

History and Management of the Coastal Fishery for Pacific Whiting, *Merluccius productus*

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Introduction

This paper summarizes the history and condition of the west coast fishery for Pacific whiting, *Merluccius productus*, and both reviews and advances some ideas concerning management of the resource. This work results equally from basic biological research, well documented survey and fisheries statistics, mathematical modeling, and a multinational examination of the biological basis for management of the resource. Additional material on these subjects is presented by Francis et al.¹

The West Coast Stock and Fishery

Catch History

Pacific whiting has been the target of a large foreign fishery off the west coast of the United States and Canada (Table 1). A Soviet fishery for whiting began in 1966 with a catch of 137,000 metric tons (t). From 1973 to 1976 Poland, the Federal Republic of Germany (West Germany), the German Democratic Republic (East Germany), and Bulgaria joined the fishery. Reported catches peaked in 1976 at 237,500 t. Reductions in catch in recent years in U.S. waters have

Table 1.—Annual catches of foreign, joint venture, and domestic fisheries (in kilotons) of Pacific whiting in U.S. and Canadian waters and estimates of effort (1,000 standard days) for total fishery, 1966-83.

Year	U.S.			Canada			Combined				
	Foreign	Joint Venture	Domes- tic	Total ¹	Foreign	Joint Venture	Domes- tic	Total ²	Total	CPUE ³	Eff. ⁴
-----Kilotons-----											
1966	137.000		0.000	137.000			0.700	137.700	19.2	7.171	
1967	168.699		8.959	177.658	36.713		36.713	214.371	36.0	5.951	
1968	60.660		0.159	60.819	61.361		61.361	122.180	11.8	10.397	
1969	86.187		0.093	86.280	93.851		93.851	180.131	18.5	9.726	
1970	159.509		0.066	159.575	75.009		75.009	234.584	25.6	9.180	
1971	126.485		1.428	127.913	26.699		26.699	154.612	17.5	8.842	
1972	74.093		0.040	74.133	43.413		43.413	117.546	15.9	7.381	
1973	145.241		0.072	145.313	15.125		0.001	15.126	160.439	23.8	6.752
1974	194.108		0.001	194.109	17.146		0.004	17.150	211.259	24.3	8.705
1975	205.654		0.002	205.656	15.704			15.704	221.360	19.0	11.646
1976	231.331		0.218	231.549	5.972			5.972	237.521	25.7	9.242
1977	127.013		0.489	127.502	3.453			3.453	130.955	30.9	4.244
1978	96.827	0.856	0.689	98.372	4.650	1.814		6.464	104.836	35.2	2.980
1979	114.909	8.834	0.937	124.680	7.900	4.233	0.302	12.435	137.115	26.0	5.276
1980	44.023	27.537	0.792	72.352	5.273	12.214	0.097	17.584	89.936	28.5	3.152
1981	70.365	43.556	0.839	114.760	3.919	17.159	3.283	24.361	139.121	28.3	4.915
1982	7.089	67.464	1.024	75.577	12.479	19.676	0.000	32.155	107.732	30.9	3.489
1983	0.000	72.100	1.050	73.150	13.117	27.657	0.000	40.774	113.924		
Mean				127.022				29.385	156.407		7.003

¹1966-80 from Bailey et al. (1982), 1981-82 from PacFin data base; Pacific Marine Fisheries Commission.

²Reported by G. A. McFarlane (6-9-83).

³1966-81 from Bailey et al. (1982) for U.S. fishery; 1982 estimated from Bulgarian fleet in U.S. waters.

⁴Estimated assuming CPUE (Canada) = CPUE (U.S.).

been due primarily to severe restrictions on foreign effort imposed subsequent to the implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA) of 1977.

In U.S. waters, a small fishery for whiting has existed since at least 1879 (Jow, 1973). With the exception of 1967, the fishery has been rather insignificant, with catches in the range of 100-1,100 t/year. However, in re-

cent years joint venture fisheries for whiting have become important in both U.S. and Canadian waters.

The fishery is tied closely to the migratory movements of the whiting population. Most years, the fishery begins in waters off northern California and southern Oregon in April and moves northward as schools migrate in a northerly direction during the summer (Bailey et al., 1982). The fishery in Canadian waters generally starts in July or early August (Beamish and McFarlane, 1985). In all areas the fishery usually ends in mid to late October with the offshore and southerly movement of the fish back to the winter spawning grounds.

¹Francis, R. C., G. A. McFarlane, A. Hollowed, G. L. Swartzman, and W. M. Getz. 1984. Status and management of the Pacific hake (*Merluccius productus*) resource and fishery off the west coast of the United States and Canada. Northwest Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112. Proc. Rep. 84-18, 73p.

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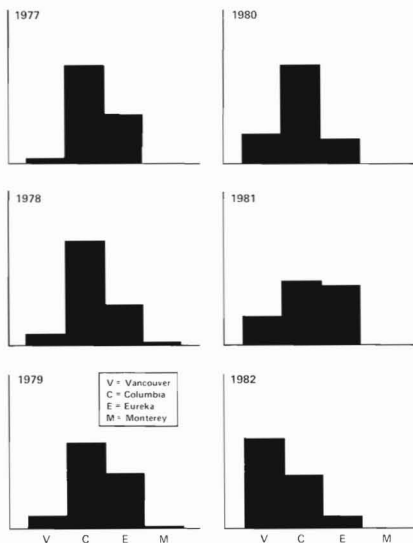


Figure 1.—Relative distribution of Pacific whiting catch in weight by INPFC area.

Table 2.—Contribution (percent catch by numbers) of fish of the strong 1970, 1973, and 1977 year classes to the Pacific whiting fisheries in the U.S. and Canadian zones.

Country and year class	Fishing Year						
	1976	1977	1978	1979	1980	1981	1982
U.S.							
1970	57	38	27	12	8	4	4
1973	10	30	36	30	21	13	10
1977	—	—	—	4	16	56	45
Total	67	68	63	46	45	73	59
Canada							
1970	36	—	22	26	44	29	19
1973	3	—	6	11	16	21	14
1977	—	—	—	—	—	5	43
Total	39	—	28	37	60	55	76

Figure 1 gives the distribution of catch by International North Pacific Fisheries Commission (INPFC) statistical areas for 1977-82. Recently the largest removal has been from the INPFC Columbia area (with the exception of 1982 when the fishery was forced north due to a preponderance of small unmarketable fish south of the INPFC Vancouver area).

Figures 2 and 3 give the relative age frequencies of catches in U.S. (1973-82) and Canadian (1976, 1978-82) waters respectively. The age

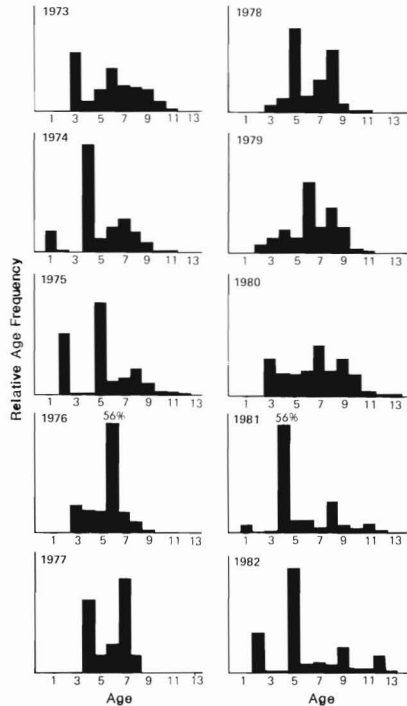


Figure 2.—Relative age-frequency of Pacific whiting catch in U.S. waters, 1973-82.

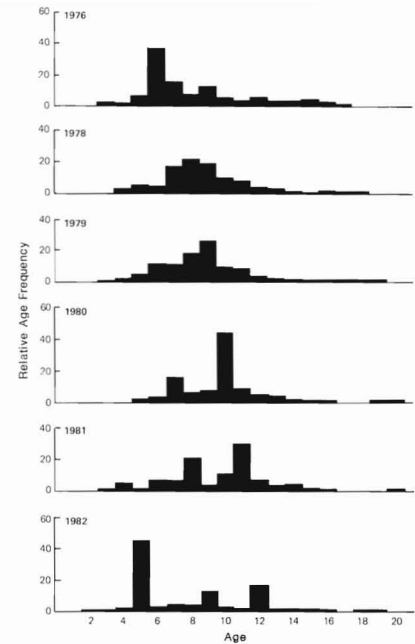


Figure 3.—Relative age-frequency of Pacific whiting catch in Canadian waters, 1976, 1978-82.

at which most fish are first recruited to the U.S. fishery is 2 or 3 years, whereas most fish are recruited to the Canadian fishery at age 5 or 6. Strong year classes clearly dominate the fisheries in both U.S. and Canadian waters (Table 2). Currently, the 1970, 1973, and 1977 year classes are dominant in the fishery. In 1982, these three year classes accounted for 59 and 76 percent of the estimated catches in the U.S. and Canadian zones, respectively. Indications are that the 1980 year class, not yet fully recruited to either the U.S. or Canadian fisheries, may be one of the strongest year classes ever observed in the fishery (T. A. Dark²). During the history of the fishery, it is apparent that strong year classes have occurred

²T. A. Dark, Northwest and Alaska Fisheries Center, Natl. Mar. Fish. Serv., NOAA, 2725 Montlake Blvd., E., Seattle, WA 98112. Pers. commun. 1984.

in 1980, 1977, 1973, 1970, 1967 or 1968, 1964, and 1961 (Beamish and McFarlane, 1985).

Bailey (1981, 1982) and Bailey and Francis (1985) document the current state of knowledge of early life history and its effects on subsequent recruitment in Pacific whiting. Their studies point to conditions during the first few months of life as being critical in determining year-class strength.

The mean size of males and females from the 1970 year class sampled in the U.S. and Canadian commercial fisheries from 1976 through 1982 is compared in Figure 4. It shows that not only do larger, older fish tend to occur in the Canadian fishery, but the individuals of any particular year class tend to stratify on a north-south gradient by size, with the larger fish occurring farther north. In addition, Beamish and McFarlane (1985) indicate that females dominate the catch in the Canadian zone, ranging from

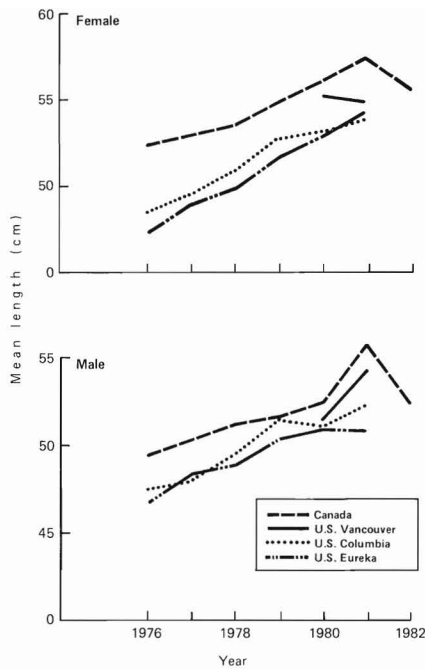


Figure 4.—Mean size of female and male Pacific whiting from the 1970 year class in the U.S. and Canadian fisheries from 1976-82.

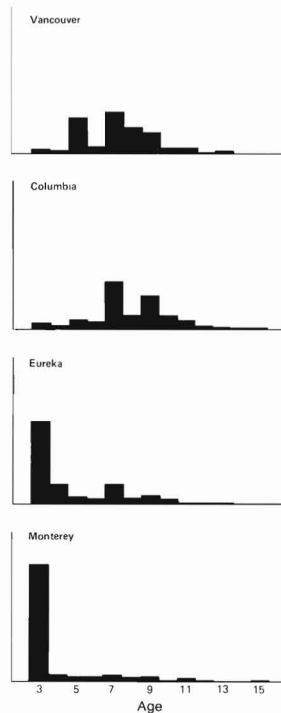


Figure 5.—Relative age-frequency of Pacific whiting in the 1980 NWAFC trawl-hydroacoustic survey of the Northwest and Alaska Fisheries Center.

Table 3.—Distribution of Pacific whiting biomass (kilotons) from two (1977 and 1980) Northwest and Alaska Fisheries Center trawl-hydroacoustic surveys¹ from International North Pacific Fisheries Commission (INPFC) Monterey area and northward.

Year and Survey type	INPFC area				Total
	Vancouver	Columbia	Eureka	Monterey	
1977					
Midwater	343.821	316.440	360.944	108.087	1129.292
Bottom	6.560	32.917	9.501	18.266	67.244
Total	350.381	349.357	370.445	126.353	1196.536
1980					
Midwater	322.335	260.477	182.783	578.841	1344.436
Bottom	17.286	20.156	11.481	143.824	192.747
Total	339.621	280.633	194.264	722.665	1537.183

¹Target strength = -35 decibels.

60 to 82 percent of the catch since 1977.

Biomass Estimates

Numerous direct estimates of the

biomass of the coastal stock of Pacific whiting have been made and are referenced by Bailey et al. (1982). The most reliable estimates of stock biomass are obtained in the triannual

National Marine Fisheries Service (NMFS) trawl/hydroacoustic groundfish survey of the west coast region (Dark et al., 1980; Nelson and Dark, In press). Table 3 shows estimates of stock biomass by INPFC statistical area for the two comprehensive surveys run and reported to date (1977 and 1980), and Figure 5 shows estimates of relative age-frequency (ages 3+) by INPFC area for the 1980 survey. All of these demonstrate the size and age stratification of Pacific whiting on the north-south gradient.

The most common indirect method for estimation of available stock biomass is cohort analysis using a time series of catch-at-age data. Francis (1983) describes a weighted cohort analysis procedure used for whiting. He reports markedly different results, especially in terms of estimates of stock biomass, between estimates made under the assumption of constant age-specific natural mortality (M) and those made under the assumption of variable age-specific natural mortality. Using the 1977 and 1980 Northwest and Alaska Fisheries Center (NWAFC) trawl-hydroacoustic survey estimates of stock biomass as validation criteria, indications are that a variable age-specific representation of M is more realistic. Results of the most recent cohort analysis are given in Francis et al. (footnote 1).

Management

Prior to the implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA) in 1977, foreign fisheries off the U.S. west coast were managed by bilateral agreements. From 1977 to 1982, U.S. management was directed by a Preliminary Management Plan (PMP) for groundfish prepared by the Department of Commerce. Subsequently, the Pacific Fishery Management Council (PFMC) has prepared a fisheries management plan (FMP) for groundfish, including whiting, which was implemented in September 1982. Under the plan, the whiting resource

in the U.S. zone is managed under the assumption that:

1) Maximum sustainable yield (MSY) is attainable;

2) For the entire resource (U.S. and Canada), MSY ranges from 120,000 to 270,000 t with a mean value of 195,000 t;

3) 90 percent of the fishable resource is available to the U.S. fishery and 10 percent to the Canadian fishery.

The implication is that MSY in the U.S. zone ranges from 108,000 to 243,000 t with a mean value of 175,500 t.

Canadian management of whiting (Stocker, 1981) is presently based on U.S. stock assessments but does not entirely reflect current U.S. management.

When combined, current U.S. and Canadian allowable catches total 210,000 t, exceeding the present U.S. estimate of MSY by 15,000 t. This reflects a higher estimate (17 percent) of the proportion of the fishable resource available to the Canadian fishery than that stated in the U.S. management plan (10 percent).

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