39	8374	0.44	

Figure ES1. Female spawning biomass (top) depletion (middle), and recruitment (bottom) 1956-2005.

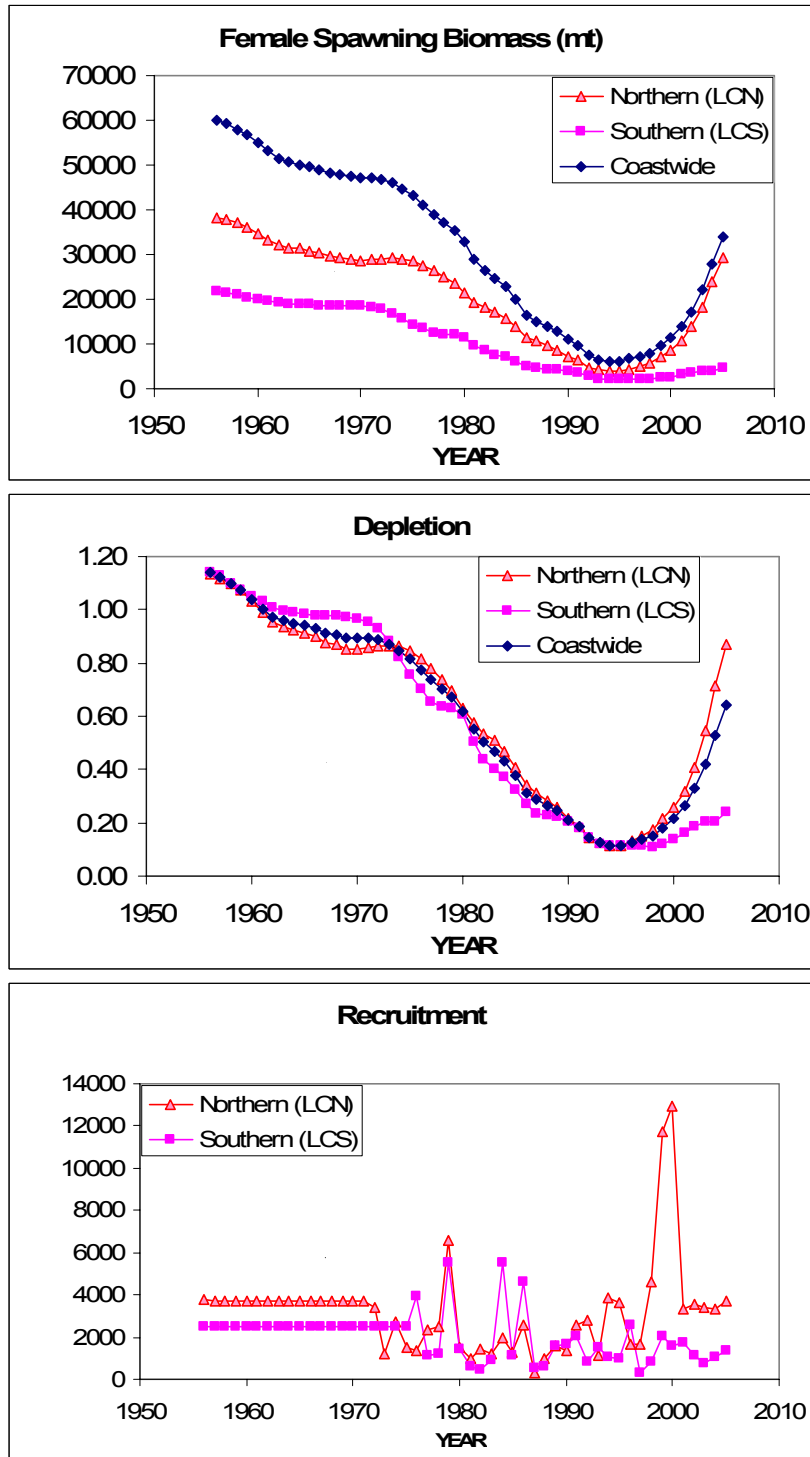


Figure ES2 Comparison of lingcod ABC, OY and landings (mt) between 1983 and 2003.

