

Special Publication No. 06-25

**Overview of the Togiak Herring Sac Roe and
Spawn-on-kelp Fisheries of Bristol Bay, Alaska; a
Report to the Alaska Board of Fisheries**

by

Charlotte Westing,

Chuck Brazil,

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and

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Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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This document should be cited as:

Westing, C., C. Brazil, F. West, and T. Sands. 2006. Overview of the Togiak herring sac roe and spawn-on-kelp fisheries of Bristol Bay, Alaska; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 06-25, Anchorage.

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ABSTRACT

The Togiak Pacific herring *Clupea pallasii* fishery is the largest sac roe fishery in Alaska with typical harvests in excess of 20,000 short tons. Although the harvest of the Togiak herring sac roe fishery has been relatively stable, the exvessel value of the fishery plummeted in 1997 and has continued to decline in most years. The low price paid per ton has led to a more relaxed fishery with a higher focus on quality. This focus on quality has led to increases in roe percentages and a much more protracted fishery.

Key words: Pacific herring, *Clupea pallasii*, Togiak, commercial fishing, sac roe, spawn-on-kelp, Alaska Board of Fisheries, ADF&G, Bristol Bay, Alaska.

INTRODUCTION

The Bristol Bay area includes all waters south of a line extending west from Cape Newenham, east of the International Date Line in the Bering Sea and north of a line extending west from Cape Menshikof (Figure 1). The Bristol Bay area is divided into three herring fishing districts: General District; including all waters west of the longitude of Cape Newenham, Bay District; including all waters east of the longitude of Cape Newenham (except the waters in the Togiak District), and the Togiak District; including all waters between the longitude of Cape Newenham and the longitude of Cape Constantine. The Togiak District spans approximately 192 km. Togiak village lies at the center of the district, 108 km west of Dillingham.

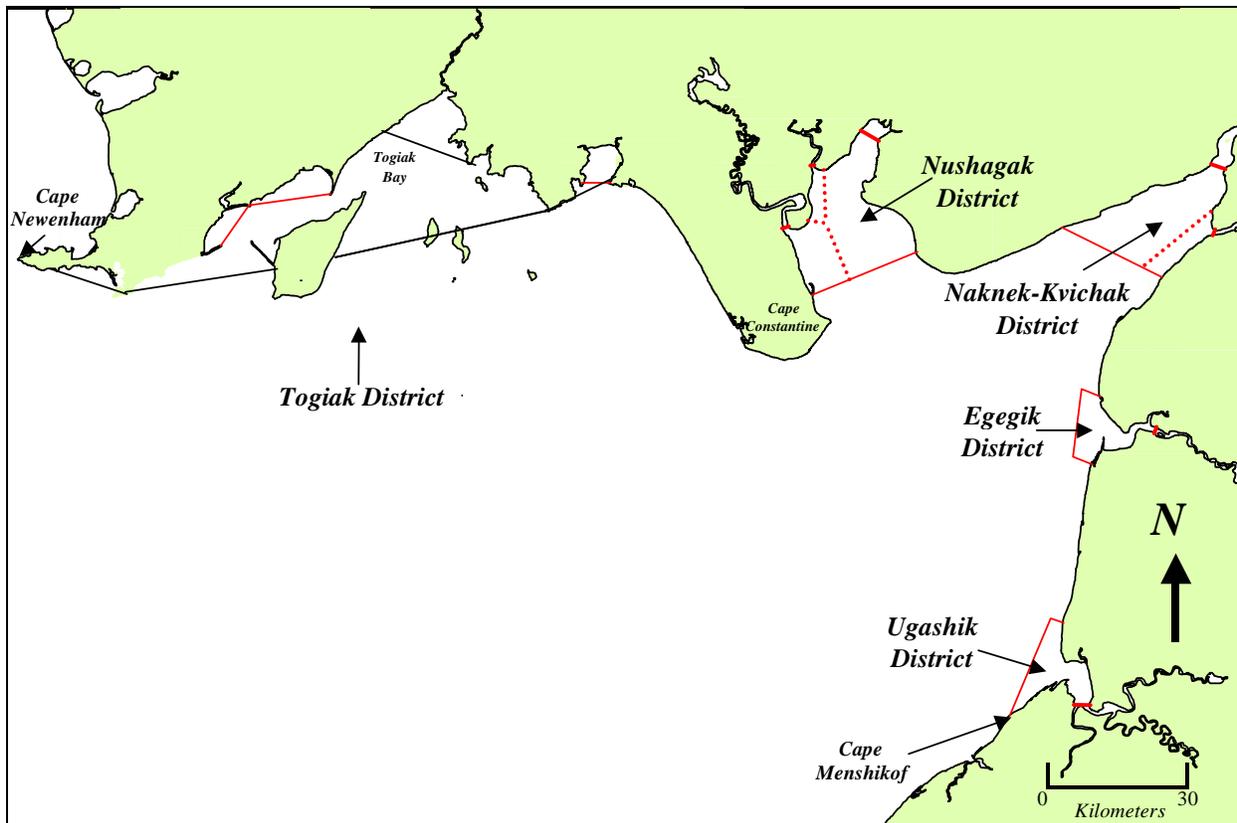


Figure 1.—Bristol Bay area showing Togiak District.

Pacific herring *Clupea pallasii* have been documented throughout Bristol Bay, but the major concentration returns to the Togiak area each spring and is the focus of herring sac roe and spawn-on-kelp fisheries. In the Togiak District, herring are commercially harvested for sac roe

using gillnets and purse seines. Herring generally spawn on rockweed kelp *Fucus spp.*, which are harvested by hand and/or rake.

The herring sac roe fishery began in Togiak District in 1967, followed by the first fishery for spawn on kelp in 1968. Effort and harvest levels remained low for the first 10 years of the fishery. Increased interest, favorable market conditions and additional incentives provided by the Fishery Conservation and Management Act of 1976 (the 200-mile limit) resulted in a rapid expansion of the Togiak herring fishery in 1977.

The Togiak herring fishery is the largest herring fishery in Alaska. Sac roe harvests since 1986 average 20,000 tons, worth \$6.8 million annually (Appendix A1 and A3). However, in the last 10 years, an average of 21,000 tons of herring have been harvested, worth 3.4 million annually. Spawn-on-kelp harvests since 1986 average over 342,000 lbs (including only the years when a fishery occurred), worth about \$295,000 to fishers. In 2006, exvessel value for sac roe harvests was higher than the previous year but was the third lowest since 1986.

This report summarizes the Togiak herring stock assessment program, reviews the Togiak District herring fisheries from 1986 through 2006 and presents projections for the 2007 herring season.

STOCK ASSESSMENT

METHODS

Since 1984, the Alaska Department of Fish and Game (ADF&G) has conducted aerial surveys throughout the spawning season of herring to estimate abundance, timing, and distribution of Pacific herring in the Togiak District. Surveys are conducted regularly from approximately April 15 until June 1 each year. Once herring are observed, surveys are conducted daily (weather permitting) until biomass declines and spawning activity subsides.

Fundamental aerial survey techniques used in Togiak have remained largely unchanged since 1978 and are described in Lebida and Whitmore (1985). Herring school surface area is estimated through a handheld tube with a measured grid and a known focal length from a known altitude. Standard conversion factors of 1.52 tons (water depths of 16 ft or less), 2.58 tons (water depths between 16 and 26 ft) and 2.83 tons (water depths greater than 26 ft) per 538 ft² of surface area is applied to herring school surface areas to estimate the total biomass observed during each flight. Over the last 3 years, ADF&G has been converting aerial survey data collection to use Geographic Information Systems (GIS) performing “real-time” data entry and analysis.

Volunteer test fisheries, originally implemented by ADF&G to estimate roe quality, provide samples for age, size, and sex composition analysis. Samples are also collected from commercial harvest for age composition and size analysis. After the season, results are used to revise biomass estimates.

SPAWNING POPULATION

Historical

Since 1978, herring were generally first observed in the district in early May, but were observed entering nearshore areas as early as April 19 and as late as May 20. Historically, biomass increased rapidly and peaked within 1 to 7 days of the first observation but recently run timing has been more protracted. In recent years, biomass declined rapidly following the peak

observation, but herring continued to enter and exit the district for several weeks. Spawn is usually first observed any time within 3 days of the first herring observation. Small “spot” spawns have been observed as late as June 7.

Annual estimates of the Togiak herring biomass range from 69,000 tons observed in 1980 to 239,000 tons documented in 1979. Abundance appeared to be high in the late 1970s, declined in the mid 1980s and remained relatively low and stable through 1991. Observed biomass levels increased to a peak of approximately 194,000 tons in 1993 (Appendix A2).

2006 Herring Season

During the winter of 2005–2006, climatic conditions were colder than average; there was a moderate amount of snowfall in southwestern Alaska in March and April and the ground still had significant amounts of snow present at the time of the first herring survey on April 19. The Bering Sea ice pack had receded north of Cape Newenham by April 24; some ice still persisted in the Togiak Herring District, especially west of Tongue Point. Ice was still present when fishing began May 12. Water temperatures in the Bering Sea and in Togiak Bay were colder than recent years. On grounds temperatures did not get above 0° C until May 4, but then warmed quickly to 2.5° C by May 7.

ADF&G predicts run timing and first spawn of the Togiak herring population using a temperature model based on sea surface temperatures from Unimak Pass. These temperatures predicted the first spawn would be May 3, with the first harvest occurring May 5. An additional model using April mean air temperatures from Cape Newenham predicted that first harvest would be approximately May 6.

Aerial surveys of the Togiak District began April 19, 2006. Herring were first reported in the district on the afternoon of May 1, when a processor reported fish observed by sonar. On May 3, a pilot transiting the district observed herring a mile off shore from Rocky Point. ADF&G personnel observed herring on May 10, when 8,000 tons were observed primarily between Hagemester and High Islands. ADF&G staff documented approximately 84,000 tons of herring during a survey on May 11, and the peak estimate of approximately 124,000 tons on May 13. Survey conditions were generally fair until May 18 when poor weather made surveys futile. A postseason survey occurred on May 26 and documented roughly 51,000 tons of herring still on the grounds.

The 2006 herring run was forecasted to be 129,976 tons. Samples to estimate the age structure of the 2006 biomass were taken from purse seine landings. During the commercial purse seine fishery ages 8, 9, and 10+ year old fish were the predominant age classes comprising 70% of the catch. At this time, the Togiak herring biomass is considered stable.

SAC ROE HERRING FISHERY

FISHING AND INDUSTRY PARTICIPATION

Unlike most herring fisheries in Alaska, the Togiak sac roe fishery is not a limited entry fishery. Gillnets, purse seines, and hand purse seines are legal gear. Since fishing effort is not limited, effort levels can vary substantially each year. Herring market conditions are one of the leading factors influencing effort in a given year, but other factors also influence fleet size. Since the majority of herring permit holders in Togiak participate in other fisheries (e.g. Bristol Bay

salmon), salmon market and markets for other fish indirectly affect effort in the herring fishery. Herring prices paid to permit holders the prior year and run timing also affect effort. In the last several years processors have developed cooperative fleets for the seine fishery. Processors in conjunction with the cooperative members exclude entrants into the fishery. The gillnet fleet has also been reduced and is restricted by market forces.

Fishing effort in the sac roe fishery increased through the late 1980s, decreased in the early 1990s, then increased again to a peak in 1996 and has declined since 1997 (Appendix A3). Gillnet effort increased to 320 vessels in 1989, declined to a low of 75 vessels in 1993, and then peaked in 1996 with 461 vessels and has since declined to a low of 49 vessels in 2006. Purse seine effort increased steadily from 1978 through 1989, when 310 vessels were observed. From 1990 to 1997, the purse seine fleet has fluctuated between 200 and 300 vessels, and has declined to less than 100 vessels since 1998. In 2006, the total number of purse seines was 28, an all-time low.

Reduction in fleet size has led to the development of cooperative seine fisheries that focus on fish with high quality roe rather than on quantity. Reduced fleet size has led to changes in the way the fishery is managed; because fishing is less aggressive, managers can allow 12-hour periods, leading to increased selectivity and smaller sets. Additionally, managers have begun to collect information on the number of released sets.

Industry participation in the fishery peaked between 1979 and 1982, when 33 processors participated in the herring fishery. From 1986 through 1997, 16 to 22 companies purchased herring or spawn on kelp in Togiak (Appendix A3). Over the past 12 years, industry participation has steadily declined to a low in 2004 of 6 companies. In the last 2 years, participation has increased by one or two companies. Processing capacity on the grounds declined to a low in 2003 of 1,920 tons per day. In 2006, the processing capacity on grounds was 2,060 tons, the second lowest on record.

GEAR SPECIFICATIONS

The Alaska Board of Fisheries (BOF) has reduced gear to limit harvesting capacity and control problems with waste. Prior to 1989, gillnet length was restricted to 150 fathoms. Permit holders were restricted to the use of one legal limit of gear, but up to 300 fathoms could be operated from a fishing vessel. Under these gear allowances, lost and abandoned nets accounted for substantial amounts of waste during some years. In 1989, the BOF reduced the legal compliment of gillnet gear to a maximum of 100 fathoms in length per permit holder, restricted the operation from one vessel to 100 fathoms, and granted ADF&G the authority to reduce length to 50 fathoms inseason. The BOF transposed this regulation in 1992 when they restricted herring gillnet length to 50 fathoms but granted ADF&G the ability to allow up to 100 fathoms of gear by emergency order. This change enabled ADF&G to maintain an orderly fishery, helping ensure roe quality and minimizing potential waste. Gillnet depth remains unrestricted.

In October of 1989, the BOF reduced purse seines to 100 fathoms in length and 16 fathoms in depth. In 1995, the BOF further restricted purse seine depth to 625 meshes, of which 600 could be no larger than 1.5 inches. Depth was reduced in 1995 to control harvesting capacity. Adjustments in allowable gear have appeared to control waste and preserve order in the fishery without a substantial reduction in harvesting capacity.

HARVESTS AND MANAGEMENT PERFORMANCE

Sac Roe Allocation

Herring sac roe purse seine and gillnet harvests are managed for allocation guidelines set forth in the Bristol Bay Herring Management Plan (BBHMP) (5 AAC 27.865) originally adopted by the BOF in late 1980. In 1980, the regulations were set forth to “try to insure that neither gear group is totally disadvantaged.” The regulation required that “when harvest reached 20,000 metric tons, if one gear type has less than 6,000 tons, the other gear type will close for 24 hours.” In 1982 and in 1985, the regulations were modified to include adjustments based on fishing time rather than tonnage so that the ratio of time for gillnets and seines was 3:1 (1982) or 5:1 (1985). In 1988, the issue of allocation was examined by the BOF again and a new plan was set forth. This plan stated that, before opening the sac roe fishery, 1,500 short tons must be set aside for the spawn-on-kelp fishery, and 7% of the remaining available harvest is allocated to the Dutch Harbor food and bait fishery. After the spawn-on-kelp and the Dutch Harbor harvests are subtracted, the remaining harvestable surplus is allocated to the Togiak sac roe fishery: 25% to the gillnet fleet, and 75% to the purse seine fleet. In 2001, allocation issues were addressed again by the BOF and harvest percentages were modified to 70% purse seine and 30% gillnet. The BOF also directed that this allocation be maintained inseason and directed ADF&G to close fishing for both gear types if one gear type was unable to catch its allocated share of the resource. This happened in 2002 when the purse seine fleet could no longer find quality fish to harvest yet had 2,500 tons of the quota remaining. Because the purse seine fleet was unable to continue fishing and the allocation was at the 70/30 break, the gillnet fleet was also closed even though they were still harvesting quality fish and had quota remaining. In 2003, the BOF modified the allocation plan, allowing for each gear type to be unrestrained by the performance of the other once each gear group harvested over 80% of their guideline harvest level. Additionally, if less than 50% of the spawn-on-kelp quota was harvested, up to 50% of the remaining amount could be reallocated to the sac-roe fleet following the 70/30 allocation rule.

To achieve the gillnet and purse seine allocations, ADF&G calculated guideline harvest levels (tons) each year by apportioning 30% and 70% of the sac roe allocation to each gear, respectively. ADF&G then regulated fishing time and area to achieve each guideline harvest level, while maintaining a 30/70 ratio. In 2006, the available harvest of herring was allocated as follows:

Spawn on Kelp:	1,500 tons
Dutch Harbor Food and Bait:	1,715 tons
Togiak Sac Roe:	22,780 tons
Purse Seine (70%):	15,946 tons
Gillnet (30%):	6,834 tons

The resulting Togiak district herring sac roe performance for purse seine and gillnet harvest fisheries for the years 2004 through 2006 are displayed in Table 1.

Table 1.—Summary of performance for Togiak District sac roe fisheries, 2004-2006.

	2004			2005 ^a			2006 ^a		
	Harvest	Effort	Processors	Harvest	Effort	Processors	Harvest	Effort	Processors
Purse seine	13,888	31	6	13,869	33	8	16,821	28	7
Gillnet	4,980	54	6	5,841	56	8	7,132	49	7
Exvessel		\$2,541			\$2,978			\$2,618	

^a A portion (50%) of spawn on kelp quota included due to absence of a market.

Exploitation

The commercial sac roe and spawn-on-kelp harvests in the Togiak District have been regulated by emergency order since 1981. From 1981 through 1987, informal policies directed ADF&G to ensure that minimum threshold biomass levels were observed before opening the herring fishery, and to manage the fishery so that exploitation did not exceed 20% of projected biomass. In 1988, the BOF incorporated the threshold and exploitation rate policies into the Bering Sea Herring Fishery Management Plan (5 AAC 27.060) for Togiak and other Bering Sea fisheries. Herring biomass in Togiak has been estimated at levels well above threshold requirements since 1981.

Exploitation rates in season have exceeded 20% in only 8 of 20 years (Appendix A4). Estimates for herring equivalent of spawn-on-kelp harvests and harvest in the Dutch Harbor fishery were not included in the exploitation figure until 1984 and 1988 respectively. Although exploitation in the past 8 years has fallen below 20%, this is more a result of changes in fleet size and strategy and the absence of spawn-on-kelp harvest (in 3 of the 5 years), than of increased management precision.

Product Quality and Value

The BOF and the industry have directed ADF&G to give product quality and fishery value an equal priority with exploitation objectives. Management Guidelines for Commercial Herring Sac Roe Fisheries (5 AAC 27.059) state that ADF&G may manage sac roe fisheries to enhance product value by opening areas in which sampling has demonstrated high herring roe content and large herring size, and to minimize harvest of recruit size herring. The BBHMP also states that the primary objective in the sac roe fishery is to prosecute an orderly, manageable fishery while striving for the highest level of product quality and a minimum of waste. Given these regulations and comments from industry, ADF&G considers maximizing quality and value to be primary objectives in the Togiak fishery.

ADF&G has used volunteer test fishing as a means to maximize harvest roe quality since 1982. Test fishing procedures were developed and became more intensive from 1982 through 1989. By 1990, ADF&G had established standard test fishing areas and sample sizes, coordinated test fishing start times between areas, coordinated and assisted in transporting samples to roe technicians, and established criteria required to open an area. Since then, ADF&G has opened to commercial fishing only areas that have documented high quality roe.

Development of test fishing procedure sped the availability of results, reduced time required between test fishing and opening an area to commercial fishing, and helped ensure high mature roe percents in harvests. Although the average mature roe percentages have fluctuated significantly over the last 20 years, the 10 and 20 year averages are 9.5%. The average mature roe for 2006 was 9.2% (Appendix A6).

As an indirect result of recent test fishing procedures, gillnet harvest area was gradually reduced in the late 1980s and early 1990s due to lack of successful test fishing or poor quality results in some areas of the district. From 1994 through 1997, gillnet fishing was opened almost exclusively in the area between Right Hand Point and Kulukak Bay. This reduction in area heightened competition among the gillnet fleet, especially during 1996 and 1997, when fishing effort was high. Since 1997, attempts have been made by management staff to spread gillnet

harvest out to include areas west of Right Hand Point. The only condition under which increased area is used by the gillnet fleet is extreme weather.

Although average mature roe for gillnets has increased from 10.3% (1986–1995) to 11.2% (1996–2005), purse seine average mature roe has remained steady at 9.5% for both the 10 and 20-year averages (Appendix A3). Gillnet-caught herring quality rose sharply in 1993 and has remained high since 1993. Although some of this difference may be attributed to management efforts, most is due to an apparent shift to larger gillnet mesh sizes. Prior to 1993, gillnets with mesh sizes smaller than 3 inches (stretched) were common. Gillnets with 3-inch mesh and larger have since become standard gear. This shift to large-mesh gillnets appears to have increased the percentage of female herring caught by herring gillnets from 49.5% (1986–1995) to 56.2% (1996–2005).

In 1992, over 20,000 tons of herring were harvested by purse seines in one 20-minute period. The magnitude of harvest from this single opening, combined with a limited processing capacity, resulted in holding times up to 7 days, and large-scale deterioration of flesh and roe quality. Increasing market demands for high quality product combined with the poor quality 1992 harvest compelled ADF&G to recognize quality problems associated with holding times. Limiting individual harvests within processing capabilities became a management objective after 1992.

From 1992 until 2000, ADF&G limited harvests by carefully controlling the open area and duration of each purse seine period. Since 2000, the fishery has become more self-regulating in that processors have smaller fleets and are much more restrictive about how long they will hold herring before processing. The reduced processing capacity makes it impossible for the whole quota to be processed in less than 10 days. Companies no longer have to buy everything they can on the first opening. Knowing the fishery will last 8 to 12 days, they can buy only what they can process each day throughout the fishery. As the quota nears completion, ADF&G must make restrictions in time and area. In the 2006 herring fishery, there were three, 14-hour periods to begin the season, followed by a 4-hour period and a break for allocation. When seine fishing resumed, there were four periods longer than 12 hours and finally, one 10-hour period. The 10-hour period was allowed because of poor weather conditions on the fishing grounds. The 113 hours of fishing time for the seine fleet in 2006 sharply contrasts with the 20-minute period in 1992 in terms of continuity of the fishery and product quality.

SPAWN-ON-KELP FISHERY

Like the sac roe fishery, the spawn-on-kelp harvest in the Togiak District has been regulated by emergency order since 1981. Since 1984, the spawn-on-kelp fishery was managed under the direction of the Togiak District Herring Spawn on Kelp Management Plan (5 AAC 27.834). The plan essentially provides for an allocation of 350,000 lbs of product, equivalent to 1,500 tons of herring, to this fishery. The plan also directs ADF&G to 1) rotate harvest areas on a 2 to 3 year basis (Figure 2); 2) ensure product quality; and 3) include the herring equivalent to the spawn-on-kelp harvest when calculating exploitation.

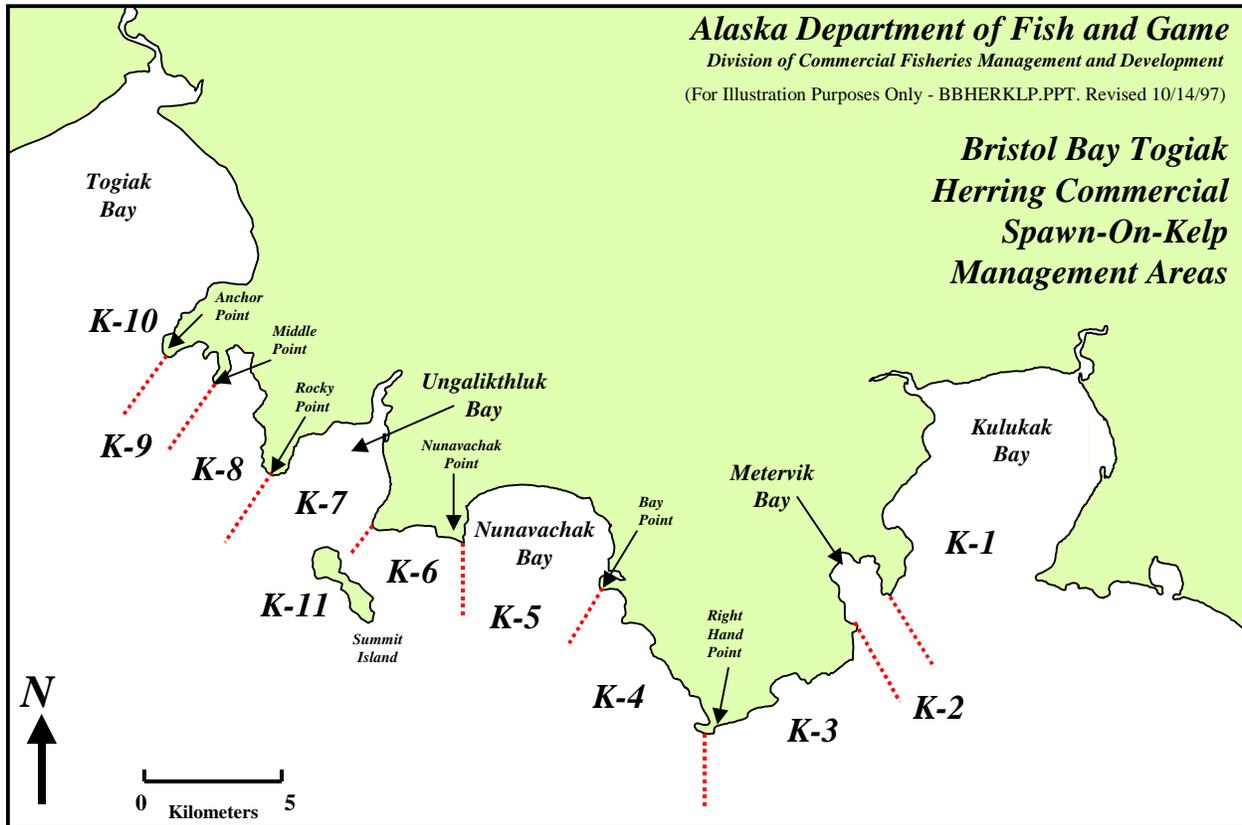


Figure 2.—Spawn-on-kelp management areas (K-1 through K11), Togiak District, Bristol Bay.

Fishing effort in the spawn-on-kelp fishery has increased steadily since its inception, and peaked at 532 participants in 1991 (Appendix A6). The fishery became limited to interim use and permanent permit holders in 1990. Following the 1991 season, the BOF limited the role of non-permit holders in the spawn-on-kelp fishery to that of assisting with transporting kelp only after the close of the period. By 1993, most permits became permanent and in 1997, 295 people held permanent permits.

Exploitation of spawn on kelp was heavy until 1996 and the fishery opened consistently until then. However since 1996, commercial interest in spawn on kelp has plummeted. In the last 10 years, there has only been a spawn-on-kelp fishery three times. Since 1986, actual harvests exceeded the 350,000 lb guideline by more than 10% in 5 years and fell short in 5 (Appendix A5). For the 3 other years in which a fishery occurred, actual harvests were within 10% of the guideline. The 2 to 3-year rotation schedule was adhered to in all years except 1987. In 1987, area K-9 was opened after harvest in area K-10 fell short of the harvest guideline; only the western half of area K-9 had been opened in 1986. In 2006, no company registered to purchase spawn on kelp in the Togiak Herring District.

REFERENCE CITED

Lebida, R. C. and D. C. Whitmore. 1985. Bering Sea Herring Aerial Survey Manual. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Bristol Bay Data Report 85-2, Anchorage.

APPENDIX A.

Appendix A1.—Exvessel value of the commercial herring and spawn-on-kelp harvest, in thousands of dollars, Togiak District, 1986–2006.

Year	Herring			Total
	Sac Roe	Food/Bait	Spawn-on-Kelp	
1986	8,648	12	187	8,847
1987	8,614	49	166	8,829
1988	14,103	3	346	14,452
1989	4,983	19	448	5,450
1990	6,494	9	360	6,863
1991	6,173	21	383	6,577
1992	8,818	26	254	9,098
1993	5,218	3	268	5,489
1994	9,090	0	212	9,302
1995	16,713	0	362	17,075
1996	14,395	5	510	14,910
1997	4,306	0	^a	4,306
1998	3,986	0	^a	3,986
1999	6,211	0	315	6,526
2000	4,000	0	^a	4,000
2001	3,090	0	^a	3,090
2002	1,880	0	20	1,900
2003	2,797	0	^b	2,797
2004	2,541	0	^a	2,541
2005	2,978	0	^a	2,978
1986-2005 Average	6,752	7	295	6,951
1996-2005 Average	4,618	1	282	4,703
2006	2,618	0	^a	2,618

Note: Exvessel value (value paid to the fishermen) is derived by multiplying price/ton by the commercial harvest. These estimates do not include any postseason adjustments to fishermen from processors and should therefore be treated as minimum estimates.

^a Fishery not conducted.

^b Data confidential under Alaska Statute 16.05.815.

Appendix A2.—Aerial survey estimates of herring biomass and spawn deposition, Togiak District, 1986–2006.

Year	Preseason Forecast ^a	Biomass Estimate	Spawn Estimates	
			Observations	Miles
1986	86,310	94,770	182	67
1987	61,100	88,398	160	76
1988	54,500	134,718	107	61
1989	80,100	98,965	69	53
1990	56,000	88,105	94	66
1991	55,000	83,229	90	70
1992	60,214	156,957	160	97
1993	148,786	193,847	76	53
1994	142,497	185,412	80	72
1995	149,093	149,093 ^b	70	59
1996	135,585	135,585 ^b	99	73
1997	125,000	144,887	79	59
1998	121,000	121,000 ^b	42	33
1999	90,000	157,028	33	56
2000	130,904	130,904 ^b	71	46
2001	119,818	115,155 ^b	100	57
2002	120,196	120,196 ^b	79	32
2003	126,213	126,213 ^b	182	95
2004	143,124	143,124 ^b	47	36
2005	96,029	156,727	106	28
1986-2005 Average	105,073	131,216	96	59
1996-2005 Average	120,787	135,082	84	51
2006	129,976	124,713	66	18

^a 1993–2006 forecasts based on Age Structured Analysis. Previous years based on age composition, abundance, average growth and mortality rates.

^b Peak biomass estimate could not be determined, therefore, preseason forecast was used.

Appendix A3.—Sac roe herring industry participation, fishing effort and harvest, Togiak District, 1986–2006.

Year	Number of Buyers	Daily Processing Capacity ^a	Fishery Dates	Gillnet					Purse Seine					Total Harvest ^c
				Effort ^b	Duration (hours)	Harvest ^c	CPUE	Roe %	Effort ^b	Duration (hours)	Harvest ^c	CPUE	Roe %	
1986	23		5/14-5/15	209	10.0	3,448	1.6	8.8	209	1.0	12,828	61.4	9.9	16,276
1987	18		4/27-5/6	148	36.0	2,685	0.5	8.6	111	5.5	12,845	21.0	8.9	15,530
1988	22		5/17	300	4.0	3,695	3.1	8.3	239	0.5	10,472	87.6	10.9	14,167
1989	19		5/9-5/14	320	5.0	2,844	1.8	7.8	310	3.0	9,415	10.1	8.5	12,259
1990	16	3,100	5/8-5/20	277	66.0	3,072	0.2	9.0	221	3.0	9,158	13.8	9.7	12,230
1991	16	3,350	5/10-5/17	170	14.0	3,182	1.3	8.5	200	3.0	11,788	19.6	10.0	14,970
1992	18	3,700	5/20-5/27	274	25.5	5,030	0.7	8.8	301	0.3	20,778	230.1	9.2	25,808
1993	12	2,500	4/27-5/9	75	144.5	3,564	0.3	10.1	140	33.8	14,392	3.0	9.6	17,956
1994	16	3,300	5/11-5/20	146	76.0	7,462	0.7	12.0	240	4.6	22,853	20.7	9.4	30,315
1995	22	4,350	5/7-5/15	250	33.5	6,995	0.8	12.0	254	12.2	19,737	6.4	10.1	26,732
1996	19	4,850	5/3-5/8	461	18.0	6,863	0.8	11.1	268	2.4	18,008	27.8	9.0	24,871
1997	18	4,200	5/2-5/6	336	24.0	5,164	0.6	11.8	231	6.4	18,649	12.6	9.4	23,813
1998	15	2,475	4/29-5/10	152	46.0	5,952	0.9	12.5	123	16.5	16,824	8.3	9.6	22,776
1999	12	2,400	5/18-5/26	171	28.0	4,858	1.0	11.5	96	4.7	15,020	33.3	9.2	19,878
2000	12	2,100	5/6-5/14	227	67.0	5,464	0.4	10.6	90	15.8	14,957	10.6	10.1	20,421
2001	11	2,255	5/6-5/13	96	84.0	6,481	0.8	10.6	64	26.0	15,849	9.5	9.2	22,330
2002	8	1,920	5/3-5/13	82	102.0	5,216	0.6	10.9	37	57.5	11,833	5.6	9.3 ^d	17,049
2003	7	1,920	4/25-5/7	75	142.0	6,505	0.6	10.9	35	110.2	15,158	3.9	8.9 ^d	21,663
2004	6	2,150	4/29-5/9	54	162.0	4,980	0.6	10.4	31	78.0	13,888	5.7	9.5	18,868
2005	8	2,330	4/30-5/8	56	149.0	5,841	0.7	11.2	33	83.0	13,869	5.1	9.6	19,711
1986-2005 Ave.	15	2,931		194	61.8	4,965	0.9	10.3	162	23.4	14,916	29.8	9.5	19,881
1996-2005 Ave.	12	2,660		171	82.2	5,732	0.7	11.2	101	40.0	15,406	12.2	9.5	21,138
2006	7	2,060	5/12-5/21	49	143.9	7,132	1.0	10.8	28	113.0	16,821	5.3	9.2	23,953

Note: Blank cells represent no data.

^a Number of tons per day based on companies registered.

^b Peak aerial survey count.

^c Harvest total does include deadloss and test fish harvest.

^d Values are lower than inseason assessment due to more stringent post-season market scrutiny compared with previous years.

Appendix A4.—Exploitation of Togiak herring stock, 1986–2006.

Year	Biomass	S-O-K Herring Equivalent	Dutch Harbor Food/Bait	Sac Roe			Total Harvest	Exploitation Rate	
	Estimate ^a (short tons)			Gillnet	Purse Seine ^b	Waste ^c			Total
1986	86,310	1,446		3,448	12,828		16,276	17,722	20.5%
1987	64,462	1,309		2,685	12,845		15,530	16,839	26.1%
1988	128,959	1,782	2,004	3,695	10,472		14,167	17,953	13.9%
1989	80,100	2,499	3,081	2,844	9,415		12,259	17,839	22.3%
1990	71,879	1,617	820	3,072	9,158		12,230	14,667	20.4%
1991	55,000	1,310	1,325	3,182	11,788		14,970	17,605	32.0%
1992	129,256	1,482	1,949	5,030	20,778		25,808	29,239	22.6%
1993	164,130	1,481	2,790	3,564	14,392		17,956	22,227	13.5%
1994	148,716	1,134	3,349	7,462	22,853		30,315	34,798	23.4%
1995	149,093	996	1,748	6,995	19,737		26,732	29,476	19.8%
1996	135,585	1,899	2,239	6,863	18,008		24,871	29,009	21.4%
1997	125,000	0	1,950	5,164	18,649	350	23,813	25,763	20.6%
1998	121,000	0	1,994	5,952	16,824	400	22,776	24,770	20.5%
1999	156,183	1,605	2,398	4,858	15,020	221	19,878	23,881	15.3%
2000	130,904	0	2,014	5,464	14,957	100	20,421	22,435	17.1%
2001	119,818	0	1,439	6,481	15,849	219	22,330	23,769	19.8%
2002	120,196	260	2,846	5,216	11,833	40	17,049	20,155	16.8%
2003	126,213	55	1,487	6,505	15,158	380	21,663	23,205	18.4%
2004	143,124	0	1,258	4,980	13,785	103	18,765	20,023	14.0%
2005	156,727	0	1,154	5,841	15,071	784	20,912	22,066	14.1%
1986-2005 Ave.	120,633	944	2,041	4,897	15,284	227	20,181	22,859	20.1%
1996-2005 Ave.	133,475	482	1,937	5,848	15,982	227	21,830	24,249	18.4%
2006	129,976	0	953	7,132	16,321	500	23,953	24906	19.2%

Note: Blank cells represent no data.

^a Preseason forecast unless peak biomass estimate inseason exceeded preseason forecast.

^b Includes test fish harvest.

^c Estimated waste, also included in purse seine harvest.

Appendix A5.—Guideline and actual harvests of sac roe herring (tons) and spawn-on-kelp (lbs), Togiak District, 1986–2006.

Year	Gillnet Sac Roe			Purse Seine Sac Roe			Spawn-on-Kelp		
	Guideline ^a	Actual	% Difference ^b	Guideline ^a	Actual ^c	% Difference ^b	Guideline ^a	Actual	% Difference ^b
1986		3,448			12,828		350,000	374,142	7
1987		2,685			12,845		350,000	307,307	-12
1988	5,647	3,695	-35	16,943	10,472	-38	350,000	489,320	40
1989	3,376	2,844	-16	10,128	9,415	-7	350,000	559,780	60
1990	2,993	3,072	3	8,980	9,158	2	350,000	413,844	18
1991	3,143	3,182	1	9,429	11,788	25	350,000	348,357	0
1992	5,662	5,030	-11	16,985	20,778	22	350,000	363,600	4
1993	6,570	3,564	-46	19,709	14,392	-27	350,000	383,000	9
1994	6,277	7,462	19	18,832	22,853	21	350,000	308,400	-12
1995	6,582	6,995	6	19,747	19,737	0	350,000	281,600	-20
1996	5,956	6,863	15	17,868	18,008	1	350,000	455,800	30
1997	5,464	5,164	-5	16,391	18,649	14	350,000		^d
1998	5,280	5,952	13	15,840	16,824	6	350,000		^d
1999	6,914	4,858	-30	20,741	15,020	-28	350,000	419,563	20
2000	5,738	5,464	-5	17,215	14,957	-13	350,000		^d
2001	6,268	6,481	3	14,624	15,849	8	350,000		^d
2002	6,288	5,216	-17	14,673	11,833	-19	350,000	67,793	-81
2003	6,624	6,505	-2	15,457	15,158	-2	350,000		^e
2004	7,568	4,980	-34	17,658	13,888	-21	350,000		^d
2005	5,667	5,841	3	13,224	15,071	14	350,000		^d
1989-2005 Ave.	5,669	5,263	-6	15,735	15,493	0	350,000	328,693	-6
1996-2005 Ave.	6,177	5,732	-6	16,369	15,526	-4	350,000	239,260	-32
2006	7,059	7,132	1	16,471	16,821	2	350,000		^d

^a Harvest guideline derived from inseason biomass estimate when available, or preseason forecast if weather prevents an estimate. Harvest guidelines not adopted until 1988.

^b Actual minus guideline divided by guideline.

^c Includes deadloss and test fish harvest.

^d No fishery conducted.

^e Data confidential under Alaska Statute 16.05.815.

Appendix A6.—Herring spawn-on-kelp industry participation, fishing effort, area and harvest, Togiak District, 1986–2006.

Year	No. of Companies	Fishery Dates	Hours	Effort^a	Area	Total Harvest in pounds	Herring Equivalent (in tons)	Openings	Average Roe %
1986	6	5/18-5/21	21.0	204	K 7, K 8, K 9	374,142	1,446	4	9.7
1987	5	4/29-5/4	6.6	187	K 9, K 10	307,307	1,309	5	8.8
1988	10	5/20	6.0	259	K 4, K 8	489,320	1,782	1	10.3
1989	11	5/14	4.0	487	K 9	559,780	2,499	1	8.3
1990	7	5/11	3.0	481	K 8	413,844	1,617	1	9.5
1991	7	5/13	2.5	532	K 4	348,357	1,310	1	9.7
1992	5	5/23	3.3	386	K 9	363,600	1,482	2	9.1
1993	2	5/1-5/2	7.0	173	K 8	383,000	1,481	2	9.7
1994	3	5/13-5/14	7.5	204	K 5	308,400	1,134	2	10.0
1995	5	5/11-5/14	14.5	188	K 2, K 3	281,600	996	3	10.6
1996	3	5/9-5/10	12.0	200	K 8, K 9	455,800	1,899	2	9.6
1997		no fishery							
1998		no fishery							
1999	1	5/23	8.0	130	K 9	419,563	1,605	2	9.8
2000		no fishery							
2001		no fishery							
2002	1	5/14	2.0	50	K 9	67,793	260	1	9.8
2003	1	5/3-5/4	3.0	35	K 3	13,884 ^b	55	1	9.45 ^b
2004		no fishery							
2005		no fishery							
1996-2005 Average	2		6.3	104		239,260	955	2	9.7
2001-2005 Average	1		2.5	43		40,839	158	1	9.6
2006		no fishery							

^a 1984–1989 and 1992–1996, number of permits fished based on fish tickets. 1990 and 1991, peak aerial survey count.

^b Data confidential under Alaska Statute 16.05.815.