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Pacific Hake - Strait of Georgia Stock Assessment for 1999 and Recommended Yield Options for 2000

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ABSTRACT

The fishery in the Strait of Georgia decreased substantially to 3,996t in 1998 from 6,561t in 1997, a result of low market demand. Age and growth data continue to indicate strong recruitment during the 1990's and a coincidental decline in the mean size-at-age. Yield options remain unchanged from the previous assessment with a range of 7,554-14,687 t. Due to uncertainty in the current assessment, including evidence of increasing seal predation we recommend that managers choose a quota from the lower half of the yield range.

RÉSUMÉ

La pêcherie dans le détroit de Géorgie a diminué de façon appréciable pour passer de 6 561 t en 1997 à 3 996 t en 1998 suite à une réduction de la demande. Les données sur l'âge et la croissance continuent d'indiquer un fort recrutement au cours des années 1990 et un déclin simultané de la taille moyenne selon l'âge. La gamme des options de rendement, qui se situe entre 7 554 t et 14 687 t, demeure inchangée par rapport à l'évaluation précédente. Étant donné le caractère incertain de la présente évaluation, notamment des indices d'une prédation accrue par les phoques, nous recommandons que les gestionnaires fixent le quota à une valeur se situant dans la demie inférieure de la gamme de rendement.

1.0 Introduction

This is an interim assessment for Strait of Georgia Pacific hake and yield options are not revised from the previous assessment (Saunders and McFarlane 1999). We review current fishery and biological data.

1.1 Landing Statistics

Pacific hake is the most abundant resident fish in the Strait of Georgia. Landings of hake from the Strait of Georgia have gradually increased from the inception of the fishery in 1978. The quota was attained for the first time in 1995 when 11,859 t were landed (Table 1.1). Since then the catch has declined substantially to 3,996t in 1998, despite higher available quotas (Table 1.1). Fishers indicated that the lower catches reflect depressed market demand at the time of peak abundance, reduced availability of hake in the post-spawning period and less interest due to an increasingly poor recovery rate due to continuously declining size of fish since 1990.

1.2. Condition of the Stock

Biological information

Age composition data (Fig. 1.1) indicate that pulses of recruitment have occurred every 3-5 years since monitoring began. The dominant year-classes are 77-78, 83-84,87, 91-92, 95, and 98-99. Since 1994 there has been a dramatic decline in the mean size at age (Fig. 1.2) for adult hake. For example, 4 year old females (age at full recruitment) throughout the 1980's were approximately 40 cm in length and have gradually declined to 35 cm by 1995 (Beamish et al. In press). The size at age of age 1's and 2's have remained constant, if not slightly increasing over the time series (Fig. 1.2). The most heavily affected year of growth appears to be the third year, a period when hake are becoming mature and moving deeper in the water column to feed. The amount of growth occurring during years 4 through 6 appears constant over the time series (Fig 1.2) indicating that cohorts do not compensate in later years for the reduced growth at age 3. This is illustrated further by growth trajectories for dominant year-classes presented in Fig. 1.3. The 1991 and 1992 cohorts are 5cm smaller after age 3 than the fish from earlier years. Finally it should be noted that there appears to be a slight increase for all but age 2's in 1999 (Fig 1.2) .

It is clear that the dynamics of the Pacific hake stock in the St. of Georgia have changed since the early 1990's. At present the mechanism for these changes is unknown however it is coincident with changes in the oceanography of the Strait, particularly water temperature, timing of the spring discharge of the Fraser River, and timing of the spring plankton bloom (Beamish & McFarlane In press). The relationship between climate, ocean processes and productivity of the Strait are currently being investigated.

Another factor to consider is predation by harbour seal populations. A recent examination of harbour seal populations in the Strait of Georgia found that the population had increased from 4,000 seals in 1973 to about 41,000 (95% confidence interval 30,000-52,500) in 1996 (Olesiuk 1999). The annual growth rate of the population was about 11.9% through the 1970's and 80's and slowed to 7.2% in the early to mid 1990's (Olesiuk 1999). There are indications that the population has been stable since 1996 (Olesiuk 1999). Rates of hake consumption were estimated from scat analysis conducted from 1982-88 (Olesiuk 1993). Hake represented 42.6 percent of the diet by weight and annual consumption was estimated to be between 2,215 and 6,664t. At the 1996 population level, this population is estimated to consume approximately 11,000t of hake annually although given the width of confidence intervals for abundance and consumption, the actual amount could vary between 4,400 and 21,000t. A large amount of the uncertainty lies with the assumption that the rates of consumption developed in the 1980's apply to the current population. In addition, the population of seals in 1980's contained a large number of juveniles and was distributed quite differently from the present. Continued monitoring of abundance, more current assessment of the feeding habits of seals in the Strait of Georgia and examination of the size and age component component of hake stock impacted would be helpful in assessing the impact of seals on hake.

Hydroacoustic surveys

The development of an age structured assessment hinges on development of an appropriate index of abundance. Hydroacoustic and trawl swept-volume survey techniques were applied to hake in 1981 and produced similar results with biomass estimated to range between 85,000 and 150,000t (McFarlane and Beamish, 1985). Since then hydroacoustic surveys of the spawning population have been conducted in the springs of 1998, 1993, and annually from 1996 through 1998. During that period a number of changes to the hydroacoustic method, including the development of length-based methods of applying target strength and implementation of new hardware, made interpretation of the time series difficult. The time series was standardized in 1999 by Kieser et al. (1999) and is presented in Table 1.2.

While the application of these hydroacoustic techniques was deemed sound there were are a number of aspects related to survey timing that indicate surveys conducted during April are overestimates of biomass and that recent surveys conducted during February/March are underestimates. The three surveys conducted during the spring of 1981 indicated that biomass available to the survey increased from January to April when peak spawning occurred (Table 1.2). Unfortunately during the April survey, signal from the spring plankton bloom was confounded with the hake producing an overestimate of hake. This occurred again in 1993 when a survey was conducted in mid-March. In order to avoid the plankton surveys conducted since 1993 were carried out in February. Unfortunately, based on the state of maturity and sex ratio, the surveys conducted from 1996-98 appear to have been well in advance of the peak in spawning (Kieser et al. 1999) when biomass would be expected to be higher.

At the present time we do not have an adequate absolute or relative index, of stock size and the recent biomass estimates should be considered a conservative minimum. Given the conservative bias resulting from factors discussed above and reported in detail in Keiser et al. (1999) we believe the biomass of hake in the 1990's to be stable at approximately 50-60,000t. In the future, as recommended by Kieser et al. (1999) a number of steps should be taken to improve the survey. Since the new split beam/multifrequency EK500 sounder used since 1996 has the potential to separate the plankton signal from the hake the feasibility of April or summer surveys when biomass availability is high should be examined. In addition multiple surveys should be conducted within one year to capture peak biomass and surveys should examine inlets adjacent to the Strait of Georgia to confirm that the majority of adult hake are in the survey area.

In the previous assessment (Saunders and McFarlane 1999) low-high risk annual rates of fishing mortality generated for the offshore (west coast of Vancouver Island) stock (Dorn 1996) were applied to the 1997 estimate of exploitable biomass resulting in a range in yield from 7,554- 14,687 t. Re-calculating using the 1998 survey estimate of 33,681t would produce a recommended range of 6,063t-11,788t. There was however, evidence based on a sex ratio that favoured females and a high proportion of pre-spawning fish (Kieser et. al 1999) that this survey, like the 1996 and 1997 surveys, is biased conservatively due to survey timing. The yield range presented in the previous assessment is close to the median of the three most recent surveys that are all believed to be underestimates. We recommend leaving the yield range unchanged from the previous assessment.

1.3. Yield Options

The apparent stability in biomass in spite of decreased growth implies increased recruitment in recent years. Had growth remained comparable to levels experienced in the 1980's, the numbers present in the 1990's would likely equate to close to 100Kt. The range in yield options are unchanged from the previous assessment 7,554-14,687t. We recommend that until a full assessment is completed and factors such as decreasing size-at-age and marine mammal predation are explicitly considered, that managers choose from the lower half of the yield range.

1.4. Literature Cited

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Table 1.1. History of Strait of Georgia Pacific hake scientific advice to managers, management quota and landings (t), excluding dumped and discarded fish from 1978-1999. Sources: 1978-95 DFO Science Branch catch and effort database (Pacific Biological Station, Nanaimo, B.C.); 1996-1999 Archipelago Marine Research annual Dock Monitoring Program summary.

Year	TAC (t)	Basis for advice	Quota (t)	Landings (t)
1976	-	-	-	5
1977	-	-	-	0
1978	-	-	-	2
1979	-	-	-	516
1980	10,000	Gulland (1970) MSY using swept-volume and acoustic survey estimates of B_0.	-	508
1981	10,000	"	10,000	2236
1982	10,000	"	10,000	2786
1983	10,000	"	10,000	3122
1984	10,000	"	10,000	4391
1985	10-15,000	As above but range considered the plausible range in B and M.	10,000	4886
1986	10-15,000	"	10,000	4798
1987	10-15,000	"	10,000	8161
1988	8-24,000	VPA conducted with constant yield (8-16,000t) and variable yield (16-24,000t projections.	11,000	5254
1989	8-14,000	VPA conducted with constant yield (8-16,000t projections.	11,000	6299
1990	8-14,000	"	11,000	6810
1991	8-14,000	"	11,000	7324
1992	8-14,000	"	11,000	8485
1993	8-14,000	"	11,000	4368
1994	8-14,000	"	11,000	9695
1995	8-14,000	"	11,000	11859
1996	8-14,000	"	11,000	6583
1997	10,300-20,100	Low risk F_{opt} from offshore stock applied to the 1996 biomass estimate.	15,200	6561
1998	7,500-14,700	Low risk F_{opt} from offshore stock applied to the 1997 biomass estimate.	14,687	3996
1999	7,500-14,700	"	10,000	

Table 1.2 Summary of biomass estimates of Strait of Georgia Pacific hake from hydroacoustic surveys conducted from 1981 to 1998 (Kieser et al. 1999).

Date		1981 Jan 12-23	1981 Feb 09-20	1981 April 13-24	1981 April 13-24	1988 March 18-28	1993 March 08-25	1996 Feb 20-05	1997 Feb 17-28	1998 Feb 16-26
Vessel		GBR	GBR	GBR	GBR	WER	WER	WER	WER	WER
Sounder		BioSonics	BioSonics	BioSonics	BioSonics	BioSonics	BioSonics	EK500	EK500	EK500
Comment				Measured	Adjusted		Fishing March 18-25			
	Area	Biomass, t								
Shallow	South	2060	3401	36010	4573	10759	5176	2294	1102	7
	North	4532	4258	10268	1769	0	9655	1660	1687	0
	NA	2054	2129	2311	0	0	0	0	0	0
	Malaspina	7004	3491	10715	0	0	438	609	346	0
	Sabine	198	1325	1737	0	0	195	0	63	0
	Total	**15848**	**14604**	**61041**	**6343**	**10759**	**15465**	**4564**	**3198**	**7**
Deep	South	20904	38239	49104	49104	55415	55773	34556	26731	25120
	North	10715	15572	5110	5110	0	23765	19073	13071	4242
	NA	946	755	709	709	0	0	0	0	0
	Malaspina	4095	8733	7075	7075	0	6416	2072	3169	2660
	Sabine	879	2622	3201	3201	0	3590	0	355	1653
	Total	**37539**	**65921**	**65199**	**65199**	**55415**	**89543**	**55702**	**43326**	**33674**
Shallow and Deep	South	22964	41640	85114	53677	66174	60949	36851	27833	25127
	North	15247	19830	15378	6880	0	33420	20734	14758	4242
	NA	3000	2884	3019	709	0	0	0	0	0
	Malaspina	11099	12224	17791	7075	0	6855	2682	3515	2660
	Sabine	1076	3947	4938	3201	0	3786	0	418	1653
	Total	**53387**	**80525**	**126240**	**71542**	**66174**	**105008**	**60266**	**46524**	**33681**

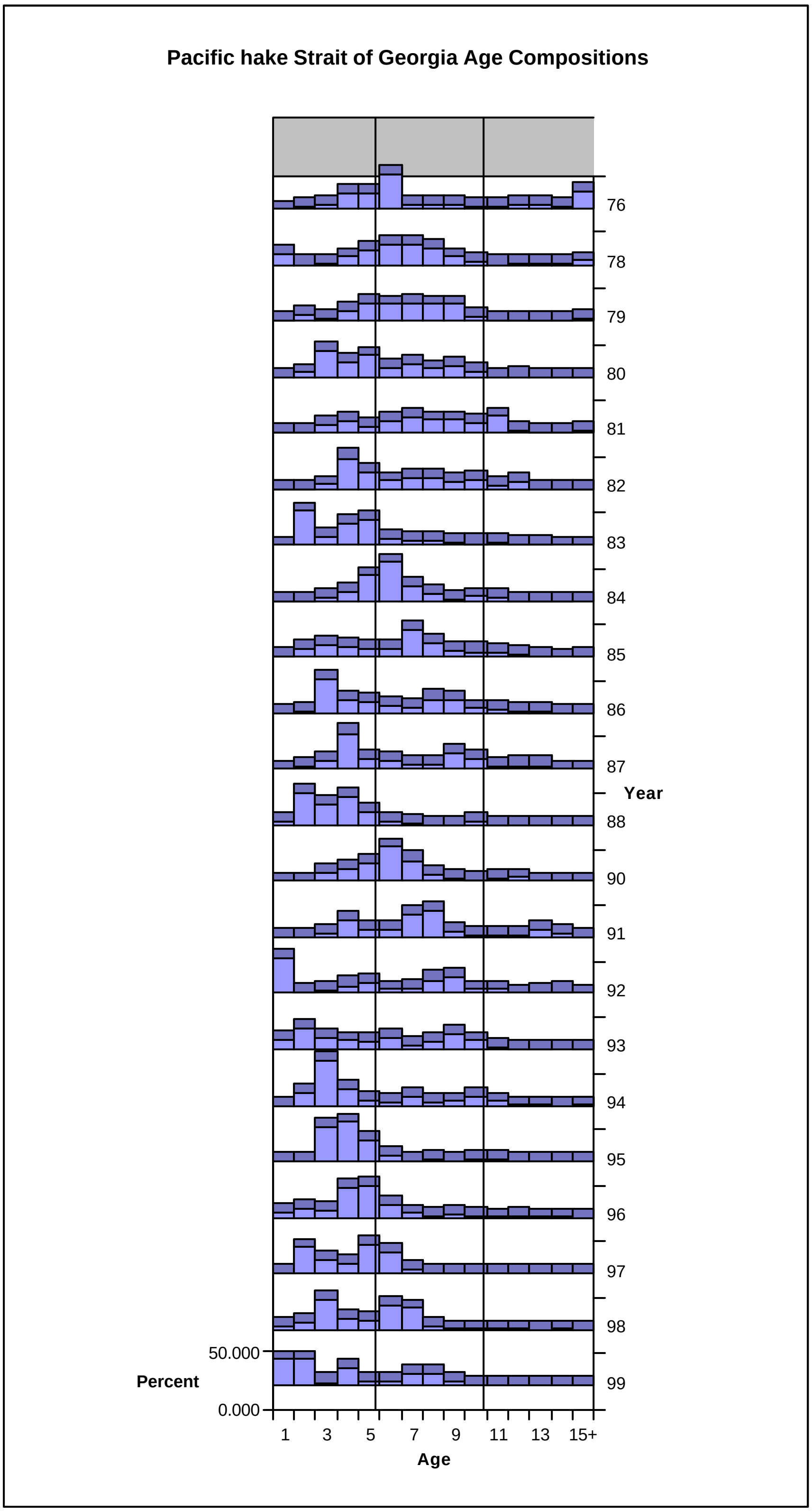

Figure 1.1. Age compositions from Strait of Georgia Pacific hake from 1976-98.

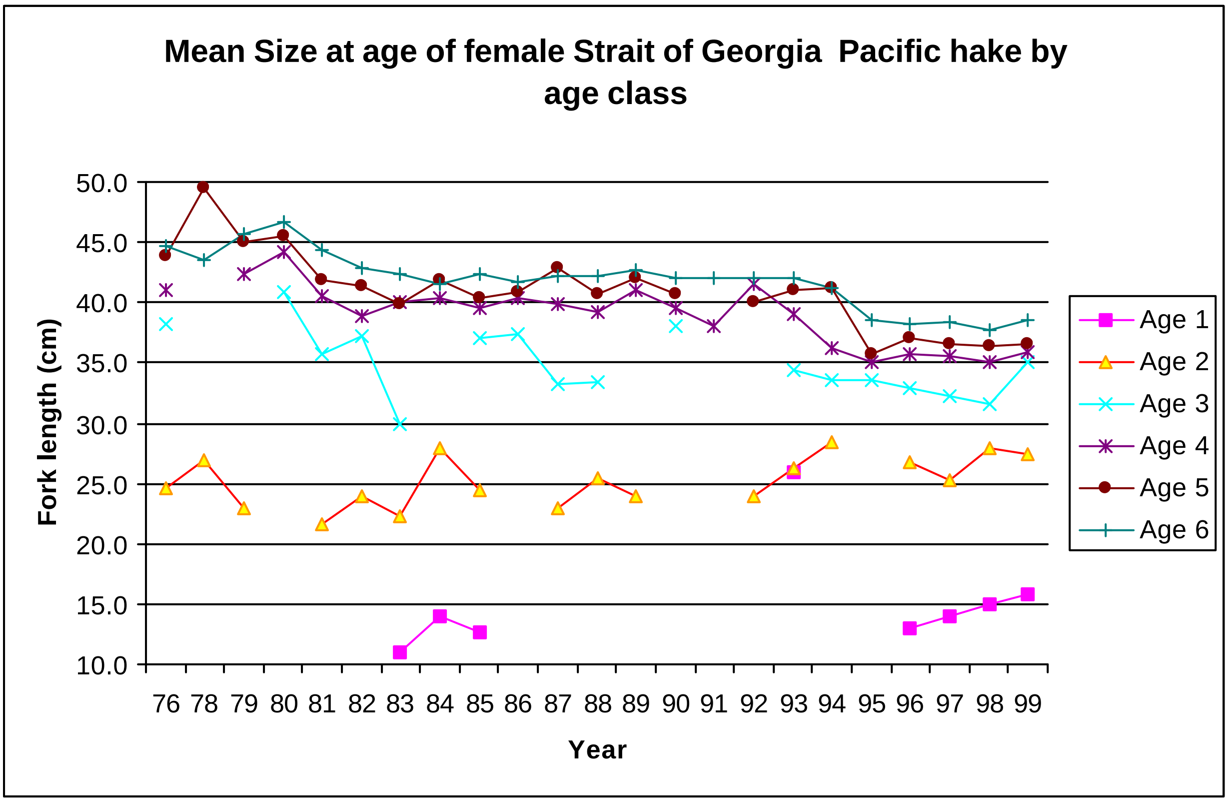

Figure 1.2. Mean size at age of Strait of Georgia Pacific hake from 1976-99.

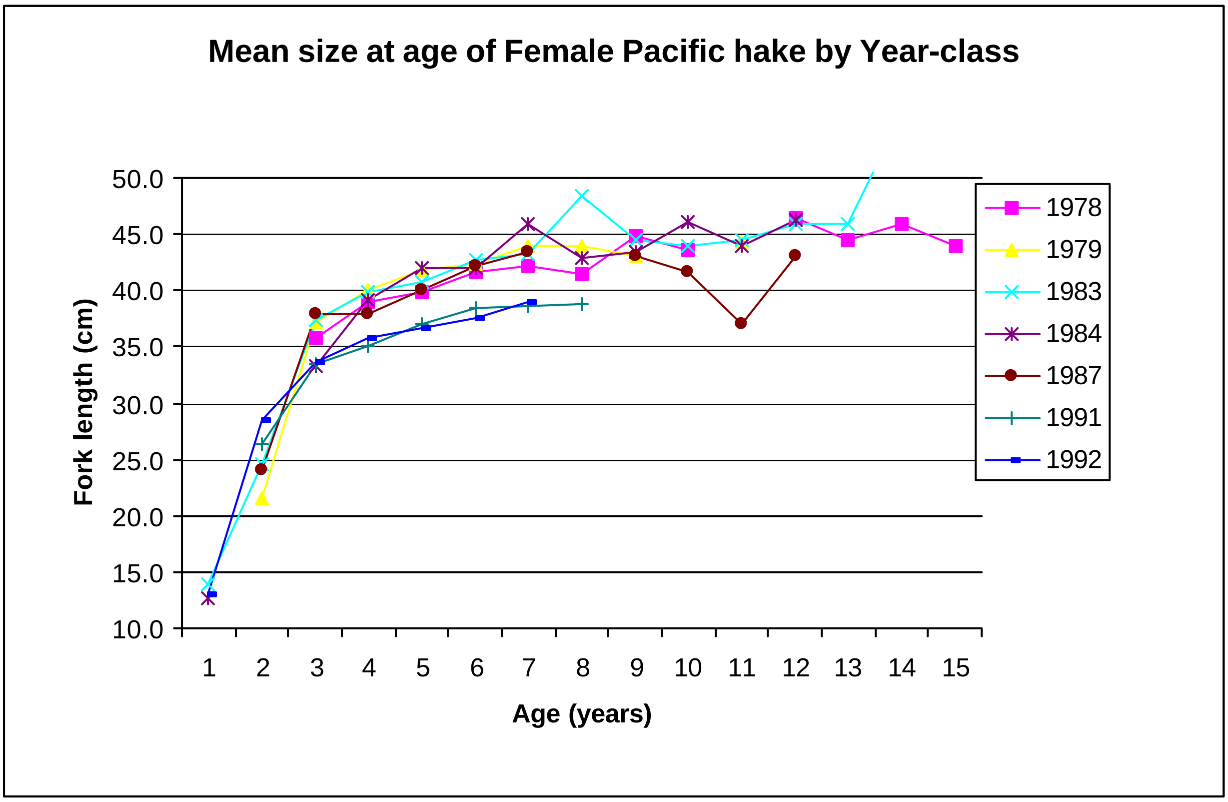

Figure 1.3. Mean size at age of prominent cohorts of Strait of Georgia Pacific hake from 1978-92.