Hecate Strait Herring Survey July 24–31, 2003

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Science Branch, Pacific Region
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HECATE STRAIT HERRING SURVEY JULY 24–31, 2003

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A seven-day mid-water trawl survey was conducted in northern British Columbia with emphasis on Hecate Strait. Aggregations of Pacific herring (*Clupea pallasi*) were identified using echo-sounding along the 50-fathom (91.45m) bottom contour. The survey was designed to evaluate if this type of sampling can provide a recruitment strength forecast six months prior to the commercial roe fishery based on the proportion of pre-recruit (age-2+) herring in northern summer feeding aggregations. In addition, this survey provided information on the spatial distribution of northern herring and their role in a northern ecosystem.

RÉSUMÉ

Thompson, M., T.W. Therriault, and P. Midgley. 2004. Hecate Strait herring survey July 24–31, 2003. Can. Manuscr. Rep. Fish. Aquat. Sci.2678: 14 p.

Nous avons réalisé une campagne de relevés au chalut semi-pélagique d'une durée de sept jours dans le nord de la Colombie-Britannique, et notamment dans le détroit d'Hécate. Des bancs de hareng du Pacifique (*Clupea pallasi*) ont été repérés à l'échosondeur le long de l'isobathe de 50 brasses (91,45 m). La campagne avait pour objectif d'évaluer si ce type d'échantillonnage peut permettre de prévoir l'importance du recrutement six mois avant la pêche commerciale du hareng rogué à partir de la proportion de pré-recrues (âge 2+) dans les bancs de harengs en phase d'alimentation dans les eaux du nord. La campagne a en outre apporté de l'information sur la distribution spatiale des harengs des eaux du nord et sur leur rôle dans un écosystème septentrional.

INTRODUCTION

Reduced biomass for some British Columbia Pacific herring (*Clupea pallasi*) stocks has renewed interest in the accuracy of recruitment forecasting procedures, especially for northern stock assessment areas. Five major stock assessment areas currently exist in British Columbia, of which three are considered northern: Queen Charlotte Islands (QCI), Prince Rupert District (PRD) and Central Coast (CC) (Figure 1). British Columbia herring mature, spawn, and recruit starting at age-3 (Hay and McCarter 1999).

The current stock assessment model uses a forecasted biomass of returning spawners plus an estimate of newly recruiting fish (Schweigert 2002). For herring, annual variability in recruitment can be substantial making a forecast of recruitment strength extremely valuable for stock assessment. Independent offshore surveys conducted in late spring or summer may be able to refine recruitment forecasts for northern herring stocks. Ware and Tanasichuk (1997) used the proportion of age-2+ herring captured offshore in summer surveys to forecast recruitment strength (the expected proportion of age-3 herring) for the West Coast Vancouver Island (WCVI) stock. Therriault (2003) suggested this type of recruitment strength forecasting tool could be applied to northern herring stocks based on catches of herring in summer groundfish trawl surveys in Hecate Strait. However, Therriault (2003) cautioned that summer trawl surveys that targeted herring aggregations were required to fully explore the potential application of this type of recruitment strength forecasting tool. In addition to determining the proportion of pre-recruit herring in northern offshore areas, this survey provides basic information on the spatial distribution of herring and the role of herring in a northern ecosystem (based on diet analyses of herring and their predators). This is the first year of ongoing northern sampling surveys which will expectantly help in the early forecast of northern pre-recruit herring.

SAMPLING METHODS

The survey was conducted over a seven day period in 2003, from July 24th to July 31st. Twenty-one mid-water trawls were performed between Goose Island Bank, Queen Charlotte Sound, in the south and Two Peaks, Dixon Entrance in the north (Tables 1, 2 and Figure 2). The survey concentrated on the 50 fathom (91.45m) contour within Hecate Strait using echo-sounding to identify major aggregations of herring (Figure 2). Two hundred herring were randomly selected and retained for biological sampling from each tow. All retained herring were measured to standard length. For selected tows, DNA samples (flesh core punch), stomachs and scales were taken for additional analyses (Table 3). Other species caught in trawl tows were measured, fork length for salmonids, total length for groundfish, and standard length for pelagics (Table 4). Stomachs of herring predators were processed with prey species identified and measured (Table 5).

Herring scales were collected and mounted as per Hamer (1989). For each fish, the preferred ageing scale located under the pectoral fin on left side of fish was removed and mounted on a glass slide using a diluted mucilage mixture. Scales were removed from either 50 or 100 fish per tow on nine separate occasions resulting in the collection of 750 scales for age analysis during this survey. The limited amount of time and amount of work for each tow determined the number of scales that were removed. Scale samples were used for age and growth determination.

DNA was collected following established protocols (Beacham et al. 2002). Fish were wiped clean using a cloth to remove scales and excess mucus and a corer was used to obtain a sample of epaxial muscle. The core sample was then preserved in 95% ethanol. DNA was collected from 100 herring from five different spatial locations in Hecate Strait, resulting in the collection of 500 individual DNA samples. These samples will be used to help the investigation of herring population structure for the three northern stock assessment regions.

A sub-sample of herring stomachs was retained for gut content analyses. From five tows, 50 stomachs were removed from the herring and preserved in 4% formaldehyde (mixture of freshwater and 37% formalin). To eliminate possible biases between feeding times and locations, stomach samples were collected from the tow made closest to 12:00 p.m. each day. A total of 250 herring stomachs were retained for gut analyses during this survey. Stomachs will be analysed for content (diet). Stomachs also will be able to show the amount of variability in feeding between tow locations and future surveys. Herring predator stomachs were analysed in the field. Identifiable gut species were measured to total lengths (Table 5).

A total of 3654 herring were measured resulting in a length frequency distribution that identified several age classes (Figure 3). Length frequency data in combination with validated herring ages from scale samples will be used to develop a forecasting tool for recruitment strength for northern herring stocks. In addition, data collected during an earlier groundfish stock assessment cruise (May-June, 2003) will allow comparisons in population structure. If population structure is consistent among cruises, alternative sampling dates and strategies may be explored for recruitment strength predictions.

FISHING

Twenty-one mid-water trawls were executed during the seven-day charter. The vessel chartered for the survey was the *Ocean Acheiver*, a 21m, steel-hulled West Coast seiner. A Dantrawl© Bering Billionaire mid-water trawl net with an opening of 12m vertically, 26m horizontally and 14m long with 7.62cm wings and body mesh and a 2.5cm knotless mesh in the codend was used. The doors were 3m Super Krups© and a net sounder on a third wire system was connected to a Furuno© FCV-1000 display. Herring were captured in 20 of 21 tows. However, tows 6 and 20 had insufficient quantities of herring for quantitative sampling, while tow 13 resulted in no herring.

PLANKTON TOWS

Six plankton tows were made during the survey. These tows corresponded to tows for which herring stomach samples were collected. Plankton sampling was conducted using an oblique tow of a SCOR net with a 60cm diameter and 0.35mm (350μm) nylon Nitex® mesh. We allowed an approximate cable descent rate of 50m/min and a cable ascent rate of 20m/min. A General Oceanics© model 2030R flow meter was mounted in the aperture of the net to estimate the total volume of water filtered (Table 6). Total volume of filtered water was calculated by using the following formula (McCarter and Hay 2002):

$$\mathbf{V = (A \cdot D)} \qquad \text{(Equation 1)}$$

and

$$\mathbf{D = (F \cdot K) / 999\,999} \qquad \text{(Equation 2)}$$

where:

V = volume of water filtered through the plankton net (m^3)
A = area of SCOR net opening ($0.2827 m^2$)
D = distance (m)
F = number of revolutions recorded by flow meter (end reading – start reading)
K = standard speed rotor constant for 7cm rotor (26,873)

Upon recovery, the net was washed down with a high-pressure deck hose and filtered contents placed in a 1-litre jar with 10% formaldehyde. A speed of approximately 3.7km/h (2 knots) was used during the tows.

CONCLUSIONS

The survey covered approximately 1349 kilometres (728.6 nautical miles) around the northern coast of British Columbia. The highest concentrations of herring were identified between eastern Dixon Entrance and Butterworth Rocks. The northwest section of Browning Entrance also contained large aggregations of herring. Additional scatterings of herring were fished through Laskeek Bank and Houston Stewart Channel. However, these fish were holding close to bottom and were in more diffuse schools compared to herring schools further north. Additional fishing effort would be advantageous throughout Dixon Entrance, Queen Charlotte Sound and possibly the north-western coast of the Queen Charlotte Islands.

Continuation of this survey could be beneficial to the understanding of the summer spatial distribution of herring and the role herring play in the northern ecosystem.

ACKNOWLEDGMENTS

We would like to thank the skipper, Peter Newman, and the crew of the *Ocean Achiever* for all their hard work in locating herring aggregations and making fishing possible. Special thanks to Lorena Hamer who made the necessary arrangements for this charter to be successful. We gratefully acknowledge financial support from the Herring Conservation and Research Society (HCRS) for making this research possible.

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Table 1. Details of trawl locations that targeted summer aggregations of Pacific herring.

Tow	Year	Month	Day	Location	Start Time	Duration (min)	End Time	Min Depth (fa)	Max Depth (fa)
1	2003	7	26	Browning Entrance	0647	25	0712	46	54
2	2003	7	26	Browning Entrance	0803	39	0842	45	47
3	2003	7	26	Browning Entrance	1128	30	1158	46	48
4	2003	7	26	W Bonilla Island	1402	20	1422	50	50
5	2003	7	26	W White Rocks	1643	15	1658	50	50
6	2003	7	26	Freeman Pass	1857	35	1932	54	54
7	2003	7	27	Butterworth Rocks	0847	64	0951	49	49
8	2003	7	27	W Stenhouse Shoal	1235	23	1258	47	47
9	2003	7	27	W Tree Nob Group	1459	7	1506	43	43
10	2003	7	27	W Tree Nob Group	1647	11	1658	46	46
11	2003	7	28	NW Two Peaks	0708	34	0742	38	38
12	2003	7	28	SE Two Peaks	0904	15	0919	39	39
13	2003	7	28	Rose Spit	1239	39	1318	39	39
14	2003	7	28	Rose Spit	1407	17	1424	36	36
15	2003	7	28	Rose Spit	1856	12	1908	42	42
16	2003	7	29	NE Laskeek Bank	0733	20	0753	36	36
17	2003	7	29	E Laskeek Bank	0857	12	0909	42	42
18	2003	7	29	SE Laskeek Bank	1241	25	1304	43	43
19	2003	7	30	Houston Stewart Channel	2137	12	2149	44	44
20	2003	7	30	Houston Stewart Channel	2241	30	2309	36	36
21	2003	7	31	SE Goose Island Bank	1019	14	1033	53	53

Table 2. Trawl location specifics including trawling speed and general comments.

Tow	Start Latitude °N	Start Longitude °W	End Latitude °N	End Longitude °W	Direction (magnetic)	Tow Speed (knots)	Remarks
1	53.69	130.77	53.67	130.77	150	3.7	
2	53.65	130.78	53.62	130.78	175	3.5	
3	53.62	130.79	53.59	130.79	162	3.4	
4	53.52	130.84	53.54	130.83	356	2.7	
5	53.65	130.66	53.66	130.65	019	2.5	
6	53.81	130.71	53.79	130.67	096	2.5	Quantitative data not possible
7	54.23	131.01	54.27	131.01	332	2.2	
8	54.32	131.11	54.34	131.12	344	2.7	
9	54.29	131.09	54.29	131.08	100	3.3	
10	54.31	131.12	54.30	131.09	110	2.7	
11	54.38	131.20	54.40	131.20	340	3.0	
12	54.31	131.23	54.31	131.24	277	1.6	3 knot tide
13	54.29	131.45	54.27	131.49	252	2.4	No fish
14	54.29	131.41	54.29	131.43	224	3.2	
15	54.23	131.68	54.23	131.66	030	2.8	
16	52.97	130.66	52.97	130.68	306	2.4	Large swell
17	52.95	130.64	52.96	130.65	340	2.7	Large swell
18	52.94	130.64	52.96	130.65	346	3.6	Flood tide and large swell
19	52.17	130.98	52.17	130.00	056	2.5	
20	52.17	130.97	52.16	131.01	224	2.7	No fish
21	51.42	129.20	51.42	129.17	088	3.1	

Table 3. Total number of scale, DNA, stomach and length samples taken from all tows. Tows where plankton samples were performed are indicated.

Tow	Scales	DNA	Stomach	Lengths	Plankton
1				154	
2	100	100		200	
3	50		50	200	√
4				200	
5	50			200	
6					√
7				200	
8	100	100	50	200	√
9				229	
10				200	
11				200	
12				200	
13					
14	50		50	200	√
15	100	100		200	
16				150	
17				200	
18	50		50	200	√
19	150	100	50	300	√
20					
21	100	100		221	
Totals	**750**	**500**	**250**	**3654**	**6**

Table 4. Catch by tow. The number of fish on the first line and average length (mm) on the second line for all nine species caught. Total catch weight given in approximate tonnes.

Tow	Total Catch Weight	Herring *Clupea pallasi*	Pink Salmon *Oncorhynchus gorbuscha*	Chum Salmon *Oncorhynchus keta*	Coho Salmon *Oncorhynchus kisutch*	Chinook Salmon *Oncorhynchus tshawytscha*	Eulachon *Thaleichthys pacificus*	Pacific Cod *Gadus macrocephalus*	Walleye Pollack *Theragra chalcogramma*	Arrowtooth Flounder *Atheresthes stomias*
1	2	154					1		59	27
		180					156		223	577
2	2	200						2	57	3
		180						498	225	598
3	2	200							24	
		181							229	
4	2	200		1						
		186		730						
5	2	200		1		3				
		182		720		693				
6	0									
7	2	200			1	1			28	
		197			588	720			460	
8	2	200								
		189								
9	2	229								
		179								
10	2	200								
		178								
11	2	200								
		188								
12	2	200		1	2					
		181		768	618					
13	0									

Table 4 Continued

Tow	Total Catch Weight	Herring	Pink Salmon	Chum Salmon	Coho Salmon	Chinook Salmon	Eulachon	Pacific Cod	Walleye Pollack	Arrowtooth Flounder
14	5	200	1		1	1				
		195	400		575	499				
15	2	200			1					
		189			604					
16	2	150	1							
		213	335							
17	2	200								
		205								
18	2	200								
		207								
19	2	300								
		174								
20	0									
21	2	221								
		200								
Totals	**39**	**3654**	**2**	**3**	**5**	**5**	**1**	**2**	**168**	**30**
		189	**368**	**739**	**596**	**637**	**156**	**498**	**284**	**588**

Table 5. Identified salmonid stomach contents including length of prey species.

Tow	Fish	Species	Fork Length (mm)	Stomach Species	Stomach Species Total Length (mm)
5	1	chinook	630	herring	185
				herring	160
5	2	chinook	670	herring	173
5	3	chinook	780	herring	171
				herring	181
7	1	chinook	720	herring	63
				herring	60
				herring	60
				herring	60
				herring	64
				herring	57
				herring	63
				herring	63
				herring	59
				herring	58
				herring	62
				herring	63
				herring	61
				herring	69
				herring	60
				herring	63
				herring	62
				herring	62
				herring	64
				herring	63
				herring	61
				herring	58
				herring	55
				herring	58
				herring	60
				herring	61
				herring	60
				herring	58
				herring	58
				herring	57
				herring	63
				herring	58
				herring	58
				herring	60
				sandlance	78
				sandlance	74
				sandlance	70
				sandlance	74

Table 5 Cont.

				sandlance	77
				sandlance	68
				sandlance	75
				sandlance	67
				sandlance	70
				sandlance	68
				sandlance	74
				sandlance	70
				sandlance	68
				sandlance	71
				sandlance	69
				sandlance	72
				sandlance	70
12	2	coho	624	sandlance	107
14	1	coho	575	herring	215
				sandlance	172
				sandlance	172

Table 6. Plankton tows matched at tow locations. Volume filtered was determined using Equations 1 and 2.

Tow	Tow Location	Flow Begin	Flow End	Flow	Volume Filtered (m^3)
1	3	226222	234147	7925	60.21
2	6	234155	240096	5941	45.13
3	8	240102	246832	6730	51.13
4	14	246840	258050	11210	85.16
5	18	258032	261988	3956	30.05
6	19	262032	270544	8512	64.67

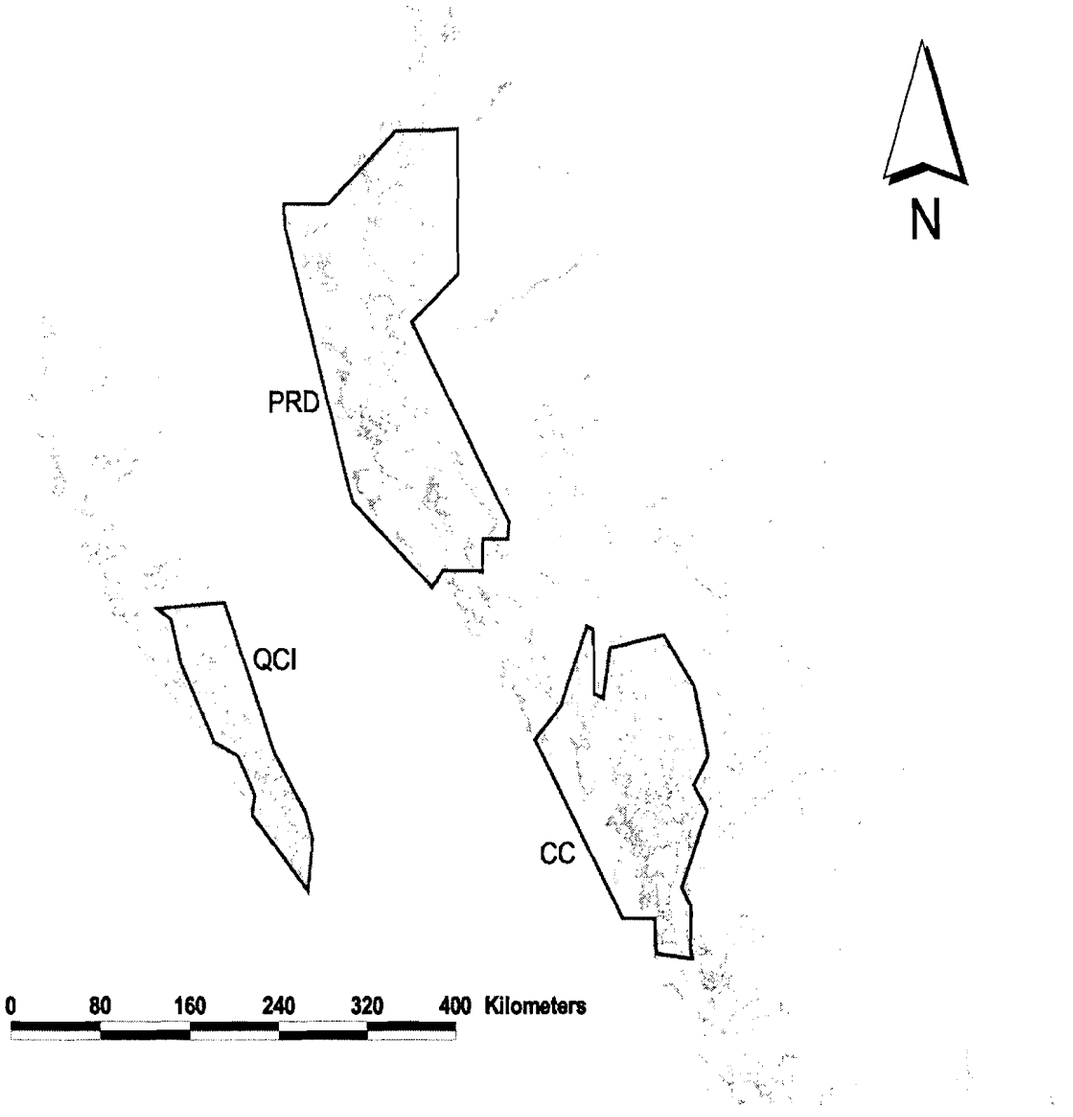

Figure 1. The three northern herring management regions. Queen Charlotte Islands (QCI), Prince Rupert District (PRD) and Central Coast (CC).

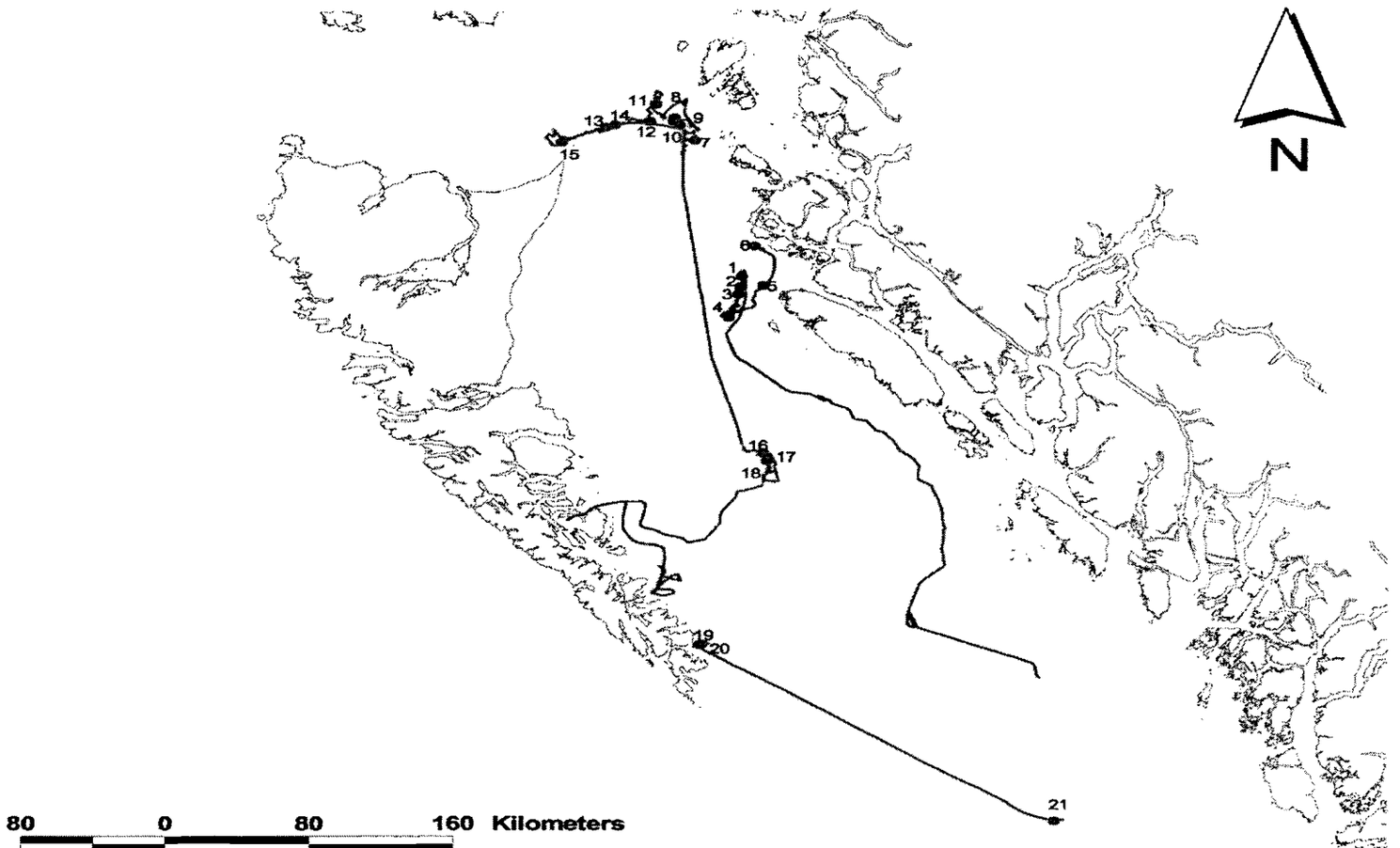

Figure 2. Map of Hecate Strait and the Queen Charlotte Islands showing all the mid-water trawl locations. Numbered circles represent tow locations and the line represents the cruise path.

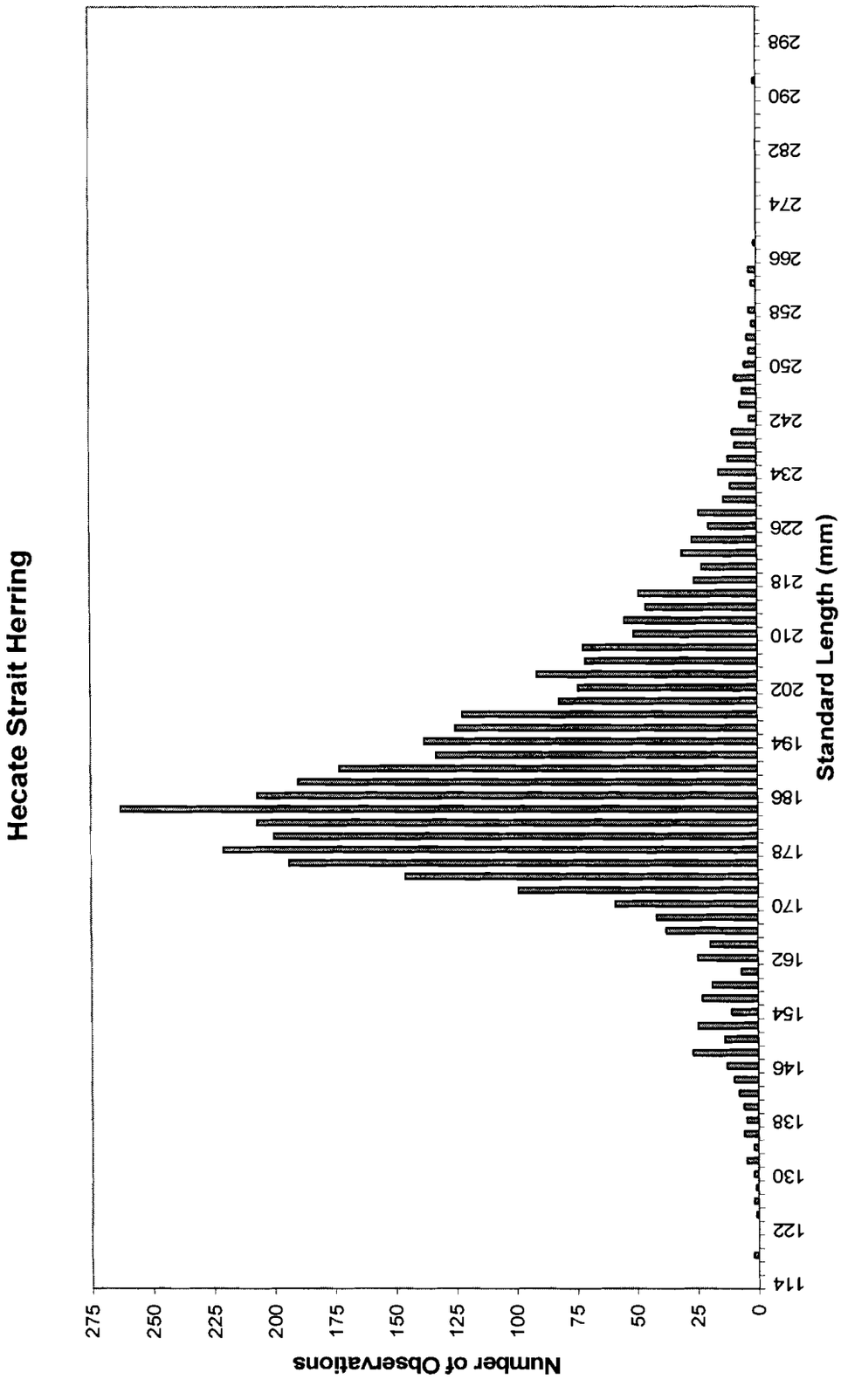

Figure 3. Length frequency distribution of all herring sampled from 18 Hecate Strait mid-water trawl tows, July 2003.