

Special Publication No. 09-15

**Overview of the Togiak District Herring Sac Roe and
Spawn-on-Kelp Fisheries of Bristol Bay, Alaska, 2009;
a Report to the Alaska Board of Fisheries**

by

Tim Sands

November 2009

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Measures (fisheries)	
centimeter	cm	Alaska Administrative Code	AAC	fork length	FL
deciliter	dL	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	mid-eye-to-fork	MEF
gram	g	all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.	mid-eye-to-tail-fork	METF
hectare	ha	at	@	standard length	SL
kilogram	kg	compass directions:		total length	TL
kilometer	km	east	E		
liter	L	north	N	Mathematics, statistics	
meter	m	south	S	<i>all standard mathematical signs, symbols and abbreviations</i>	
milliliter	mL	west	W	alternate hypothesis	H _A
millimeter	mm	copyright	©	base of natural logarithm	<i>e</i>
		corporate suffixes:		catch per unit effort	CPUE
Weights and measures (English)		Company	Co.	coefficient of variation	CV
cubic feet per second	ft ³ /s	Corporation	Corp.	common test statistics	(F, t, χ^2 , etc.)
foot	ft	Incorporated	Inc.	confidence interval	CI
gallon	gal	Limited	Ltd.	correlation coefficient (multiple)	R
inch	in	District of Columbia	D.C.	correlation coefficient (simple)	r
mile	mi	et alii (and others)	et al.	covariance	cov
nautical mile	nmi	et cetera (and so forth)	etc.	degree (angular)	°
ounce	oz	exempli gratia		degrees of freedom	df
pound	lb	(for example)	e.g.	expected value	<i>E</i>
quart	qt	Federal Information Code	FIC	greater than	>
yard	yd	id est (that is)	i.e.	greater than or equal to	≥
		latitude or longitude	lat. or long.	harvest per unit effort	HPUE
Time and temperature		monetary symbols		less than	<
day	d	(U.S.)	\$, ¢	less than or equal to	≤
degrees Celsius	°C	months (tables and figures): first three letters	Jan, ..., Dec	logarithm (natural)	ln
degrees Fahrenheit	°F	registered trademark	®	logarithm (base 10)	log
degrees kelvin	K	trademark	™	logarithm (specify base)	log ₂ , etc.
hour	h	United States (adjective)	U.S.	minute (angular)	'
minute	min	United States of America (noun)	USA	not significant	NS
second	s	U.S.C.	United States Code	null hypothesis	H ₀
		U.S. state	use two-letter abbreviations (e.g., AK, WA)	percent	%
Physics and chemistry				probability	P
all atomic symbols				probability of a type I error (rejection of the null hypothesis when true)	α
alternating current	AC			probability of a type II error (acceptance of the null hypothesis when false)	β
ampere	A			second (angular)	"
calorie	cal			standard deviation	SD
direct current	DC			standard error	SE
hertz	Hz			variance	
horsepower	hp			population	Var
hydrogen ion activity (negative log of)	pH			sample	var
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

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Division of Sport Fish, Research and Technical Services
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November 2009

The Special Publication series was established by the Division of Sport Fish in 1991 for the publication of techniques and procedures manuals, informational pamphlets, special subject reports to decision-making bodies, symposia and workshop proceedings, application software documentation, in-house lectures, and became a joint divisional series in 2004 with the Division of Commercial Fisheries. Special Publications are intended for fishery and other technical professionals. Special Publications are available through the Alaska State Library, Alaska Resources Library and Information Services (ARLIS) and on the Internet: <http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm>. This publication has undergone editorial and peer review.

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This document should be cited as:

Sands, T. 2009. Overview of the Togiak District herring sac roe and spawn-on-kelp fisheries of Bristol Bay, Alaska, 2009; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 09-15, Anchorage.

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ABSTRACT

The Togiak District Pacific herring (*Clupea harangus pallasii*) fishery is the largest sac roe fishery in Alaska with typical harvests in excess of 20,000 short tons. Although the biomass of the Togiak District herring sac roe fishery has been relatively stable, the exvessel value of the fishery fell significantly in 1997 and has leveled off at \$100–150 per ton. The low price paid per ton has led to a slower paced fishery characterized by longer fishing periods and effort determined by processor needs with a focus on increased quality. This focus on quality has led to increases in roe percentages and a more protracted fishery. Since 2007 the fishery has begun later than average due to cold weather in the spring and the runs have been compressed.

Key words: Togiak, herring, *Clupea harangus pallasii*, sac roe, commercial fishing, spawn-on-kelp, *Fucus spp.*, Alaska Board of Fisheries, management, 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. The Bristol Bay area is divided into three herring fishing districts: the General District, including all waters west of the longitude of Cape Newenham, the 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 (Figure 1). Togiak village lies at the center of the district, 108 km west of Dillingham.

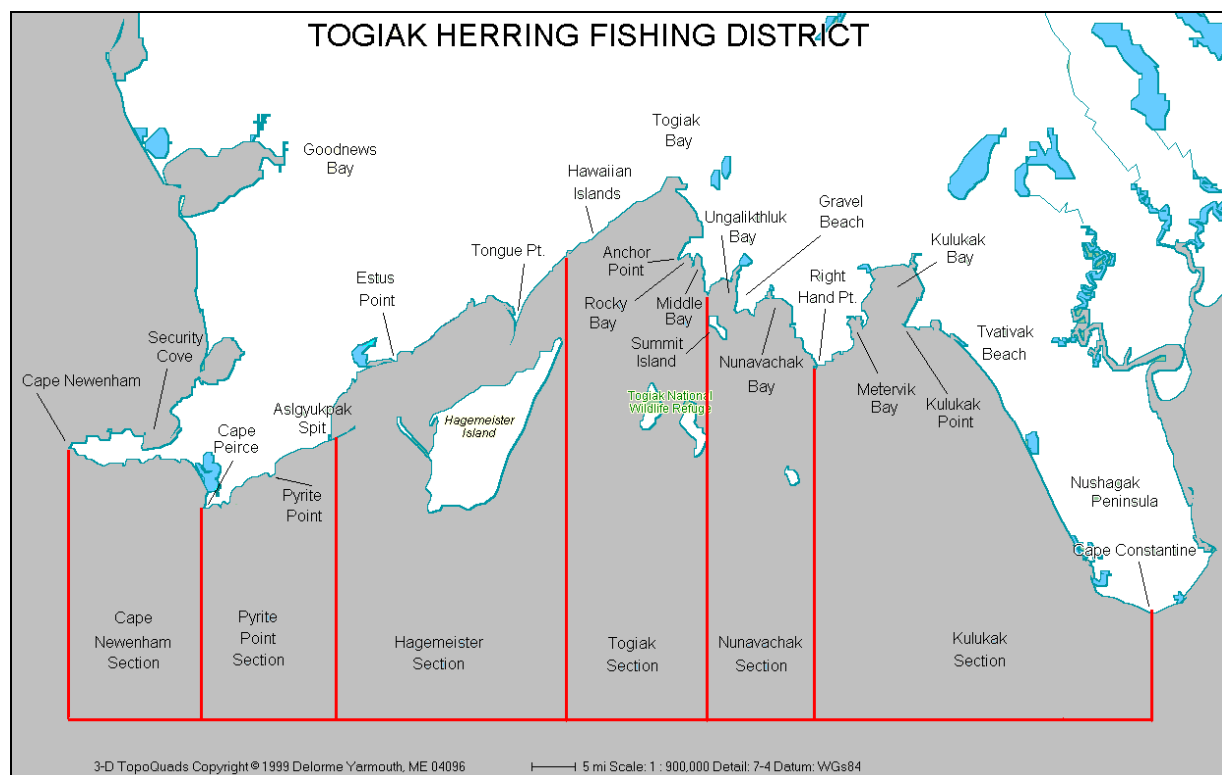


Figure 1.—Togiak Herring District, Bristol Bay.

Pacific herring (*Clupea harangus pallasii*) have been documented throughout Bristol Bay, but the major concentration returns to the Togiak District 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 is 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 District herring fishery in 1977.

The Togiak District herring fishery is the largest herring fishery in Alaska in terms of biomass harvested. Sac roe harvests from 1989–2008 averaged 20,700 tons, worth \$5.5 million annually (Appendices A1 and A3). Since the peak in 1996, the value of herring has decreased dramatically. Between 1999 and 2008, an average of 20,200 tons of herring has been harvested worth \$3.1 million annually. There have been two spawn-on-kelp harvests since 2000 and both have been insignificant in value and volume. In 2009, exvessel value for sac roe harvests was \$2.5 million, the third lowest since 1989.

STOCK ASSESSMENT

METHODS

Since 1984, Alaska Department of Fish and Game (department) has conducted aerial surveys throughout the spawning season of herring to estimate abundance, timing, and distribution of Pacific herring in the Togiak District. In the past, surveys to assess biomass, spawn deposition, and fishing effort were flown on a daily basis with a dedicated helicopter on the grounds for department use. Since 2006, with the continued low value of the fishery, the department has reduced costs by conducting surveys with fixed-wing aircraft and by reducing the number of surveys. Surveys are now initiated when weather and ice conditions indicate herring might be arriving on the grounds, varying from late April to mid-May. Once herring are observed, surveys are conducted 2 to 3 times per week (weather permitting) until biomass declines and spawning activity subsides. The reduced survey effort makes comparisons with data from previous years more difficult, especially for spawn deposition.

Fundamental aerial survey techniques used in Togiak District 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. The estimated surface area of the herring school is converted to a biomass estimate based on survey altitude, water depth, and school density. Over the last 6 years, the department has been converting aerial survey data collection methods to incorporate Geographic Information Systems (GIS). This allows staff to enter data in “real-time” and facilitates faster and more accurate data analysis.

Herring samples are 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. Since 2003, herring biomass has declined rapidly following the peak

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

Annual estimates of the Togiak District 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. More recent observed biomass levels increased to a peak of approximately 194,000 tons in 1993 (Appendix A3).

2009 Herring Season

During the winter of 2008–2009, 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 May 4. The Bering Sea ice pack persisted south of Cape Newenham through early May; some ice still persisted in the Togiak Herring District, especially west of Tongue Point and in Togiak Bay, until mid-May. Ice was still present when fishing opened May 16.

Aerial surveys of the Togiak District began May 4, 2009. Herring were first reported in the district on the afternoon of May 13, when department staff observed herring during an aerial survey. On May 16, department staff partially surveyed the Togiak District under poor conditions and documented the threshold biomass of 35,000 tons. Department staff documented approximately 76,000 tons of herring during a survey on May 22, and the peak estimate of approximately 94,000 tons on May 24. Survey conditions were generally fair after May 18. The last survey occurred on May 26, documenting roughly 54,000 tons of herring still on the grounds.

The 2009 herring run forecast was 121,800 tons. Samples to estimate the age structure of the 2009 biomass were taken from purse seine and gillnet landings. 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 District 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 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 District participate in other fisheries (e.g., Bristol Bay salmon), markets for salmon and other fish affect effort in the herring fishery. Herring prices paid to permit holders the prior year and run timing also affect effort. For the last several years, processors have used cooperative fleets for the seine fishery. The gillnet fleet has also been reduced and is restricted by market forces.

Fishing effort in the sac roe fishery increased during the late 1980s, decreased in the early 1990s, 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, peaked in 1996 at 461 vessels, and has since declined to a low in 2007 of 25 vessels. Purse seine effort increased steadily from 1978, peaking in 1989 when 310 vessels were observed. From 1990 through 1997, the purse

seine fleet fluctuated between 200 and 300 vessels and has declined to less than 100 vessels since 1998. In 2009, 21 purse seine vessels participated in the Togiak District herring fishery.

Reduction in fleet size has led to the development of cooperative purse 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, the department can allow continuous fishing, leading to increased selectivity and smaller sets. There is concern that this approach may result in increased numbers of released sets and the department has begun to monitor 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 District (Appendix A3). Over the past 12 years, industry participation has steadily declined to a low in 2007 of 5 companies. In the last 2 years, participation has increased by one or two companies. Processing capacity on the grounds declined to a low in 2007 of 1,420 tons per day. In 2009, the processing capacity on grounds was 2,015 tons.

GEAR SPECIFICATIONS

The Alaska Board of Fisheries (board) 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 board 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 of gillnet, and granted the department the authority to reduce length to 50 fathoms inseason. The board acted on this regulation again in 1992, restricting herring gillnet length to 50 fathoms and giving the department the ability to allow up to 100 fathoms of gear by emergency order. This change enabled the department to maintain an orderly fishery, helping ensure roe quality, and minimizing potential waste. Gillnet depth remains unrestricted.

In October 1989, the board reduced purse seines to 100 fathoms in length and 16 fathoms in depth. In 1995, the board further restricted purse seine depth to 625 meshes, of which 600 could be no larger than 1.5 inches. 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 board in 1980. The primary objective of the plan is to have an orderly fishery and strive for the highest product quality with minimum waste. A secondary objective is to attempt to insure that neither gear group is totally disadvantaged. In 1980, this was accomplished, in part, by closing fishing for a gear type for 24 hours if the other gear type had less than 6,000 metric tons when total harvest reached 20,000 metric tons. 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 gillnet to seine was 3:1 (1982) or 5:1 (1985). In 1988, the issue of allocation was examined by the board again and a new plan adopted. 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 District sac roe fishery: 25% to the gillnet fleet and 75% to the purse seine fleet. In 2001, allocation issues were addressed again by the board and harvest percentages were modified to 70% purse seine and 30% gillnet. The board also directed that this allocation be maintained inseason and directed the department 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 board modified the allocation plan, allowing each gear type to be unrestrained by the performance of the other once each gear group harvested over 80% of its 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 fishery following the 70/30 allocation rule. In 2006, the board modified the allocation plan again by reducing the 80% mark at which the inseason management for allocation could be relaxed, to 50%. Currently, the allocation between gillnet and purse seine is 30/70 and once each gear group has harvested at least 50% of its quota, each gear types can harvest the rest of its quotas without consideration of the other gear type's harvest.

To achieve the gillnet and purse seine allocations, the department calculated guideline harvest levels (GHLs) each year by apportioning 30% and 70% of the sac roe allocation to each gear, respectively. Since 2001, when the board last changed allocation percentages, the gillnet GHL has averaged 6,652 tons and the purse seine GHL has averaged 15,522 tons. The GHLs have varied up and down by no more than 15% since 2001. Since 2001, the department has regulated fishing time and area to achieve each GHL, while maintaining a 30/70 ratio. In 2009, the available harvest of herring was allocated as follows:

Fishery	GHL
Spawn on Kelp	1,500 tons
Dutch Harbor Food and Bait	1,600 tons
Togiak District Sac Roe	21,260 tons
Purse Seine (70%)	14,882 tons
Gillnet (30%)	6,378 tons

Exploitation

The commercial sac roe and spawn-on-kelp harvests in the Togiak District have been managed by emergency order since 1981. From 1981 through 1987, informal policies directed the department 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 board incorporated the threshold and exploitation rate policies into the *Bering Sea Herring Fishery Management Plan* (5 AAC 27.060) for Togiak District and other Bering Sea fisheries. Herring biomass in Togiak District has been estimated at levels well above threshold requirements since 1981.

Exploitation rates have exceeded 20% in 9 of the last 20 years, but averaged 19.1% (Appendix A3). Exploitation in the past 10 years has decreased to an average of 17.4% as a result of changes in fleet size, demand, and the absence of the spawn-on-kelp harvest.

Table 1–Summary of the Togiak District herring sac roe fishery performance, 2007–2009.

	2007			2008			2009		
	Harvest	Effort	Processors	Harvest	Effort	Processors	Harvest	Effort	Processors
Purse seine	13,120	21	5	15,691	28	7	12,404	21	6
Gillnet	4,012	25	5	4,832	27	6	4,167	32	6
Exvessel	\$1,600,000			\$2,600,000			\$2,500,000		

Product Quality and Value

The board and the industry have directed the department 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) states the department 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, thereby minimizing the harvest of small 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, the department considers maximizing quality and value to be primary objectives in the Togiak District fishery.

The department has used volunteer test fishing as a means to maximize roe quality since 1982. Test fishing procedures developed and became more intensive from 1982 through 1989. By 1990, the department 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. Until recently, the department has opened to commercial fishing only areas that have documented high quality roe.

Given the decrease in both fishing and processing effort in recent years, the department has stopped orchestrating test fishing operations through the fleet since 2007. Instead, the department opens commercial fishing as soon as threshold biomass is documented. This allows each processor to make its own decision about when to buy fish and what quality of product is required for its market. As available processing capacity has decreased, the inability of industry to process all the herring available for harvest has become a recurring reality. By opening the fishery as soon as threshold biomass is documented the department allows the maximum amount of fishing and processing time.

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 the department to recognize quality problems associated with holding times. Limiting individual harvests within processing capabilities became a management objective after 1992.

From 1992 until 2000, the department 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 virtually impossible for the whole quota to be processed in less than 10 days. As occurred in early years of the fishery, companies no longer need to buy as much as possible 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, the department may make restrictions in time and area. In 2009, fishing was allowed continuously for the purse seine fleet from late on May 16 until it was closed on May 26 because of the small size of fish, the increasing number of released sets, and the high numbers of spawned out fish. The 266 hours of fishing time for the seine fleet in 2009 contrasts sharply with the 20-minute period in 1992 both in 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 the department 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.

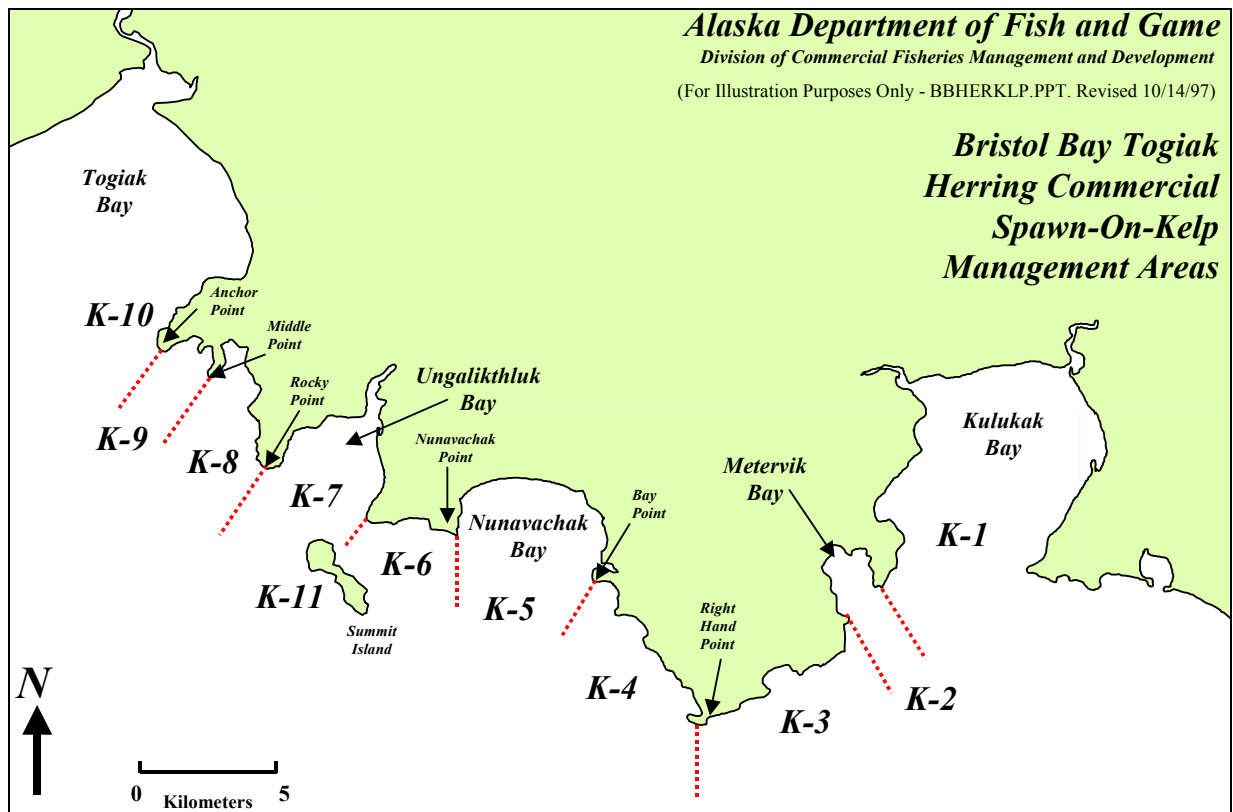


Figure 2.—Spawn-on-kelp management areas (K-1 through K-11), Togiak District, Bristol Bay.

Fishing effort in the spawn-on-kelp fishery increased steadily from its inception and peaked at 532 participants in 1991. The fishery became limited to interim use and permanent permit holders in 1990. Following the 1991 season, the board 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 and the fishery opened consistently until 1996. Since 1996, however, commercial interest in spawn on kelp has plummeted. In 2002 and 2003, there was some market interest in the spawn-on-kelp product and there were very limited openings in both of those years. The combined harvest from these seasons was less than 25 tons with a value of less than \$20,000. There has been no buyer registered to participate in the spawn-on-kelp fishery since 2003 and it seems unlikely that a market for a significant amount of the GHL will emerge in the near future.

SUMMARY

Overall, the Togiak District herring population is stable and healthy. The biomass and GHL have fluctuated less than 15% from their averages since 2001. The value of, and participation in, the sac-roe fishery is much diminished from historical highs, but seems to have leveled off and is also relatively stable. The spawn-on-kelp fishery has not had sufficient market interest to necessitate an opening since 2003.

REFERENCE CITED

Lebida, R. C. and D. C. Whitmore. 1985. Bering Sea herring aerial survey manual. Alaska Department of Fish and Game, Division of Commercial Fisheries, 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, 1989–2009.

Year	Herring			Total
	Sac Roe	Food/Bait	Spawn-on-Kelp	
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	b	1,900
2003	2,797	0	b	2,801
2004	2,541	0	a	2,541
2005	2,978	0	a	2,978
2006	2,618	0	a	2,618
2007	1,869	0	a	1,869
2008	2,600	0	a	2,600
1989–2008 Ave.	5,538	4	285	5,827
1999–2008 Ave.	3,058	0	113	3,171
2009	2,500	0	a	2,500

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

^a Fishery not conducted.

^b Less than 4 buyers; records are confidential Alaska Statute 16.05.815.

Appendix A2.–Sac roe herring industry participation, fishing effort, and harvest, Togiak District, 1989–2009.

Year	Number of Buyers	Daily Processing Capacity ^a	Gillnet					Purse Seine				Total Harvest ^c
			Fishery Dates	Effort ^b	Duration (hours)	Harvest ^c	Roe %	Effort ^b	Duration (hours)	Harvest ^c	Roe % ^d	
1989	19		5/9-5/14	320	5.0	2,844	7.8	310	3.0	9,415	8.5	12,259
1990	16	3,100	5/8-5/20	277	66.0	3,072	9.0	221	3.0	9,158	9.7	12,230
1991	16	3,350	5/10-5/17	170	14.0	3,182	8.5	200	3.0	11,788	10.0	14,970
1992	18	3,700	5/20-5/27	274	25.5	5,030	8.8	301	0.3	20,778	9.2	25,808
1993	12	2,500	4/27-5/9	75	144.5	3,564	10.1	140	33.8	14,392	9.6	17,956
1994	16	3,300	5/11-5/20	146	76.0	7,462	12.0	240	4.6	22,853	9.4	30,315
1995	22	4,350	5/7-5/15	250	33.5	6,995	12.0	254	12.2	19,737	10.1	26,732
1996	19	4,850	5/3-5/8	461	18.0	6,863	11.1	268	2.4	18,008	9.0	24,871
1997	18	4,200	5/2-5/6	336	24.0	5,164	11.8	231	6.4	18,649	9.4	23,813
1998	15	2,475	4/29-5/10	152	46.0	5,952	12.5	123	16.5	16,824	9.6	22,776
1999	12	2,400	5/18-5/26	171	28.0	4,858	11.5	96	4.7	14,368	9.2	19,226
2000	12	2,100	5/6-5/14	227	67.0	5,464	10.6	90	15.8	14,957	10.1	20,421
2001	11	2,255	5/6-5/13	96	84.0	6,491	10.6	64	26.0	15,879	9.2	22,370
2002	8	1,920	5/3-5/13	82	102.0	5,216	10.9	37	57.5	11,833	9.3	17,049
2003	7	1,920	4/25-5/7	75	142.0	6,505	10.9	35	110.2	15,158	8.9	21,663
2004	6	2,150	4/29-5/9	54	162.0	4,980	10.4	31	78.0	13,888	9.5	18,868
2005	8	2,330	4/30-5/8	56	149.0	5,841	11.2	33	83.0	15,071	9.6	20,912
2006	7	2,060	5/12-5/21	49	143.9	7,132	10.8	28	113.0	16,821	9.2	23,953
2007	5	1,420	5/10-5/25	25	366.0	4,012	11.2	21	244.0	13,120	10.0	17,132
2008	7	1,950	5/16-5/31	27	312.0	4,832	11.4	28	292.0	15,691	8.4	20,523
1989–2008 Avg.	13	2,754		166	100	5,273	11	138	55	15,419	9	20,692
1999–2008 Avg.	8	2,051		86	156	5,533	11	46	102	14,679	9	20,212
2009	6	2,015	5/16-5/30	32	338.0	4,140	9.6	21	266.0	12,967	9.2	17,107

Note: Blank cells represent no data.

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

^b Peak aerial survey count.

^c Harvest total includes deadloss and test fish harvest.

^d Values are lower than inseason assessment due to more stringent postseason market scrutiny.

Appendix A3.—Exploitation of Togiak District herring stock, 1989–2009.

Year	Biomass Estimate ^a (short tons)	Spawn-on-Kelp Herring Equivalent	Dutch Harbor Food/Bait	Sac Roe			Total ^c	Total Harvest	Exploitation Rate
				Gillnet ^b	Purse Seine ^c	Waste ^d			
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	18,298	350	23,462	25,762	20.6%
1998	121,000	0	1,994	5,952	16,424	400	22,376	24,770	20.5%
1999	124,946	1,605	2,398	4,858	14,170	198	19,028	23,229	18.6%
2000	130,904	0	2,014	5,464	14,857	100	20,321	22,435	17.1%
2001	119,818	0	1,439	6,491	15,660	219	22,151	23,809	19.9%
2002	120,196	260	2,846	5,216	11,793	40	17,009	20,155	16.8%
2003	126,213	55	1,487	6,505	14,778	380	21,283	23,205	18.4%
2004	143,124	0	1,258	4,980	13,785	103	18,765	20,126	14.1%
2005	108,585	0	1,154	5,841	14,287	784	20,128	22,066	20.3%
2006	129,976	0	953	7,132	16,321	500	23,453	24,906	19.2%
2007	134,566	0	1,214	4,012	12,800	320	16,812	18,346	13.6%
2008	130,516	0	1,536	4,832	15,533	0	20,365	21,901	16.8%
1989–2008 Ave.	122,430	717	1,877	5,273	15,242	283	20,515	23,392	19.1%
1999–2008 Ave.	126,884	192	1,630	5,533	14,398	264	19,931	22,018	17.4%
2009	121,800	0	1,335	4,140	12,967	100	17,207	18,542	15.2%

Note: Blank cells represent no data.

^a Preseason forecast unless peak biomass estimate in season exceeded preseason forecast.

^b Includes bait harvest.

^c Includes test fish harvest.

^d Estimated waste.

^e Does not include waste.