MEETING REPORTS OF WORKING GROUP 2, TRINATIONAL SARDINE FORUM: REGIONAL BIOMASS OF PACIFIC SARDINE (*Sardinops sagax*) OFF WEST COAST OF NORTHERN AMERICAN CONTINENT, IN 2003 AND 2004

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Introduction

At the first Trinational Sardine Forum (TSF) held in Ensenada, México, November 29-30, 2000 (Hunter and Baumgartner 2001), four working groups were formed to carry out the research and data management planning to be implemented following 2000 TSF: Working Group 1 - Industry Supported Directed Sardine Sampling, Working Group 2 - Compilation and Management of Existing Sardine Databases, Working Group 3 - Regional Estimates of Biomass with the following plans, and Working Group 4 - Validation of Stock Structure and Latitudinal Origin of Catches.

It was concluded that the most cost effective topics for improving coast-wide stock assessment and monitoring through Forum collaboration were: coast-wide coordinated sampling for age, size composition and reproductive state; regional biomass estimates; development of a common data base for size, age and landings information; and use of vertebral counts as a way to identify temperature-specific spawning habitats. Thus four working groups were formed and charged with writing draft implementation plans for each of these topics. Each group was to develop plans to describe objectives and approaches, and to identify contact people and agencies that had agreed to cooperate, specifying delivery dates for the information, and identifying contributions. These activities were to provide new information on age and size structure of the population, regional biomass, reproduction, and movements thereby, enabling the development, for the first time, of a coast-wide stock assessment model that would take into account distribution and movements of sardines over their full geographic range. The progress of implementing these plans was to be discussed in subsequent forums even though the progress was slower than planned.

These four working groups continued through 2001(Hunter and Baumgartner 2001, 2002). In the 2002 TSF (Hunter and Pleschner-Steeler 2003), four working groups were reduced to three by including task of group 1 (industry supported sardine sampling) into those of other working groups with the principal goal to promote coast-wide cooperation in producing information needed on the biology and dynamics of the sardine population. The Forum planned to continue with these three working groups in the future. Of course, any revisions deemed to be necessary by the Forum to deal with upcoming issues may result in formation of additional working groups. The three working groups as of 2004 with their reports and future plans were summarized as follows:
Working group 1: Age structure and adult sampling group that conducted a Sardine Ageing Workshop in 2004, the results of which and cross-lab ageing project were discussed, along with ongoing issues pertaining to coast-wide adult sampling and databases at the 2004 TSF. Working group 2: Regional biomass estimate group, has annual reports of regional estimates since 2000. Plankton surveys in Mexico, plankton and trawl surveys off the U.S., and trawl surveys off the northwest U.S. and Canada are ongoing activities covered by this working group. Working group 3: responsible for identifying sardine movements, origins and population structure, and for conducting research on stock structure, which was a Focus Issue at the 2004 TSF.

Each working group determines the way to assimilate the information regarding their working progress and new findings. The Working Group 2 [1]annual reports for 2000-2002 were included in TSF meeting reports (Hunter and Baumgartner 2001, 2002; Hunter and Preschner-Steel 2003). In this report, for continuity we included two separate annual reports of Working Group 2: regional biomass estimates in 2003 and 2004 TSF. Each year, various types of surveys were conducted off Mexico, California, Oregon, Washington, and British Columbia, and spawning biomass or biomasses were estimated accordingly. In the following sections, results from individual surveys were reported when data were analyzed in time. The numbering of tables and figures are those in the original report.

Report of 2003 regional biomass and recommendations

1. IMECOCAL and CalCOFI, April cruises, 2003.
   Objectives: To estimate spawning biomass of Pacific sardine from Baja California, Mexico to San Francisco, CA, US.

Activities:

1.1 CalCOFI.

In 2003, only ichthyoplankton survey was conducted. Egg and yolk-sac larval samples together with adult reproductive parameter estimates from 2002 surveys (Lo and Macewicz, 2002) were used to estimate the spawning biomass of Pacific sardine for 2003. During the 2003 survey, the regular CalCOFI survey was extended to CaCOFI line 60.0 (north of Morro Bay) with the *Revelle* cruise (April 4 - 25) occupying six regular CalCOFI lines (93.0 - 76.6, 40 nm apart) and R/V *Jordan* (April 7-30) occupying 10 lines (73.3- 60.0), half of which belonged to regular CalCOFI survey pattern. Bongo samples were taken on regular CalCOFI survey lines only. In addition, *Jordan* occupied six lines from line 95.0 north to line 75.0, 40 nm apart (Figures 1 and 2).

The daily egg production of Pacific sardine (*Sardinops sagax*) off California from San Diego to Morro Bay was estimated to be1.52/0.05m^2 (CV = 0.18) and the spawning biomass was estimated to be 485,121 mt (CV=0.36) for an area of 365,906 km^2, using the daily specific fecundity (number of eggs/population weight (gm)/day of 22.94 from the 2002 cruise (compared to 23.55 used in the years of 1994-2001) (Lo and Macewicz, 2002). The area is slightly larger than 325,082 km^2 in 2002. The estimates of spawning biomass of Pacific sardine in 1994 and 1996 - 2003 are 127,000 mt, 83,000 mt, 410,000 mt, 314,000 mt, 282,000 mt, 1.06 million mt, 791,000 mt, 206,000 mt, and 485,000 mt, respectively. Therefore, the estimates of spawning biomass have been fluctuated since 1994.

[1] Starting 2005, three working groups are WG 1: Regional biomass, WG 2: Stock structure, age structure age adult sampling and WG 3: Industry trends and issues.

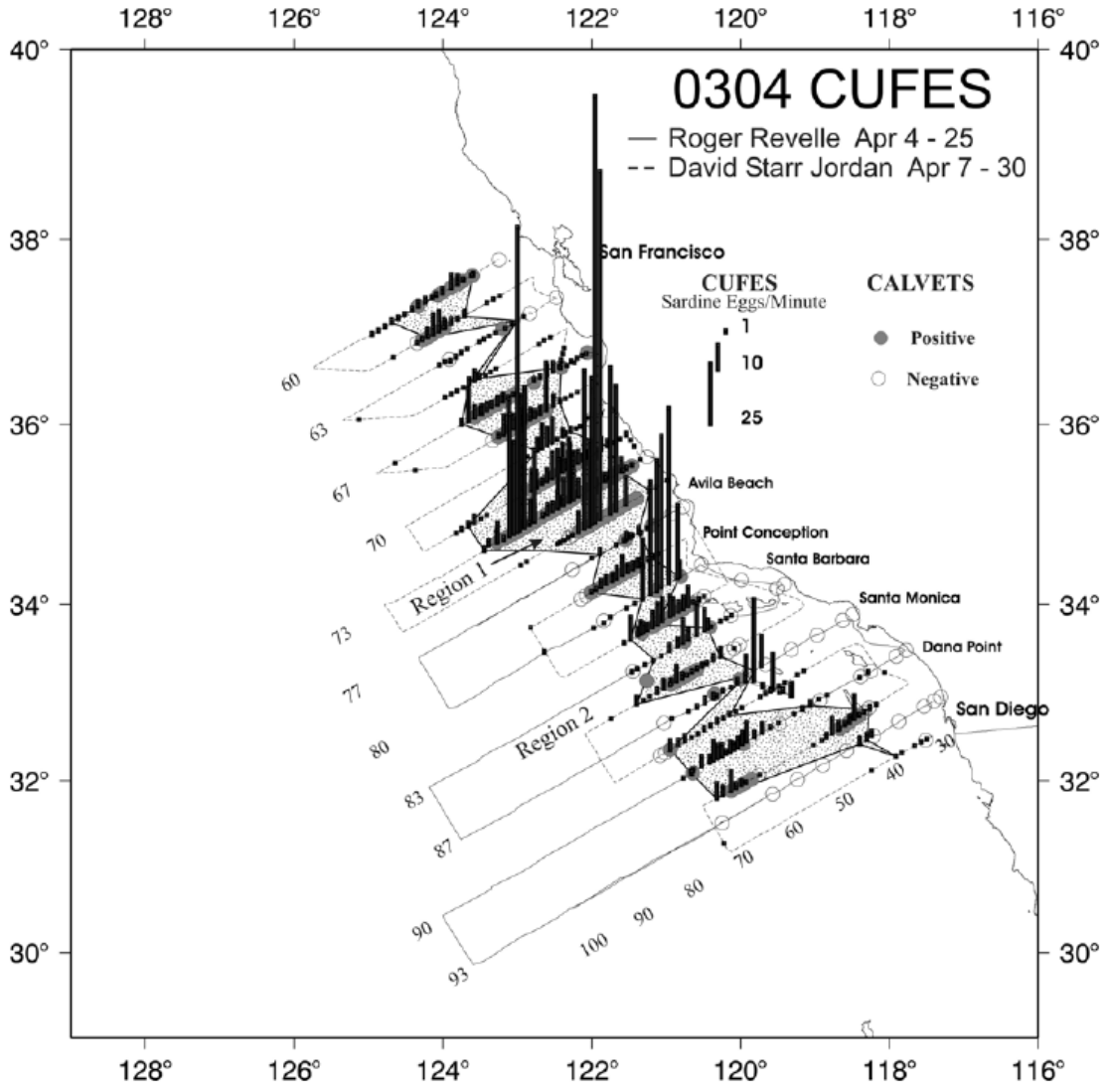

Figure 1. Sardine eggs from CalVET (or Pairovet; solid circle denotes positive catch and open circle denotes zero catch) and from CUFES (stick denotes positive collection) in March-April 2002 survey. The numbers on line 93 are CalCOFI station numbers. Region 1 is stippled area.

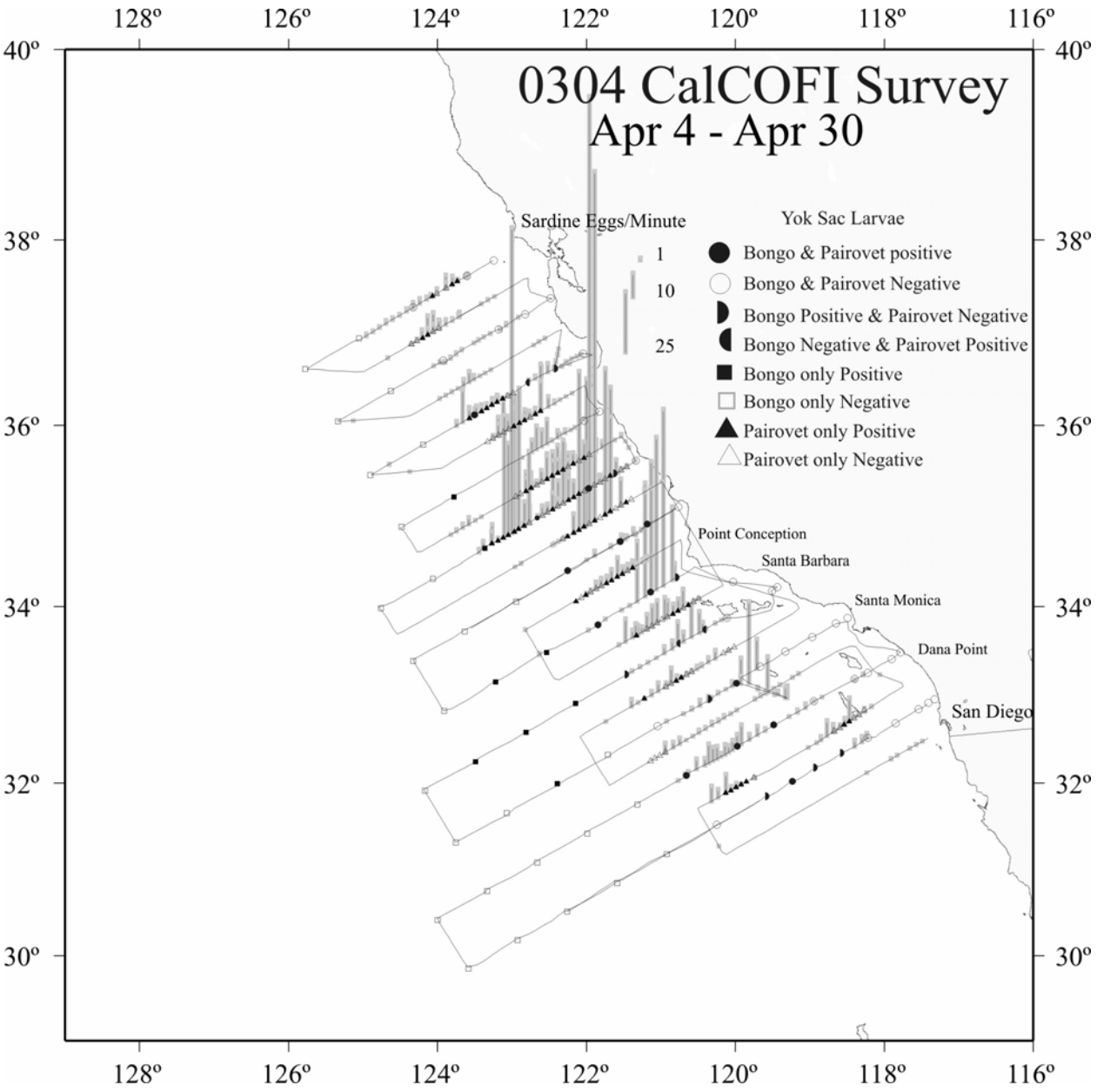

Figure 2. Sardine yolk-sac larvae from CalVET (or Pairovet; circle and triangle) and from Bongo (circle and square) in April 2003 survey. Solid symbols are positive and open symbols are zero catch.

1.2 IMECOCAL

Data from 0304 survey are not ready at the time of writing this report. For 0204 survey (April 19-May 9), only 2 CalVET tows out of 65 CalVET tows had sardine eggs greater than zero. For CUFES, out of 839 collections, 74 were positive (Figure 3). Because of the small sample size, the egg density (average eggs/min = 0.046) from CUFES was used to estimate first eggs/0.05m^2, a measurement from CalVET samples, and subsequently, the daily egg

production/0.05m^2 at age 0 (equation 1) based on hatching time (t_h) and a range of daily egg instantaneous mortality rates (z) (equation 1). Since no directly conversion factor (E) from eggs/min to eggs/0.05m2 was obtained off Mexico, i.e. eggs/min = E* eggs/0.05m^2 , three values of E were considered (0.29, 0.25 and 0.2) based on data off California (Lo 2003). Similarly, a range of egg mortality rates were used: 0.4-0.8. The hatching time (t_h) was computed from the the temperature-dependent egg development equation (equation 1, Lo et al. 1996). The mean temperature of positive CUFES collections was 15.88°C.and the hatching time (t_h) was 2.72 days. The estimates of P_0 ranged from 0.1 to 0.27 for the combination of E values and Z value(Table 1). For the estimates of adult parameters: the sex ratio (R) was computed from fish >70 gm collected from February 19 - March 13, 2003: 0.4. The mean weight of females (W) was computed from weight-length relationship: 100 gm. Two values were used for the spawning fraction (S): 0.15 (Macewicz et al. 1996 and Lo 2003) and 0.08. The batch fecundity (F) was computed from mean oocytes/gm * mean female weight: 33510 oocytes (Macewicz 1996). For an area of 167,018 km^2 and the daily specific fecundity of 20.1 or 10.79 eggs/gram of population weight, the estimates of spawning biomass off Mexico ranged from 16,000 -65,000 mt (Table 1). So the spawning biomass was likely around 40,000 mt. Note that the 1st semester landing for Ensenada in 2002 was approximately 15,000 mt. Therefore around 37% of the spawning biomass was taken by the fishery.
From

$$\bar{\chi} = \int_0^{t_h} p_0 \exp(-zt)\,dt$$

where $\bar{\chi}$ is eggs/0.5m^2

Therefore, we can express P_0 as a function of t_h and z:

$$p_0 = \frac{z\bar{\chi}}{1-\exp(-zt_h)} \quad (1)$$

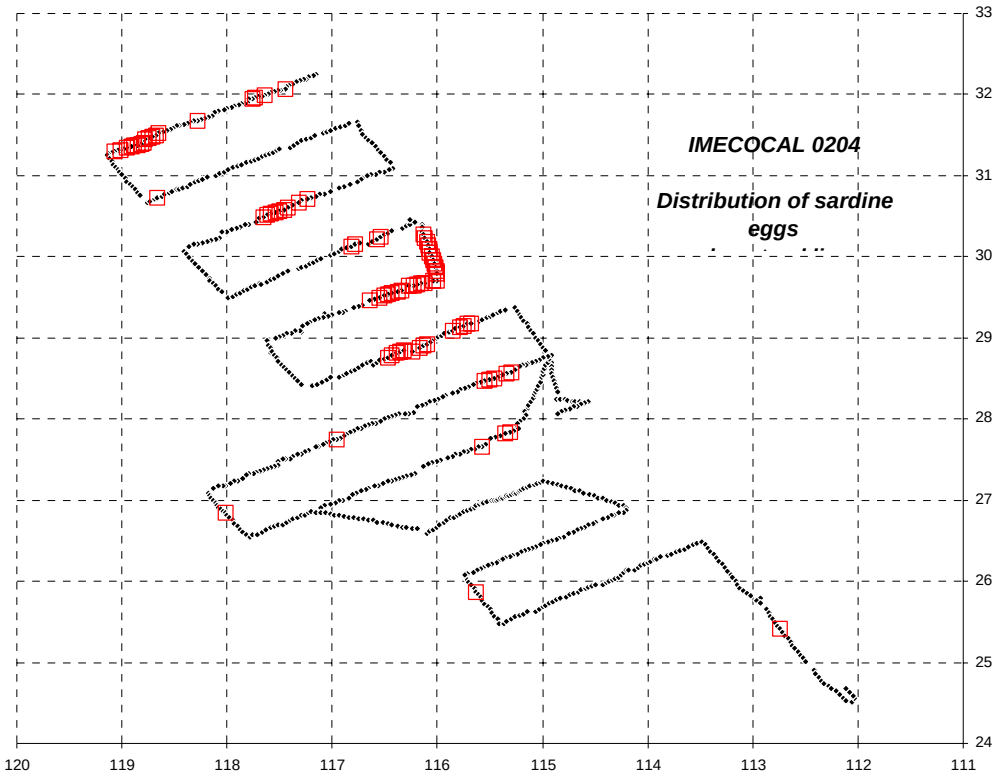

Figure 3. The distribution of eggs/min from CUFES collection during 0204 IMECOCAL survey. Red squares were positive for sardine eggs. Square denotes positive collection.

Table 1: Crude estimates of egg production (P_0) based on various combinations of conversion factor (E), mortality rates (Z). Spawning biomass estimates for 2024 based on estimates of adult parameters for sardine off Mexico and two values of spawning fraction (S). The average eggs/min was 0.046

Conversion factor (E): eggs/min = E eggs/0.05m^2: 0.29, 0.25, and 0.2
Mortality rate (Z): 0.4,0.5,0.6,0.7 and 0.8

P_0/0.05m^2

E	0.29	0.25	0.2
Z			
0.4	0.0957	0.111	0.139
0.5	0.1070	0.124	0.155
0.6	0.1180	0.137	0.172
0.7	0.1300	0.151	0.189
0.8	0.1430	0.166	0.208

E	0.29	0.25	0.2
Z			
0.4	0.129	0.145	0.181
0.5	0.139	0.161	0.202
0.6	0.154	0.179	0.224
0.7	0.170	0.197	0.247
0.8	0.187	0.217	0.271

Batch fecundity (F) for mean fish weight of 100 gm: 33512 = -13667 + 471.79 * 100
Sex ratio (R): 0.4, Female weight (W): 100 gm

Estimates of spawning biomass (mt) for an area of 167018 km^2

S = 0.15

E	0.29	0.25	0.20
Z			
0.4	15895.55	18438.84	23048.55
0.5	17724.93	20560.92	25701.14
0.6	19653.83	22798.45	28498.06
0.7	21674.82	25142.79	31428.49
0.8	23779.90	27584.69	34480.86

S = 0.08

E	0.29	0.25	0.20
Z			
0.4	29804.16	34572.83	43216.04
0.5	33234.24	38551.72	48189.65
0.6	36850.94	42747.09	53433.86
0.7	40640.28	47142.73	58928.41
0.8	44587.32	51721.29	64651.62

2. NWFSC Biomass off Northern Oregon and Southern Washington.
   Objectives: To estimate spawning biomass of Pacific sardine off Oregon in 1999 - 2003.

Activities:
2.1. Egg surveys in 1999-2003.
No egg surveys were conducted in 1999-2003.

2.2. Adult surveys. Similar to year 2001 and 2002, no off shore survey was conducted to capture adults in June because locations and timing of the spawning were unknown. Effort was concentrated on near shore trawling surveys off Oregon and Washington:

a) BPA Columbia River plume study: from northern Washington to Newport in May, June, and September.
b) Predator/baitfish study off the Columbia River: night surface trawl surveys off the Columbia River every 10 days from late April through July.
c) Lower Columbia River purse seine survey: every 2 weeks from April through September.

This section reports the preliminary estimates of biomass of Pacific sardine based on July samples from night surface survey trawls of predator/baitfish study off the Columbia River from Willapa Bay down to Tillamook Head in 1999-2003 (Figure 4). Night surface trawls were conducted every 10 days from late April through July. During each survey, 12 surface trawls were conducted: 6 on 2 lines (Willapa Bay and the Columbia) from 6 distances from shore: 0-10, 10-20, .50-60 km which constitute six strata. The net reached down to 20 meters depth of water. We believe this area has similar hydrographic conditions: dominated by the Columbia River plume, has high Chlorophyll, and evidently higher abundance of sardines than other areas, where fishery is concentrated there.

For each stratum within a month, the density was computed by the number caught divided by volume swept (number/106m3). Mean number/stratum/month was calculated using Delta method (accounts for zeros) (Pennigton 1996). Average weight of sardine estimated from mean length of sardine for that month was computed from a length/weight relationship was derived from data collected in 1999/2000. Number/month was estimated by summing number of sardine in each stratum for each month. Biomass for each month was estimated by multiplying number/month * average weight/sardine for that month. The mean value of biomass over all strata in July was used as the estimate of biomass for the season.

The biomass estimates ranged from 21,000 mt to 191,000 mt during these five years for the area from Willapa Bay (Grays Harbor) down to Tillamook Head (Table 2 and Figure 4). Few sardines were captured at 60 NM from shore. So the sampling area effectively covers the western boundary of their population but not the southern or northern distribution. This high fluctuation may be due to sampling effort or due to movement of the population. The fork length of 852 sardines collected from Late April to early August (n = 36 for April; n = 75; n = 346 for May; and n = 395 for June) was measured and tabulated (Figure 5). Fork lengths ranged from 102 to 296 mm. The fat contents were not available for 2003 from commercial catches off Washington. In June-October, 2002, the fat content was ranging from 7% in June to a maximum of 25% in September (Hunter and Pleaschner-Steel 2003)

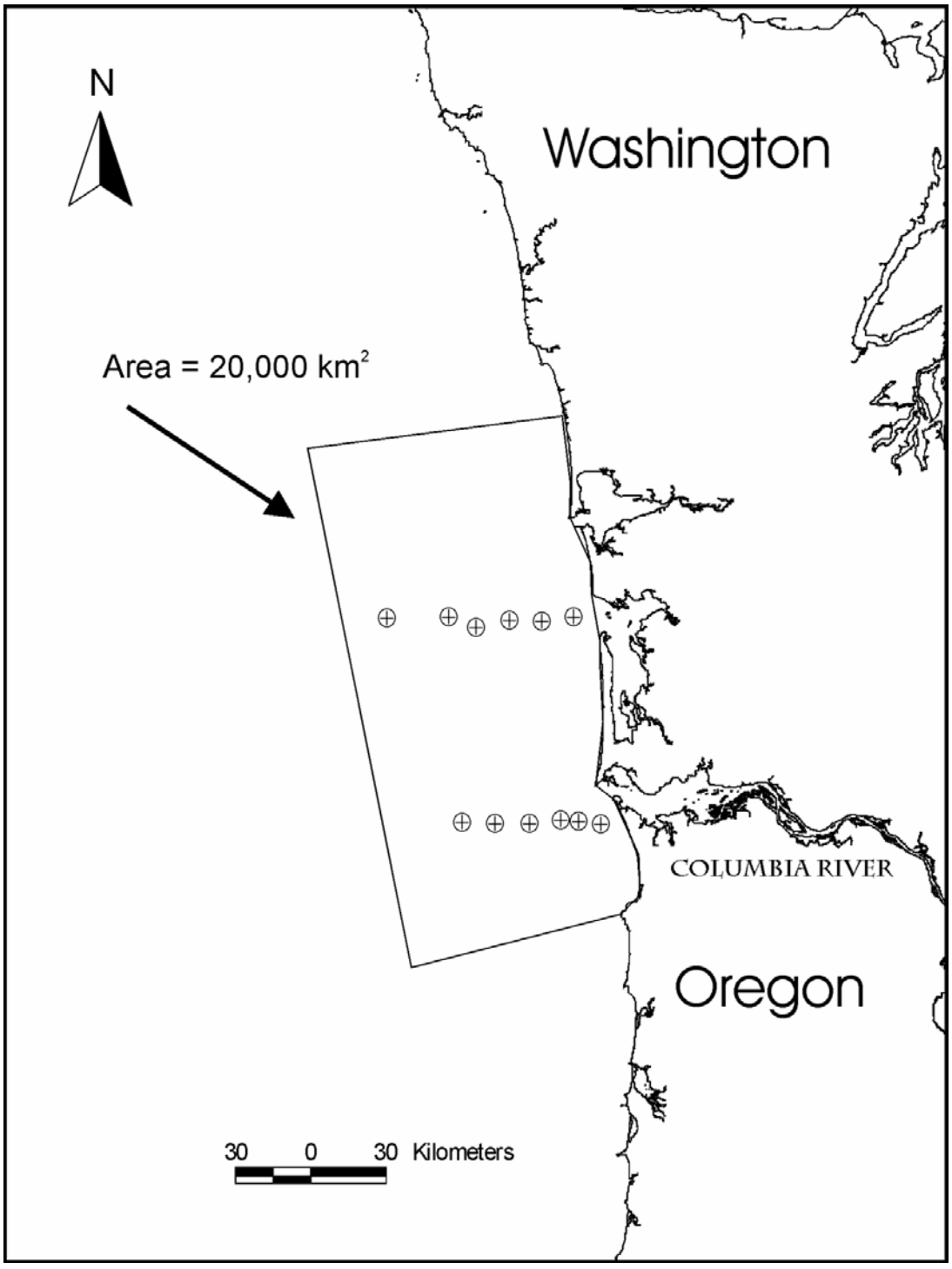

Figure 4. Survey area for Northwest surface trawl survey off Oregon and Washington from April-August, 2003

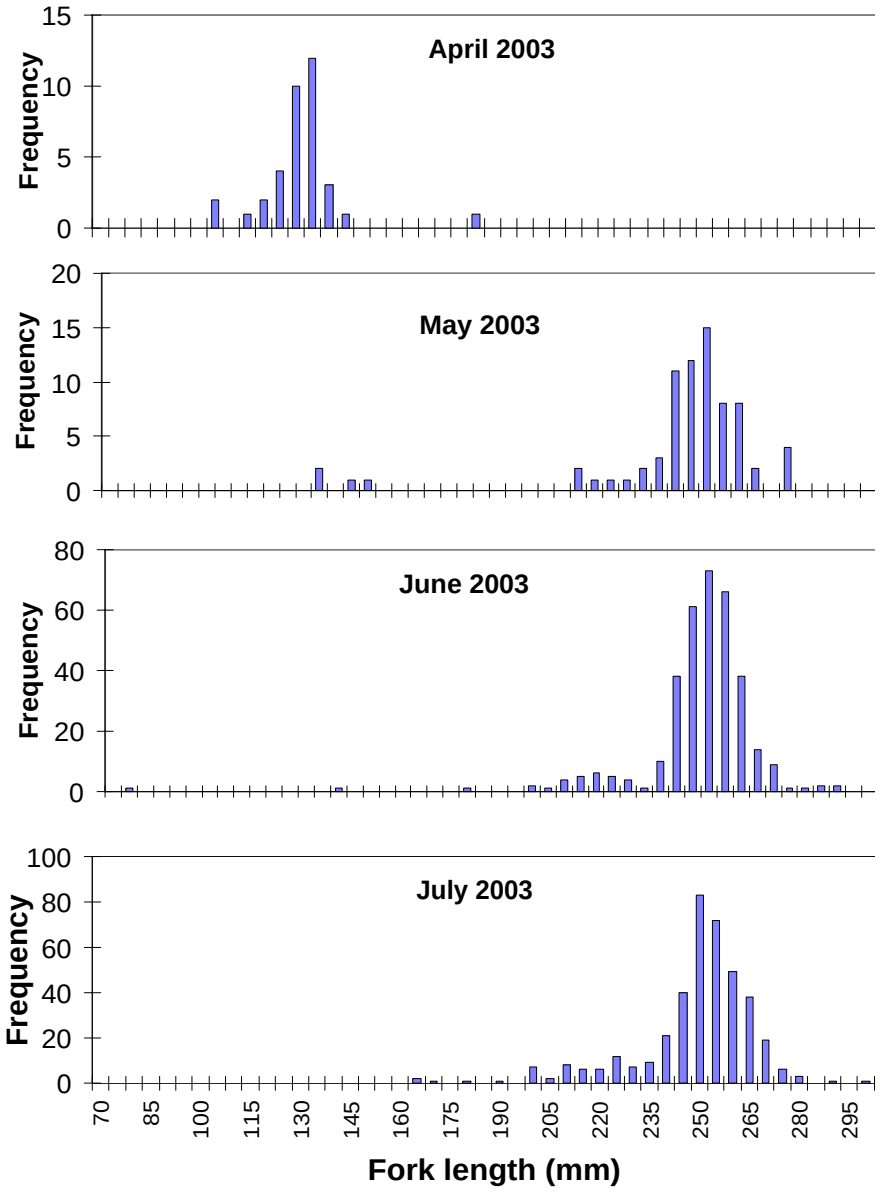

Figure 5. Distributions of fork length of Pacific sardine off Oregon and Washington, April-July, 2003

Table 2. Summary statistics and estimates of biomass of Pacific sardine from July surface trawl surface off Oregon from 1999-2003

Number of Pacific Sardine off S Wash/N Oregon from July surface trawl surveys

Year	early July	Mid July	Late July
1999	16,738,383	10,282,076	667,488,503
2000	644,545,899	766,670,243	no trawls after 22 July 2000
2001	35,637,249	162,221,196	235,583,259
2002	544,696,457	48,770,214	non taken
2003	26,997,079	2,177,182,868	193,544,001

Average Length of Pacific Sardine

Year	Early July	Mid July	Late July
1999	246	239	235
2000	237	243	
2001	233	241	242
2002	247	247	
2003	251	249	237

Average weight of Pacific Sardine (g) Calculated from average length

Year	Early July	Mid July	Late July
1999	154	143	137
2000	140	149	
2001	133	146	148
2002	156	156	
2003	165	160	149

Biomass of Pacific Sardine off S Wash/N Oregon (metric tons)

Year	Early July	Mid July	Late July	mean
1999	2,585	1,471	91,200	31751.98
2000	90,129	114,467		102298.2
2001	4,740	23,612	34,904	21085.55
2002	85,229	7,607		46417.95
2003	4,448	542,448	27,049	191315.3

3. Canadian Trawl surveys

Objectives:To provide information on the distribution of presence and absence of sardine, biological parameters, and feeding behavior and to estimate a minimum biomass of Pacific sardine off Vancouver Island from July cruise each year since 1996.

Activities:

This report summarizes sardine data collected during a research cruise conducted from August 6 to August 19, 2003. Over 30 research cruises have obtained sardine samples since 1992. This is the 4th survey directed at estimating abundance in offshore waters along the WCVI. Sardines (*Sardinops sagax*) were the largest fishery in British Columbia from the mid-1920s to the mid 1940s. Following their collapse in 1947 (McFarlane and Beamish, 2001), sardines were absent from British Columbia waters until 1992 (Hargreaves, Ware and McFarlane, 1994). From 1992 until 1995 sardines were captured in limited numbers in research and commercial fisheries, but were not found in spawning condition off the west coast of Vancouver Island until 1997 (McFarlane and MacDougall, 2001). In 1998, juvenile sardines first became a common component of the Vancouver Island surface water community (McFarlane and Beamish, 2001), and since then have been captured throughout Vancouver Island waters. From 1997 to 2000, sardines were captured in cruises during February, March and April, and June to November, although the majority of sardines were captured between June and August. From 1997 to 1999 sardines were found in the Juan de Fuca Strait, and as far north as the east coast of Queen Charlotte Islands. In 1998 sardines were also found on the east coast of Vancouver Island and in the southern Strait of Georgia. The sardine distribution in 2000 was concentrated on the west coast of Vancouver Island, and ranged as far south as Barkley Sound, and as far north as mainland British Columbia, north of Vancouver Island. However, in 2003, sardines were less prevalent during research cruises than in previous years.

Research cruise 2003-16 was carried out aboard the R/V *W.E. Ricker*, and all fish were captured using a model 250/350/14 mid water rope trawl (Cantrawl Pacific Ltd., Richmond, British Columbia). Fish were measured for fork lengths, and were recorded to the nearest millimetre.

From August 6 to August 19, 2003, a total of 71 sets were made in surface waters (=45m) off the west coast of Vancouver Island (Figure 6). Of these, 15 sets contained sardines. One set made deeper than 45m also contained sardines. Set 70 was made at a depth of 80m and contained 2 sardines.

Virtually no sardines were captured in the outside waters of the WCVI. A few sardines were captured offshore in the Barkley Sound area, but were only found near shore and in inlets in all other areas (Figure 6). The largest catches of sardines were made in Kyuquot Sound (sets 132 and 134; 593 kg and 584 kg respectively), and Nootka Sound (set 126, 666kg). All other sardine sets captured small numbers of sardines, ranging from 1 fish to 11 kg of fish.

Recent information from the fishery indicates large concentrations of sardines were present in all inlets off the WCVI. At this point, just under 500 mt have been landed with some catch was taken from all of the inlets but the majority (>90%) was taken from Barkley Sound because of the preferred smaller size and proximity to processing plants. Sardines found in the

northern inlets of Vancouver Island were found to be too large for the market. A small number of sardines were also found during a juvenile herring survey in east Higgins Passage in the Central Coast of British Columbia.

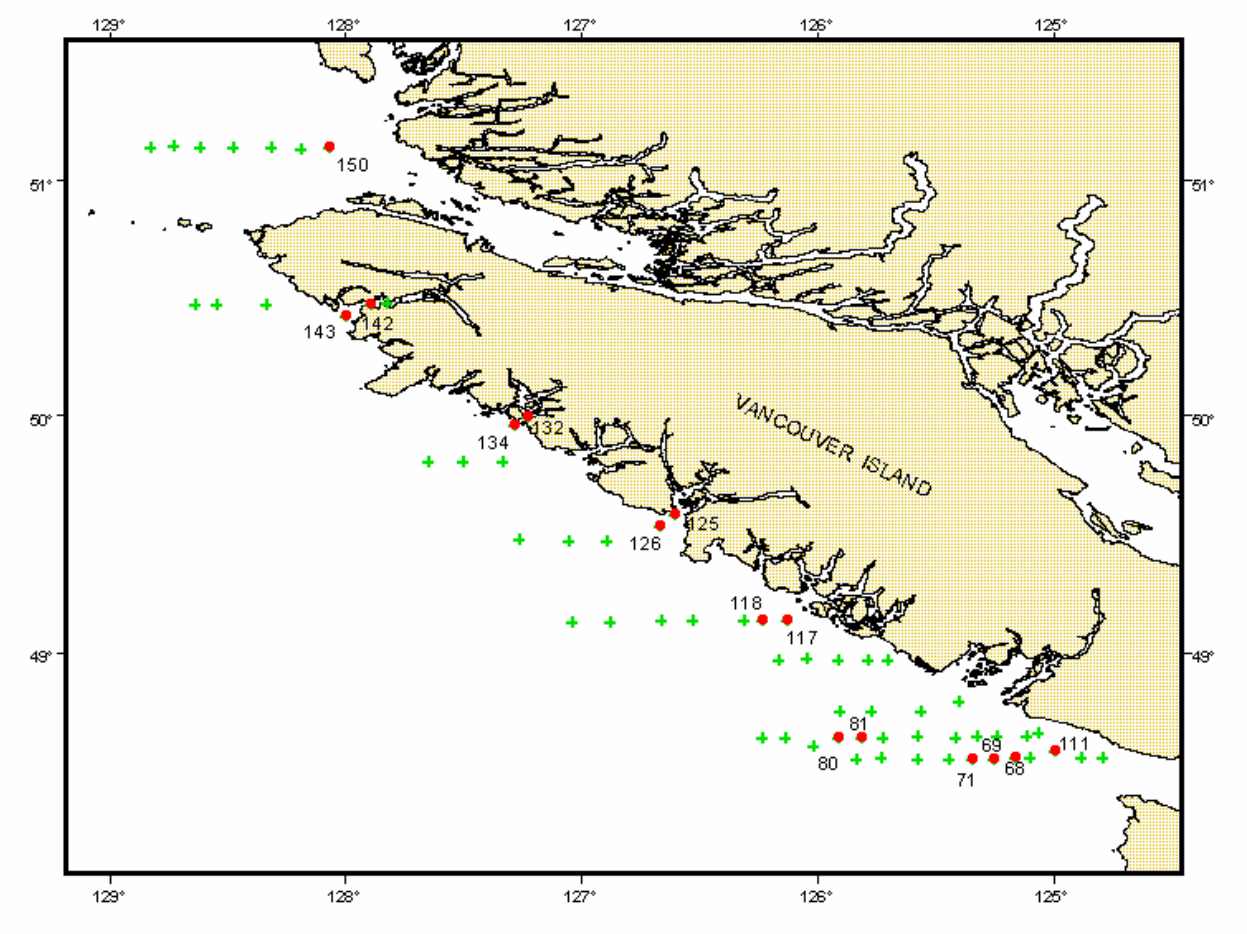

Figure 6. Research cruise, August 6 – 19, 2003. +'s represent sets at depths of 45m or shallower in which sardines were not captured. Red dots represent sets in which sardines were captured.

Biological data:

Table 3 summarizes other species captured in association with sardines. In general, salmon species, particularly pink salmon (*Onchorhycus gorbusha*), coho salmon (*Onchorhynchus kisutch*), chinook salmon (*Oncorhynchus tshawytscha*), and sockeye salmon (*Oncorhynchus nerka*) were commonly captured with sardines. Other species found in sardine sets included jack mackerel (*Trachurus symmetricus*), chub mackerel (*Scomber japonicus*), and spiny dogfish (*Squalus acanthias*). One lingcod (*Ophiodon elongatus*) was captured with sardines in set 118, and herring (*Clupea harrengus*) were captured with sardines in set 80.

Table 3. Species captured in association with sardine, Cruise 2003-16, August 6-19, 2003.

Set #	Pink	Coho	Sockeye	Chum	Chinook	Juvenile Salmon	Spiny Dogfish	Jack Mackerel	Chub Mackerel	Lingcod	Herring	Sardine
68	18.36	1.99	0	0	0	0	5.56	207.96	0	0	0	0.18
69	28.82	78.26	0	0	18.14	2.6	39.74	98.48	0	0	0	2.08
70	5.54	0	0	0	0	0	0	0	0	0	0	0.3
71	12.56	79.64	0	0	43.28	0.61	0	67.64	0	0	0	0.53
80	14.85	26.94	0	0	0	0.19	0	1.75	0	0	0.22	10.14
81	1.75	6.08	0	0	0	4.21	0	12.52	0	0	0	0.82
111	0	0	0	0	0	0	0	0	0	0	1363.64	0.32
117	3.39	1.85	36.68	0	52.76	1.04	0	0	0	0	0	2.08
118	61.38	19.62	12.1	6.24	21.46	1.01	0	3.2	0	4.97	0	0.29
125	0	0	0	0	0.6	0.2	0	0	0	0	0	0.2
126	0	1.69	0	0	0	3.62	0	0	0.61	0	0	665.84
132	0	0	0	0	0.9	0.49	0	0	0.57	0	0	593.34
134	0	3.51	0	0	0	2.34	0	0	0	0	0	583.52
142	0	19.04	0	0	0	1.57	0	0	0	0	0	8.86
143	0	58.5	0	0	0	0.15	0	0	0	0	0	0.93
150	37.06	11.86	13.86	19.82	22.5	10.26	0	0	0	0	0	0.62

Biological samples obtained from sardines during cruise 2003-16 were summarized (Table 4). Lengths were obtained more often than any other measurement, but some stomach and otolith samples were collected as well, for in-lab analysis at a later date.

Table 4. Summary of biological samples obtained from sardines by set, captured during research cruise 2003-16, August 6 – 19, 2003.

Set #	Length	Weight	Sex	Stomach	Otolith
69	15	15	15	0	0
80	45	45	0	0	0
117	10	10	0	0	0
118	1	1	0	0	0
126	319	150	319	50	50
132	272	169	272	50	50
134	140	40	140	0	0
142	43	43	0	0	0
150	3	3	0	0	0

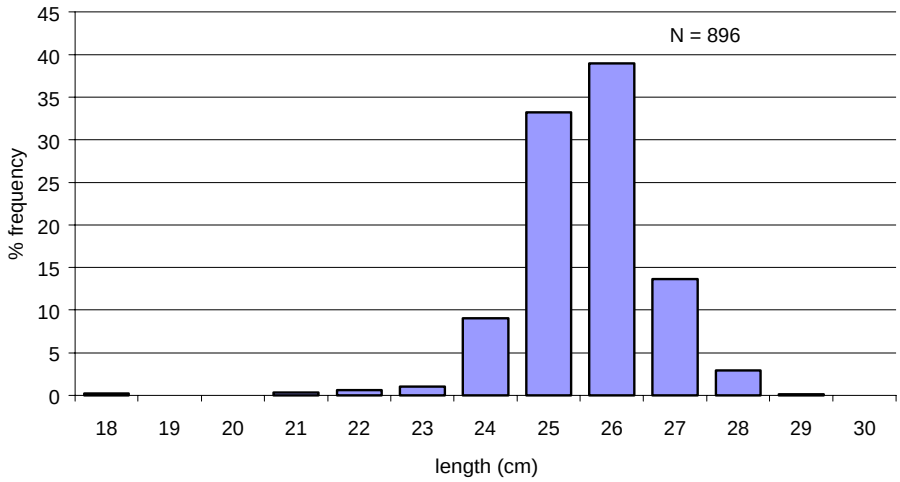

Figure 7. Length frequency for all sardines measured, August 6 – 19, 2003.

A total of 896 fish were measured for fork length. Lengths ranged from 175 mm to 292 mm, with an average length of 255 mm. The majority of fish measured (73%) were between 245 mm and 264 mm, with 95% of the fish measured between 235 mm and 275 mm in length (Figure 7).

Length by area:

Sardine length frequencies were also determined by area (Figure 8). Overall, there was little difference in the length frequency distribution from southern sites (La Perouse, Clayoquot, and Nootka Sound) to northern sites (Kyuquot Sound, Winter Harbour and Triangle Island). The smallest sardines were measured from a Kyuquot Sound sample (2 sardines, each 175 mm), while the largest sardine (292 mm) was sampled from Nootka Sound. The mean lengths at each site were within one standard deviation of the overall mean, and ranged from a high of 258 mm offshore at La Perouse, to a low of 254 mm at Kyuquot Sound.

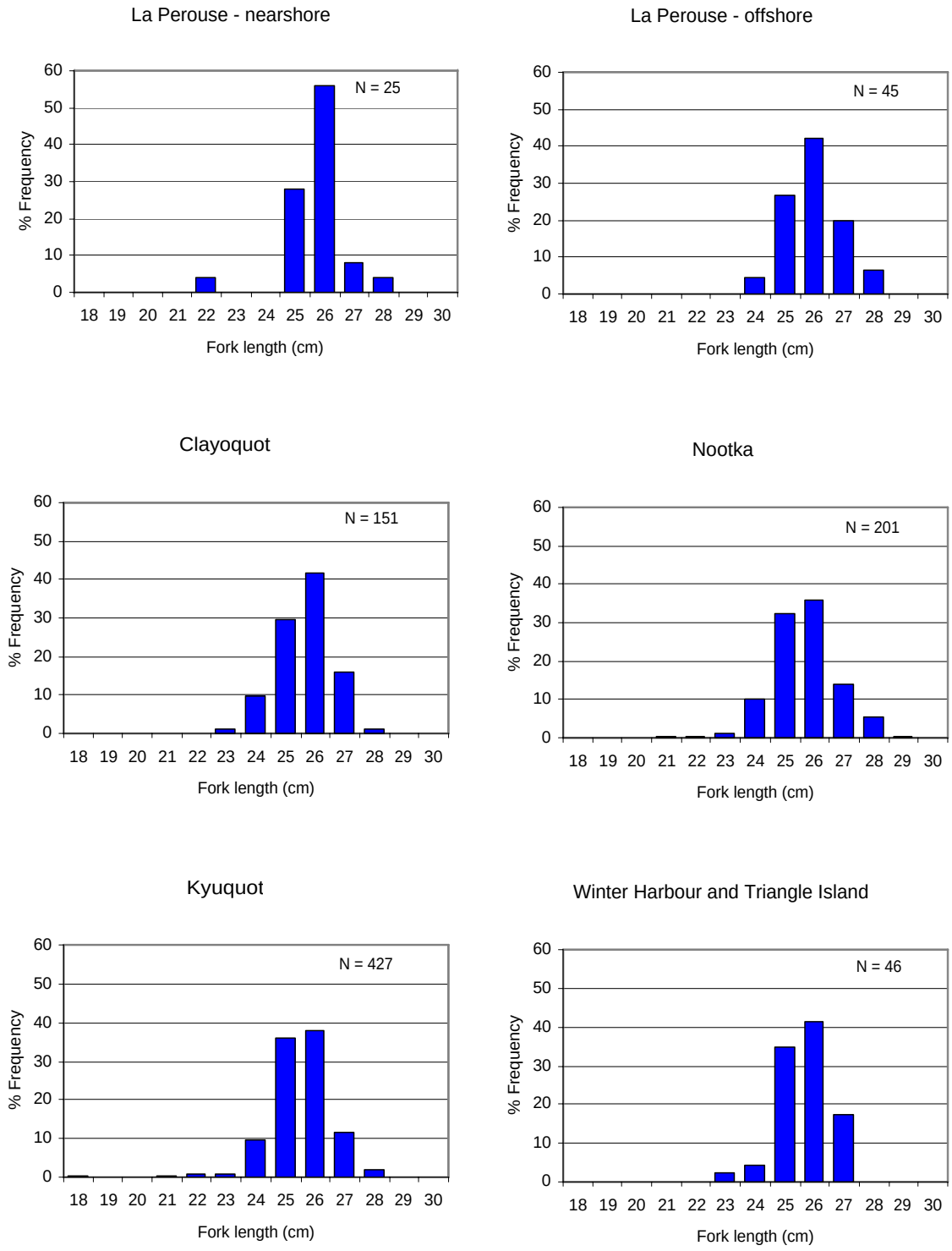

Figure 8. Length frequency by area *Sardinops sagax*, during research cruise 2003-16.

Biomass estimates:

Biomass estimates were calculated from cruises in 1997, 1999 and 2001. Biomass estimates were calculated according to the method described in Beamish et al (2000). The west coast of Vancouver Island was partitioned into 6 major "regions" and total volume was determined to allow biomass estimates to be calculated regionally (Figure 9).

Volume swept during each set was determined by multiplying the area of the mid-water trawl net used during the fishing operations, by the distance traveled during fishing. Minimum and maximum estimates were determined using the 95% Confidence Interval for the calculated average swept volume within each major area. In previous years, sardines were captured from sufficient sets along the west coast of Vancouver Island to estimate abundance in all 6 regions in 1997, 1999 and 2003 and provide an overall estimate for coast wide abundance. In 2003 sardines were scarce, and despite wide coverage of the coast (as shown in Figure 6) were not captured in sufficient numbers to estimate abundance.

Few sardines were captured in area 6 during cruise 2003-16. A total of 90 sardines were captured in 30 sets conducted in area 6. The average number of sardine captured per set was 3 fish for area 6 during this cruise, with an average mass of 0.5 fish per set. Consequently, the estimated abundance for area 6 is extremely low (> 40t).

It is clear that distribution of biomass during summer 2003 changed dramatically from previous years. Almost all the biomass moved directly into the inlets along the WCVI.

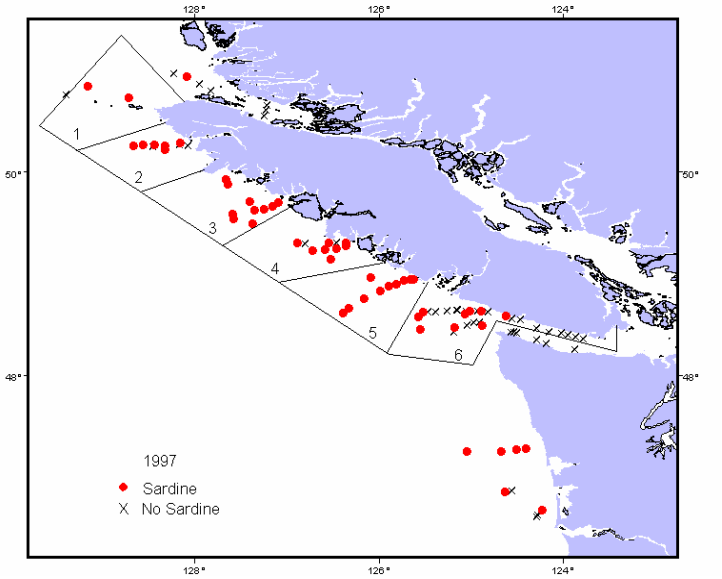

Figure 9. Sardine distribution, sets made in depths 0 – 30m included, abundance estimate cruises (1999, 2000, and 2001)

Table 5. Sardine abundance estimates (Mt), west coast Vancouver Island, 1997, 1999 and 2001.

Year	Area	Total Volume (km^3)	Average Swept Vol (km^3)	Swept Volume 95%Cl	Average # fish per area	Average Mass of fish per area	Total Fish (numbers)	Abundance (Mt) Minimum (ave – 95%Cl)	Average	Maximum (ave + 95%Cl)
1997	1	91.0	0.0039	0.0007	57	9.4	1316578	184.6	217.2	263.9
	2	66.6	0.0042	0.0009	3509	801.0	55589704	7499.4	9172.3	11838.4
	3	119.7	0.0031	0.0016	645	106.7	24662768	2672.8	4069.4	8522.3
	4	83.9	0.0032	0.0012	12696	2154.3	332440542	39454.3	54852.7	89964.5
	5	71.8	0.0028	0.0006	1222	201.6	31372655	4234.3	5176.5	6658.0
	6	127.7	0.0021	0.0004	1521	239.3	93061220	12901.5	15355.1	18961.0
	Total							66947	88843	136208
1999	2	66.6	0.0019	0.0002	1186	194.5	40875249	6146.1	6744.4	7471.8
	3	119.7	0.0020	0.0001	430	70.8	26334474	4126.9	4345.2	4587.9
	4	83.9	0.0019	0.0002	559	91.9	25209905	3774.0	4159.3	4632.3
	5	71.8	0.0017	0.0006	1307	215.7	52665988	6487.3	8689.9	13157.2
	6	127.7	0.0020	0.0005	5262	877.3	330056295	44121.8	55459.3	71123.0
	Total							64656	79398	100972
2001	4	83.9	0.0017	0.0005	4	0.7	98298	12.7	16.2	22.3
	5	71.8	0.0017	0.0002	4	0.6	149410	21.6	24.7	28.7
	6	127.7	0.0017	0.0005	3616	596.8	265598220	33804.2	43823.7	62284.8
	Total							33839	43845	62336

4. IMECOCAL, January survey in South Baja California and Gulf of California.
   Objectives: To estimate spawning biomass of Pacific sardine fin the south Baja California, Mexico and in the Gulf of California and to investigate the migration of Pacific sardine between the Gulf and West of Baja California.

No report.

5. Future plan and Recommendations

Mexico

1. Celia Eva Cotero-Altamirano, Yanira Green Ruiz of INP and Tim Baumgartner of CICESE submitted a proposal to require funding from CONACYT (National Science and Technology council) for ichthyoplankton surveys off Southern Baja California in Pacific Ocean in February-March 2005 between IMECOCAL surveys, to determine the peak spawning season. Yanira has a budget to acquire a 2nd CUFES equipment package for R/V *BIP XII* to conduct survey inside Gulf of California for January 2004.

2. Improve procedures for adult reproductive parameters. Biologists collected adult reproductive samples aboard commercial vessels to obtain fresh gonad samples and preserve specimen aboard commercial fishing boats during April 2003 in Ensenada. Eva will report the results in 2004 Trinational Forum. No discussion on samples from San Carlos Fishery in 2004 to incorporate Cedros Island with laboratory in freezer ship (Bajo Cero).

3. Organize a workshop in August, 2004 in Ensenada on the procedures of implementation of DEPM for 2002 survey data for estimating sardine biomass off Mexico.

Oregon and Washington

It would be valuable to do a acoustic/surface trawl survey from Southern California to Canada in July or August. This would identify the spatial distribution of the sardine population along the west coast. Because during this time period, no spawning is occurring and most are nearshore and on the shelf off Oregon/Washington/BC Canada. Such a survey would also provide information on the relative proportions of the population in each area and age and size distributions. Genetic and morphometric data may also reveal differences between individuals captured at different locations.

Canada

1. Report on estimates of biomass from qualitative in-shore surveys in October 2003. Conduct an inshore survey in spring 2004 for biomass estimate and more accurate estimates of annual migration.

2. Report on minimum biomass estimates for 2002 and 2003 offshore area based on incomplete trawl survey in July-August 2002 and 2003. Continue annual trawl survey in July-August 2004.
3. Propose an ichthyoplankton survey of the WCVI and Nootka Sound in conjunction with Canadian trawl survey in July-August, 2004 if a portable CUFES from SWFSC is available for loan. During this survey, we will attempt to collect CalVET and bongo net tows in addition to trawls.

4. Propose scientific workshops to address specific sardine population related issues in the near future. Recruitment prediction will be included with the original proposal for predictive economic-oceanographic model for sardine biomass estimates. Our goal is to develop a predictive economic-oceanographic-biological model. Tim Baumgartner, Sandy McFarlane, and Don Pepper will take the lead to organize this workshop.

US

1. Following the NW trawl surveys in July 2003, Southwest Fisheries Science Center will conduct a trawl-acoustic survey in February 2004. The surveys can be conducted more efficiently if spotter pilots in Washington and Oregon are able to assist locating fish schools for trawling. Volunteers from Washington and Oregon are needed.

2. Aerial survey by spotter pilots in Oregon and Washington. During 2002 Trinational forum, Darrell Kapp and Ryan Kapp who fish and pack sardines in Astoria indicated about 5 pilots spotting sardines June-September in Oregon and Washington. In addition to inviting spotter pilots to join the July trawl survey to search for fish schools, John Hunter proposed that spotter pilots off NW join the ongoing aerial survey program off California by submitting their logbooks of their flights off Oregon and Washington. One spotter pilot introduced by Kapps is Jerry Mahoney. They indicated that Mahoney knew all the other pilots and could contact other pilots. It would certainly be useful to have an index of sardine abundance for the area off NW.

3. In April, 2004, a statistical design of aerial survey will be conducted off Central California. In addition to the fixed grid that the pilots will be flying over, pilots are also allowed to search over schools freely, similarly to the flying pattern during their routine operation to search for schools for commercial boats. The data from this survey will be used to obtain fishery-independent estimates of recruits, which will be compared with those during routine spotter pilot surveys.

4. A ‘BC to BC’ Coast wide surveys in April, 2005 to obtain estimates of total biomass off American continent from northern Baja California to British Columbia. The working group propose to conduct trawl surveys off NW (Oregon, Washington and WCVI) during April when cruises of CalCOFI and IMECOCAL ichthyoplankton surveys are conducted. Another set of estimates can be obtained for July-August each year without extra ship time.

5. Extend the survey pattern off shore in California water for 2006 tri-annual hake survey conducted by Northwest Fisheries Science Center to obtain trawl samples for sardine.

Report of 2004 regional biomass and recommendations

The 2004 Trinational Sardine Forum was held on November 18th, Large conference room, SWFSC on November 18th after the CalCOFI meeting from November 15-17, at Scripps Institution of Oceanography, UCSD. The format of 2004 Trinational Sardine Forum was different from previous years in that each workgroup presented their reports in this year, problems encountered and future plans in the plenary session, so that ideas could be exchanged among three working groups and the attendees.

1. U.S. surveys

Activities:

1.1 CalCOFI, April cruises, 2004.

Objectives: To estimate spawning biomass of Pacific sardine from Baja California, Mexico to San Francisco, CA, US.

During the 2004 survey, the regular CalCOFI survey was extended to CaCOFI line 60.0 (near Morro Bay) with the *New Horizon* cruise (March 28 - April 9) occupying six regular CalCOFI lines (93.0 - 76.6, 40 nm apart) and R/V *Jordan* occupying 5 lines (73.3 - 60.0), regular CalCOFI survey (April 13 - 25). Bongo samples were taken on regular CalCOFI survey lines only aboard *Jordan* in the north and *New Horizon* in the south. Therefore, the total number of lines occupied by both vessels was 11 lines, 40 nm apart. For *Jordan* cruise occupying the northern 5 lines, CalVET tows were taken at 4 nm intervals on each line after the egg density from each of two consecutive CUFES samples exceeded 1 egg/min. Similarly, CalVET tows were stopped after the egg density from each of two consecutive CUFES samples was less than 1 egg/min. The threshold of 1 egg/min was reduced from the number used in years prior to 2002 (2 eggs/min) to increase the area identified as the high density area and, subsequently, to increase the number of CalVET samples. This adaptive allocation sampling was similar to the 1997 survey (Lo et al. 2001).

The daily egg production of Pacific sardine (*Sardinops sagax*) off California from San Diego to Monterey was estimated to be 0.96/0.05m^2 (CV = 0.24) and the spawning biomass was estimated to be 281639.27 mt (CV=0.3) for an area of 320,619.8 km^2, using the daily specific fecundity (number of eggs/population weight 21.85(gm)/day:

(compared to 23.55 used in the years prior to 2002 and 22.94 from the 2002 cruise). The area, 320,620 km^2 is similar to 365,906 km^2 in 2003. The estimates of spawning biomass of Pacific sardine in 1994 - 2004 are 127,000 mt, 80,000, 83,000 mt, 410,000 mt, 314,000 mt, 282,000 mt, 1.06 million mt, 791,000 mt, 206,000 mt, and 485,000 mt, 300,00 mt respectively. Therefore, the estimates of spawning biomass have been fluctuating and increasing since 1994.

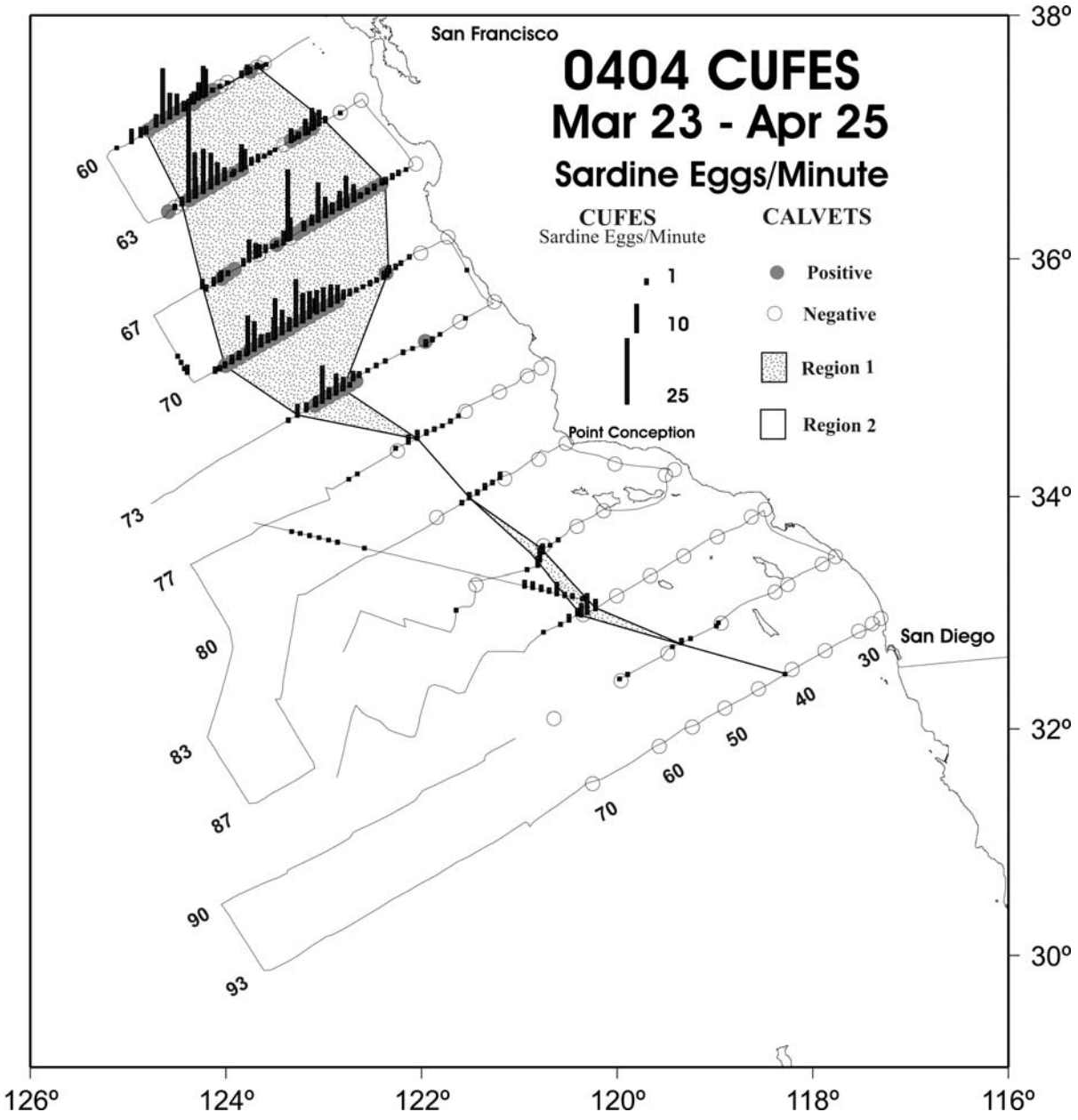

Figure 1. Sardine eggs from CalVET (or Pairovet; solid circle denotes positive catch and open circle denotes zero catch) and from CUFES (stick denotes positive collection) in April 2004 survey. The numbers on line 93 are CalCOFI station numbers. Region 1 is stippled area.

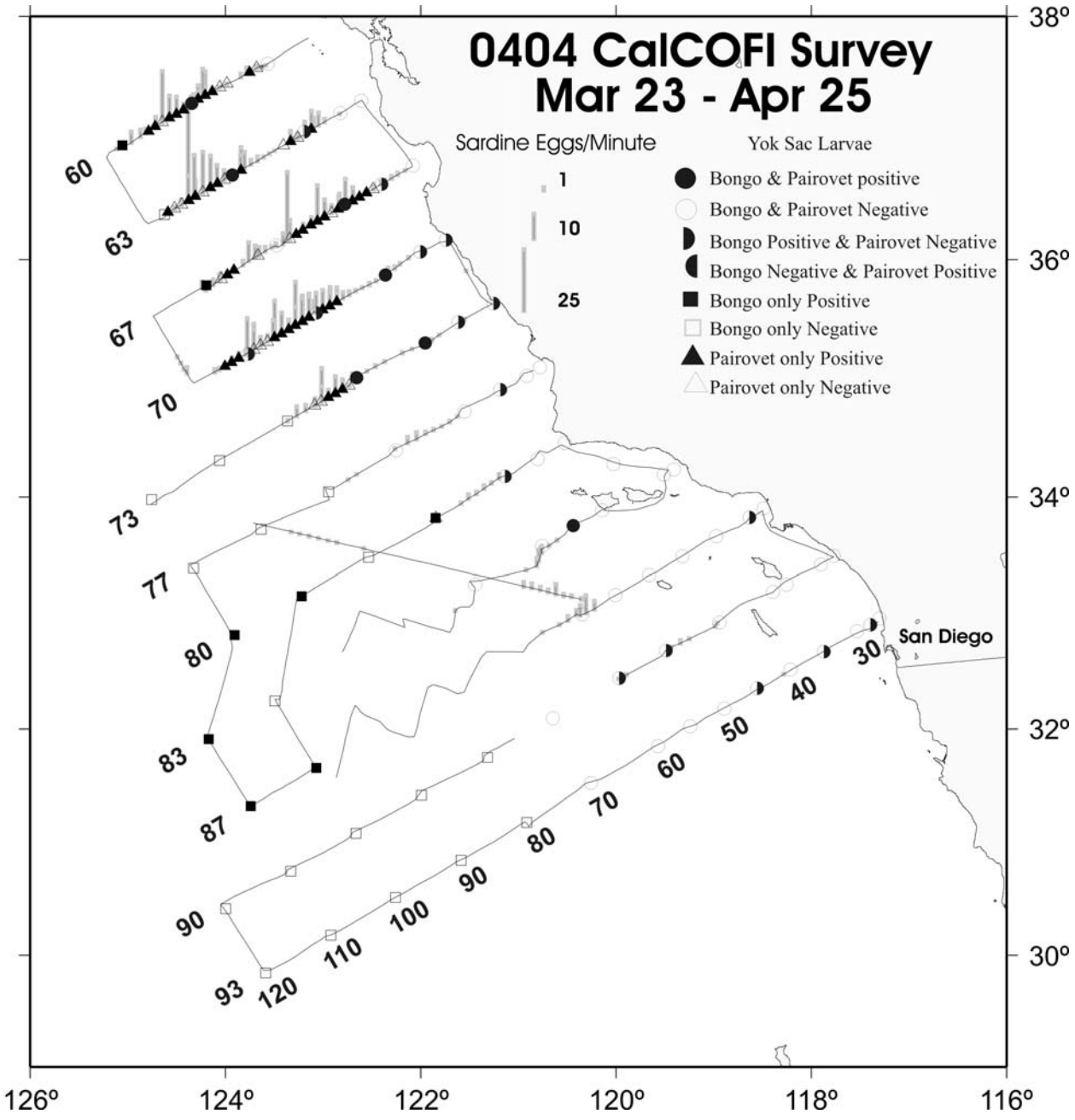

Figure 2. Sardine yolk-sac larvae from CalVET (or Pairovet; circle and triangle) and from Bongo (circle and square) in April 2004 survey. Solid symbols are positive and open symbols are zero catch.

1.2 NW winter (February, March) and summer (July) trawl and acoustic surveys were conducted and 8 out of 59 were positive in March survey, and 27 out of 58 were positive in July survey. 100 out of 684 CUFES collections were positive in July 2004.

1.3 In April, 2004, a statistical designed aerial survey was conducted off Central California. In addition to the fixed grid that the pilots will be flying over, pilots are also

allowed to search over schools freely, similarly to the flying pattern during their routine operation to search for schools for commercial boats. The data from this survey will be used to obtain fishery-independent estimates of recruits, which will be compared with those during routine spotter pilot surveys. As of now, 10 surveys have been conducted. Data are yet to be analyzed.

2. Mexico survey: IMECOCAL

Spawning biomass was estimated for years: 1997-1999 and 2002 as 2662, 59,000, 94,000 and 40,000 mt. The first three estimates were computed sardine larval data and the 2002 spawning biomass was estimated from CUFES egg samples from IMELCOCAL surveys. Data from 0304 and 0404 survey are not ready at the time of writing this report. It was suggested to ship sardine eggs of CUFES collections of IMECOCAL to SWFSC for staging as done for 0304 and 0404 data. Even though no adult samples were taken of Baja California, retrospective estimates of spawning biomass of 2003 and 2004 will be obtained in the near future. Tim Baumgartner will be working closely with Richard Charter and Nancy Lo of SWFSC.

A 2003 proposal to require funding from CONACYT (National Science and Technology council) for ichthyoplankton surveys off Southern Baja California in Pacific Ocean in February-March 2005 between IMECOCAL surveys, to determine the peak spawning season, was not approved. Eva Cotero A did report the Historical reproductive cycle of sardine Monterrey *Sardinops caeruleus* in the western coast of Baja California from 1991-2003. Procedures for adult reproductive parameters need to be improved, e.g. adult samples need to be taken off Baja California.

3. NWFSC Biomass off Northern Oregon and Southern Washington.

Objectives: To estimate spawning biomass of Pacific sardine off Oregon since 1994.

Activities:

3.1 Egg surveys were conducted in 1994-1998 and no egg surveys were conducted in 1999-2004.

3.2. Adult surveys. Since 2001, no off shore survey has been conducted to capture adults in June because locations and timing of the spawning were unknown. Effort was concentrated on near shore trawling surveys off Oregon and Washington:

a) BPA Columbia River plume study: from northern Washington to Newport in May, June, and September.
b) Predator/baitfish study off the Columbia River: night surface trawl surveys off the Columbia River every 10 days from late April through July.
c) Lower Columbia River purse seine survey: every 2 weeks from April through September.

In past years a monthly purse seine study in the Columbia River estuary documented use of the estuary by subyearling and yearling sardines (item c). Vessel problems caused this project to be canceled in 2004. This project is scheduled to occur in 2005.

This section reports the preliminary estimates of biomass of Pacific sardine based on July samples from night surface survey trawls of predator/baitfish study off the Columbia River from Willapa Bay down to Tillamook Head in 1999-2004 (Figure 3). Night surface trawls were conducted every 10 days from late April through July. During each survey, 12 surface trawls were conducted: 6 on 2 lines (Willapa Bay and the Columbia) from 6 distances from shore: 0-10, 10-20, 50-60 km which constitute six strata. The net reached down to 20 meters depth of water. We believe this area has similar hydrographic conditions: dominated by the Columbia River plume, has high Chlorophyll, and evidently higher abundance of sardines than other areas, where fishery is concentrated there. This can be summarized as below:

Two lines (Willapa and Columbia River) were surveyed every 10 days from late April through July since 1999.

Gear – 264 rope trawl – mouth opening of 360 m^2

Estimated representative survey area – 20,000 km^2 (From above Grays Harbor to Cape Falcon – and out ~35 nm).

Total volume (4×10^{11} m^3) within the survey area was calculated using 20 m (depth the net fished) x the survey area.

Sardine population estimates in the Columbia River region (Figure 3) were calculated using volume swept methodology. During each cruise (2 days, 12 trawls) the mean number/m^3 was calculated. Total density in the study area (Figure 1) was calculated by multiplying mean sardine/m^3 by $4*10^{11}$ [area of the study area (20,000 km) x 20 m]. Average weight of sardines captured was calculated from mean length. In 2004, two distinct size classes (Figure 4) were observed so data are presented by size group (small and large) (Table 1).

The biomass estimates for 2004 ranged from 51 mt of small sardines in early July to over 95,000 MT of large sardines in late July/August (Table 1). The wide fluctuations in estimates may be a result of sampling efforts related to very patchy sardine distributions, movements of sardines, or both. The length/frequency data indicate that the small sardines appear to be one-year-olds. Large numbers of 0-age sardines were captured in fall 2003 off the Oregon coast (Figure 5). These 0-age sardines appeared to have overwintered in Oregon/Washington coastal waters during winter 2003-2004. There were no indications that older sardines overwintered. A November 2003 surface trawl survey off Oregon/Washington found no large sardines. Many 0-age sardines were also captured in September 2004 off Oregon (BPA survey). We suspect that these sardine will also overwinter in Oregon/Washington coastal waters during winter 2004-2005.

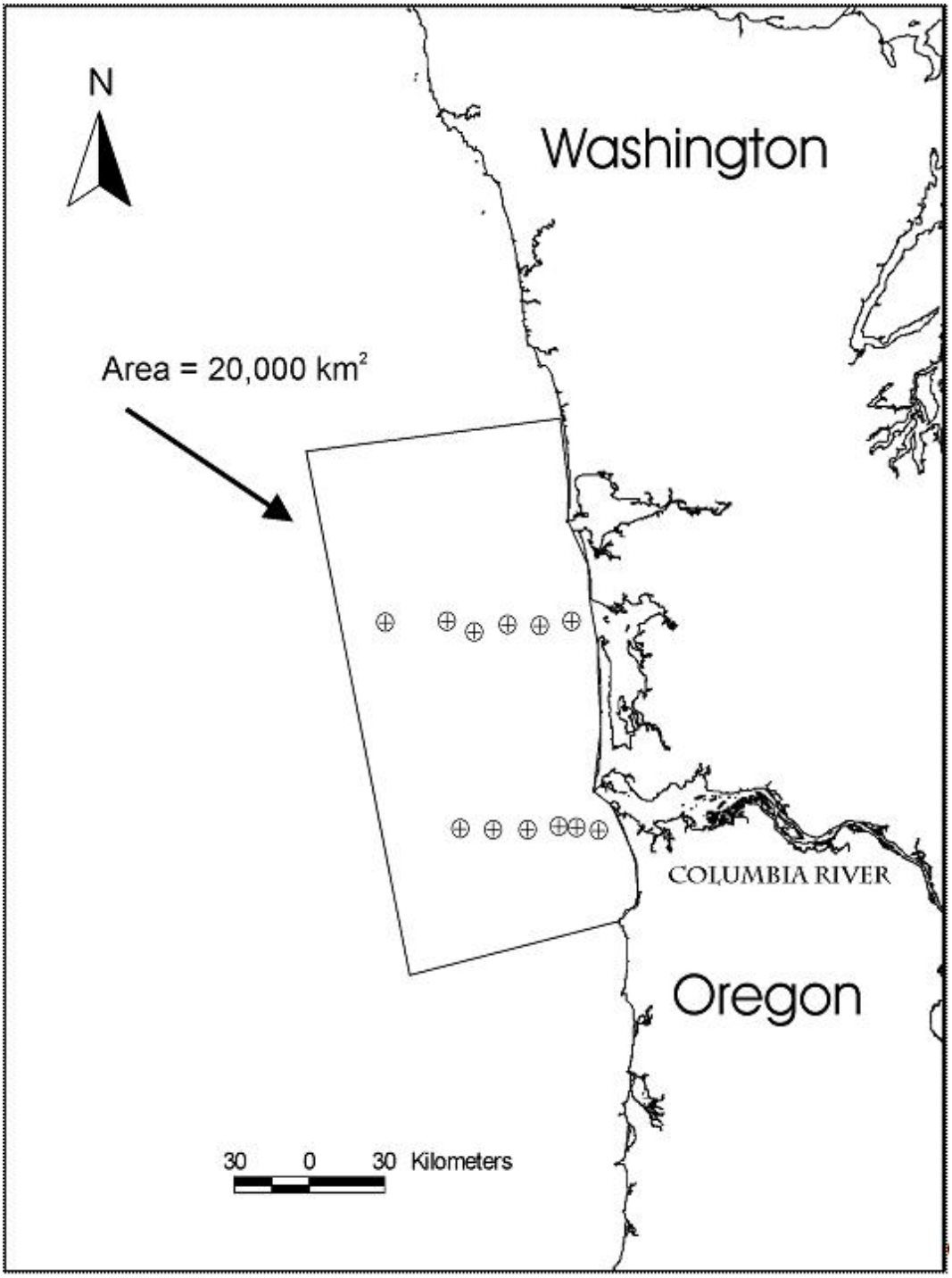

Figure 3. Survey area for Northwest surface trawl survey off Oregon and Washington from April-August, 2004.

The warm ocean conditions in both spring 2003 and 2004 appears to have been very conducive for successful spawning and recruitment of Pacific sardine off the Oregon/Washington coast. We believe that this will be adding significant biomass to the sardine population in the California Current.

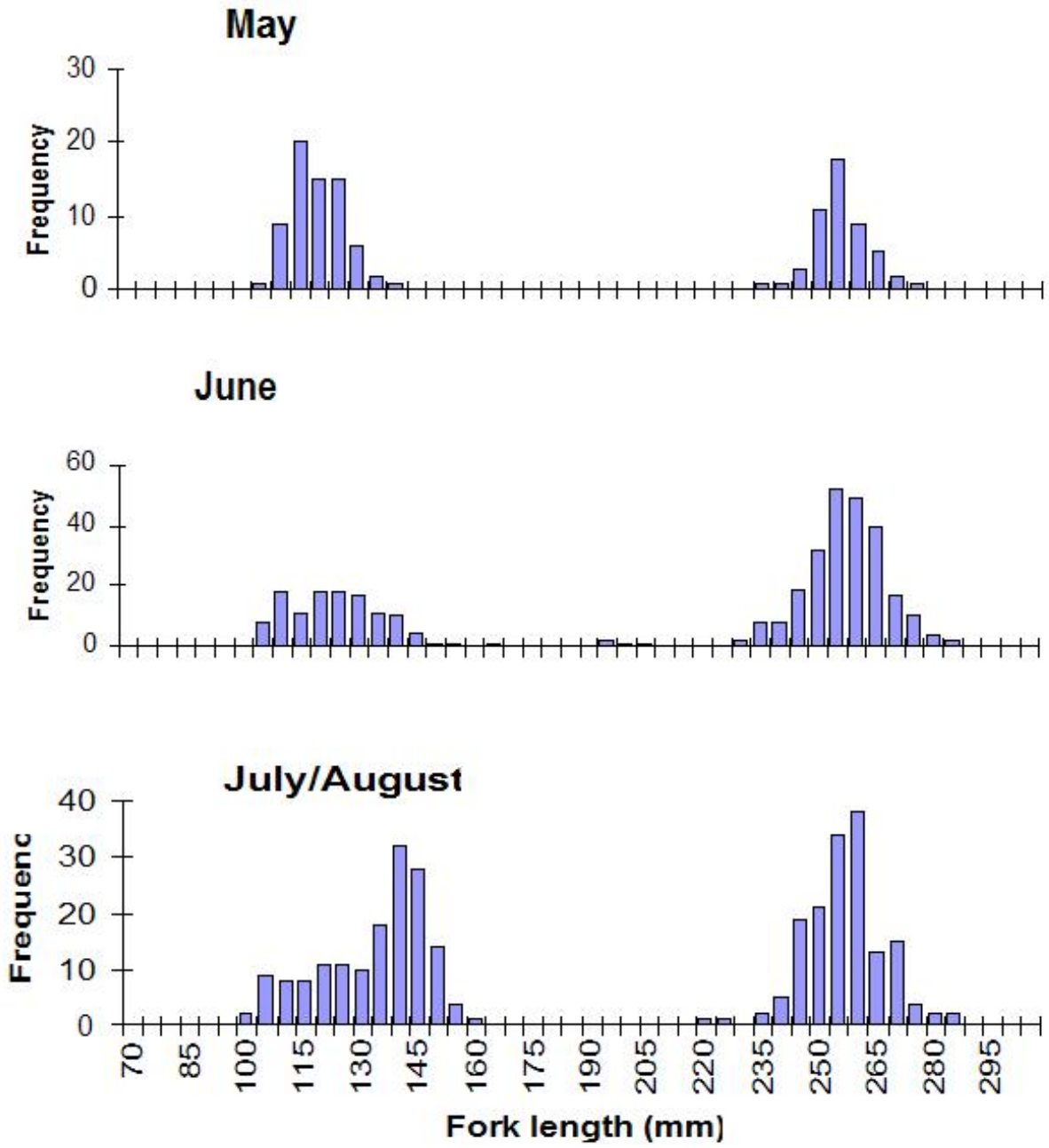

Figure 4. Distributions of fork length of Pacific sardine off Oregon and Washington, April-July, 2004.

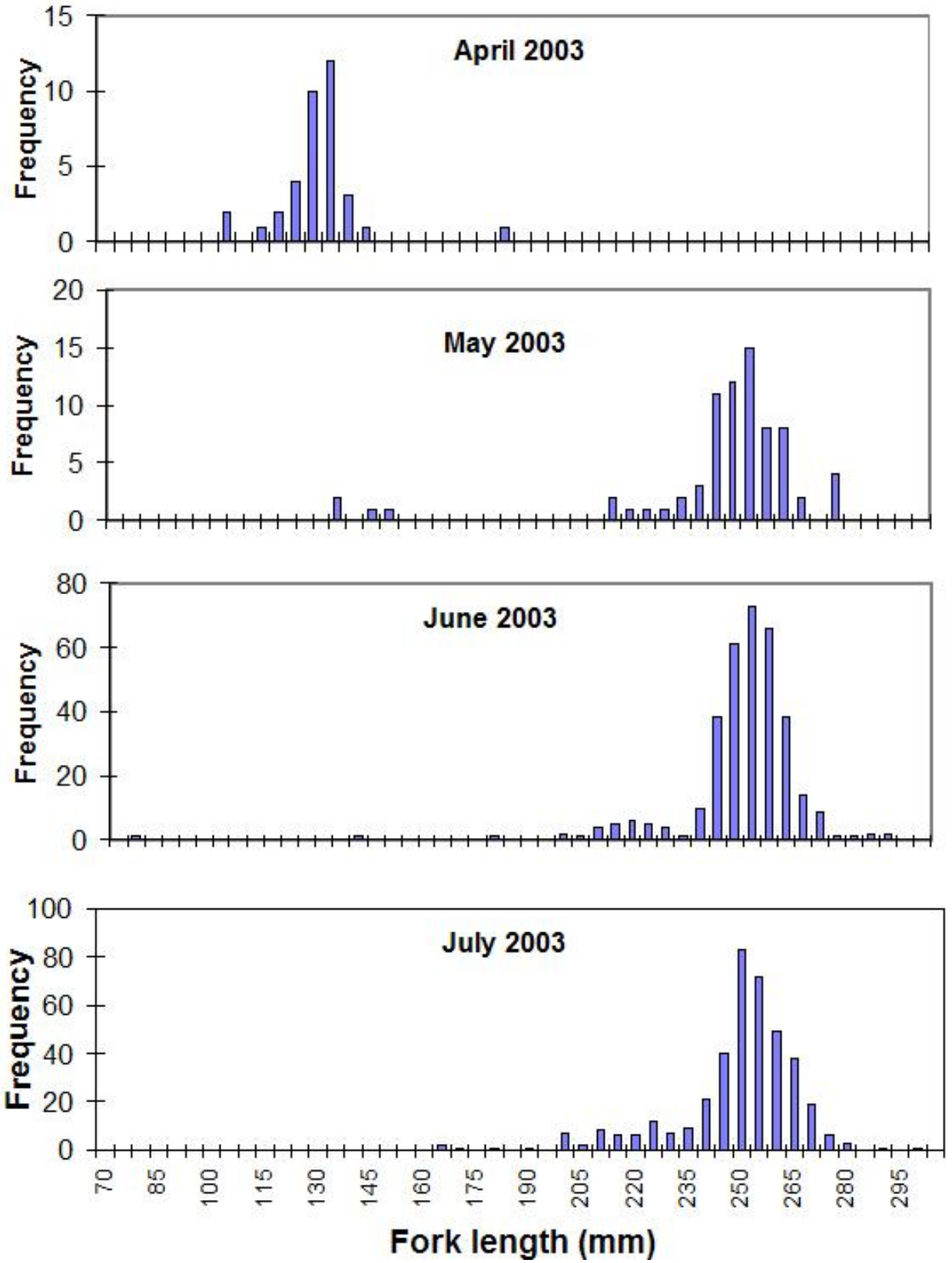

Figure 5. Distributions of fork length of Pacific sardine off Oregon and Washington, April-July, 2003.

Table 1. Summary statistics and estimates of biomass of Pacific sardine from July surface trawl surface off Oregon from 1999-2004

Number of Pacific Sardine off S Wash/N Oregon from July surface trawl surveys

Year	early July	Mid July	Late July
1999	16,738,383	10,282,076	667,488,503
2000	644,545,899	766,670,243	no trawls after 22 July 2000
2001	35,637,249	162,221,196	235,583,259
2002	544,696,457	48,770,214	non taken
2003	26,997,079	2,177,182,868	193,544,001

Average Length of Pacific Sardine

Year	Early July	Mid July	Late July
1999	246	239	235
2000	237	243	
2001	233	241	242
2002	247	247	
2003	251	249	237

Average weight of Pacific Sardine (g) Calculated from average length

Year	Early July	Mid July	Late July
1999	154	143	137
2000	140	149	
2001	133	146	148
2002	156	156	
2003	165	160	149

Biomass of Pacific Sardine off S Wash/N Oregon (metric tons)

Year	Early July	Mid July	Late July	mean
1999	2,585	1,471	91,200	31,751.98
2000	90,129	114,467		102,298.2
2001	4,740	23,612	34,904	21,085.55
2002	85,229	7,607		46,417.95
2003	4,448	542,448	27,049	191,315.3
2004*	7,118	14,561	96,247	39,309
	small/large	small/large	small/large	
*2004	51 and 7,067	7376 and 7,185	1,050 and 95,197	

3.3 Other possible activities

It was suggested in 2003 meeting to conduct an acoustic/surface trawl survey from Southern California to Canada in July or August. This would identify the spatial distribution of the sardine population along the west coast. Because during this time period, no spawning is occurring and most are nearshore and on the shelf off Oregon/Washington/BC Canada, such a survey would provide information on the relative proportions of the population in each area and age and size distributions. Genetic and morphometric data may also reveal differences between individuals captured at different locations. Derrel Kapp would prefer a survey from BC to BC in summer to a survey in spring (April) as proposed in 2003 forum. However, based on observation from Derrel and Ryan Kap this year, sardine have been spawning from the end of May to first part of June. They believe that survey in July may not be a good idea. As mentioned by Bob Emmett at the last Trinational sardine forum, lots of juvenile fish (recruits) were off the Columbia River and Oregon. Fishermen experienced the same phenomena: net with larger mesh size had these fish gill caught in them were problematic and thus fishermen stayed away from catching these fish. As fish grow bigger, September turned out to be a better month for fishing sardine.

As to conducting any aerial survey by spotter pilots in Oregon and Washington, Darrel Kapp indicated that the spotter pilot did not see much fish in the North, even though sometimes, the boats are loaded with fish. As a result, Darrel thinks that the spotter pilot index may work in California but may not in the NW.

4. Canadian Trawl surveys

Objectives: To provide information on the distribution of presence and absence of Pacific sardine (*Sardinops sagax*), biological parameters, and feeding behavior and to estimate a minimum biomass of Pacific sardine off Vancouver Island from July cruise each year since 1996.

Activities:

This report summarizes sardine data collected during a research cruise conducted from July 21 to August 2, 2004. Over 30 research cruises have obtained sardine samples since 1992. This is the 5th survey directed at estimating abundance in offshore waters along the WCVI. The Pacific sardine disappeared from Canadian waters in 1947 (McFarlane and Beamish, 2001), and were absent until 1992 (Hargreaves, Ware and McFarlane, 1994). From 1992 until 1995 sardines were captured in limited numbers in research and commercial fisheries, but were not found in spawning condition off the west coast of Vancouver Island until 1997 (McFarlane and MacDougall, 2001). Juvenile sardines first became a common component of the Vancouver Island surface water community in 1998 (McFarlane and Beamish, 2001), and since then have been captured throughout Vancouver Island waters.

From 1997 to 2000, sardines were captured in cruises during February, March and April, and June to November, although the majority of sardines were captured between June and August. From 1997 to 1999 sardines were found in the Juan de Fuca Strait, and as far north as the east coast of Queen Charlotte Islands. In 1998 sardines were also found on the east coast of

Vancouver Island and in the southern Strait of Georgia. The sardine distribution in 2000 was concentrated on the west coast of Vancouver Island, and ranged as far south as Barkley Sound, and as far north as mainland British Columbia, north of Vancouver Island. From 2001 to 2003 sardine distribution became progressively concentrated near shore along the southwest Vancouver Island coast, and progressively less prevalent in research cruises. By 2004, sardines were rarely captured offshore or along the research grid; however, large catches of sardines have been made in inlets and in the shallows along the west coast of Vancouver Island.

Research cruise 2004-19 was carried out aboard the R/V *W.E. Ricker*, and all fish were captured using a model 250/350/14 mid-water rope trawl (Cantrawl Pacific Ltd., Richmond, British Columbia). Fish were measured for fork lengths, and were recorded to the nearest millimetre.

From July 21 to August 2, 2004, a total of 96 sets were made in surface waters (≤45 m) off the west coast of Vancouver Island (Figure 6). Of these, 10 sets contained sardines. Virtually no sardines were captured in the outside waters of the WCVI. A few sardines were captured offshore in the Barkley Sound area, but were only found near shore and in inlets in all other areas (Figure 6). The largest catches of sardines were made in Kyuquot Sound (set 71, 1852 kg), Nootka Sound (set 39, 3174 kg), Clayoquot Sound (set 37, 452 kg) and Amphitrite (set 31, 3401 kg). All other sardine sets captured small numbers of sardines, ranging from 1 fish to 17 kg of fish. Recent information from the fishery indicates large concentrations of sardines were present in all inlets off the WCVI.

Biomass estimates were calculated from cruises in 1997, 1999 and 2001: 85,993, 72,080, and 43,5845 mt respectively. Biomass estimates were calculated according to the method described in Beamish et al. (2000). The west coast of Vancouver Island was partitioned into 6 major "regions" and total volume was determined to allow biomass estimates to be calculated regionally (Figure 6). Volume swept during each set was determined by multiplying the area of the mid-water trawl net used during the fishing operations by the distance traveled during fishing. Minimum and maximum estimates were determined using the 95% Confidence Interval for the calculated average swept volume within each major area. In previous years, sardines were captured from sufficient sets along the west coast of Vancouver Island to estimate abundance in all 6 regions to provide an overall estimate for coast wide abundance. Biomass estimates have not been completed for recent years, as the numbers of sardine captured and the distribution of offshore catches preclude obtaining meaningful results. This year was similar to 2003 in that few sardine were captured in open waters, mainly found near the coast and in the inlets. Thus it appears that at least for the last two years sardine have changed their summer distribution patterns.

At this point, just under 4,000 mt have been landed with some catch taken from all of the inlets but the majority (~85%) coming from the northern portion of the west coast of Vancouver Island, Nootka Sound and Kyuqot Inlet. Although market preference was for smaller sardines most of the inlets contained fish averaging about 250 mm in length. A small number of sardines were again found during a juvenile herring survey in east Higgins Passage in the Central Coast of British Columbia.

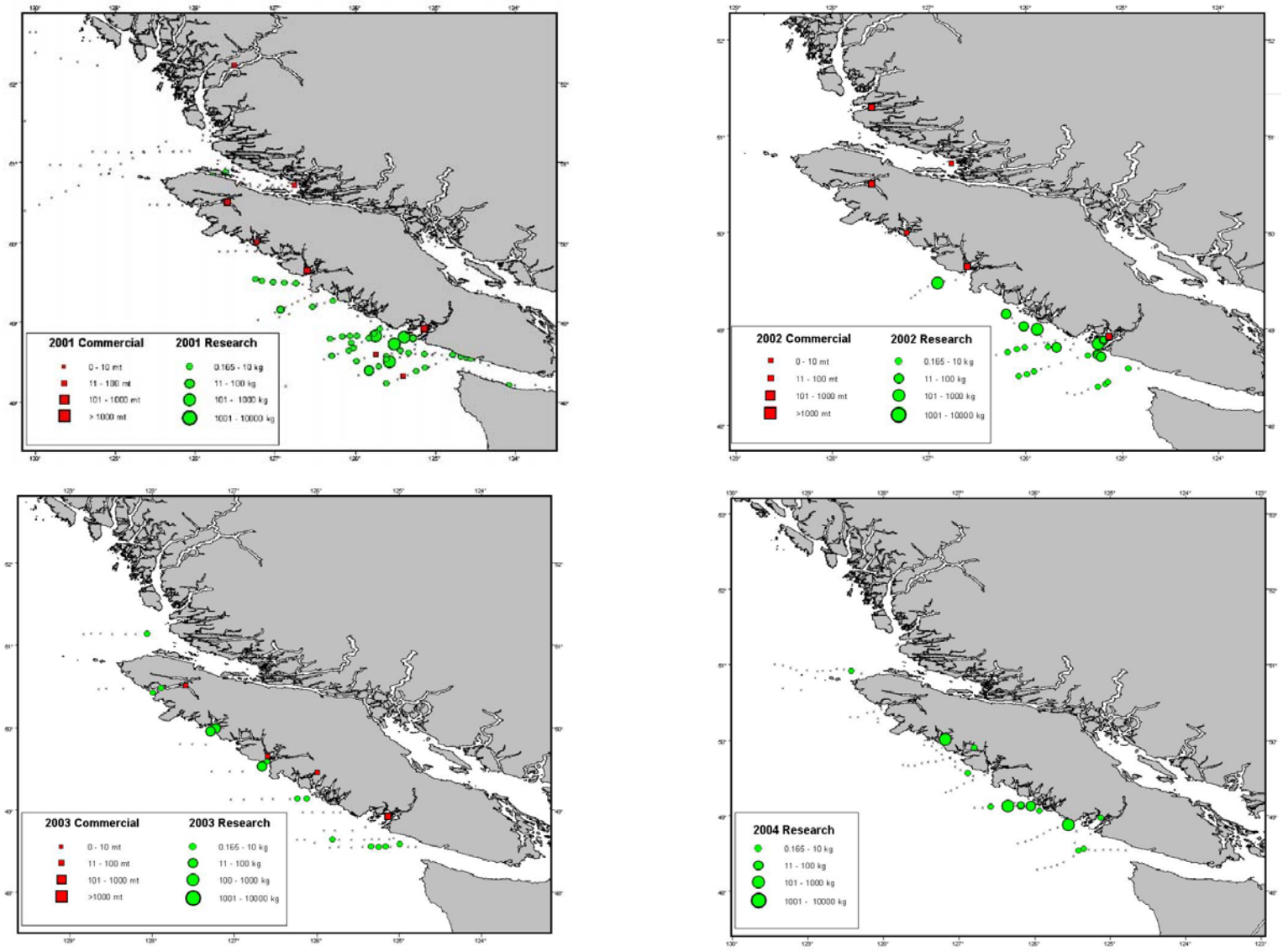

Figure 6. Distribution of relative abundance of sardine in trawl research surveys 2001-2004 off the west coast of Vancouver Island (Green = Research catch; Red = Commercial catch).

Biological data:

Table 2 summarizes other species captured in association with sardines.

In general, salmon species, particularly pink salmon (*Onchorhycus gorbusha*), coho salmon (*Onchorhynchus kisutch*), chinook salmon (*Oncorhynchus tshawytscha*), and sockeye salmon (*Oncorhynchus nerka*) were commonly captured with sardines. Other species found in sardine sets included jack mackerel (*Trachurus symmetricus*), chub mackerel (*Scomber japonicus*), and spiny dogfish (*Squalus acanthias*). Two small wolf eels (one in set 40 and one in set 60) were also captured along with sardines.

Biological samples obtained from sardines during cruise 2004-19 are summarized in Table 3. Lengths were obtained more often than any other measurement, but some stomach and otolith samples were collected as well, for in-lab analysis at a later date.

A total of 667 fish were measured for fork length. Lengths were very similar to those obtained for 2003, and ranged from 143 mm to 292 mm, with an average length of 256 mm. The majority of fish measured (72%) were between 250 mm and 270 mm, with 91% of the fish measured between 235 mm and 275 mm in length (Figure 7).

Length by area:

Sardine length frequencies were also aggregated into northern sets and southern sets for comparison of length by area. Overall there was a trend of smaller sardines captured in southern sites (Kyuqot Sound (LaPerouse, Barkley Sound, Clayoquot Sound and Nootka Sound), compared to those captured in northern sites (Kyuquot Sound). The smallest sardines were measured from a Clayoquot Sound sample (2 sardines, each 143 mm from set 35), however, the largest sardines (two at 292 mm, set 39) were also sampled within the southern area, in Nootka Sound. The mean length for south sites was 255 mm, while the mean length for north sites was 261 mm.

Summary of Pacific sardine, *Sardinops sagax*, eggs found in BC Coastal waters.

During the 2004 sardine survey on the *H.M.V. W.E. Ricker*, CUFES was deployed on the transects lines that were covered for the usual surface trawl survey on the west coast of Vancouver Island from July 26 to August 3, 2004. Due to a shortage of man-power, CUFES was only operated during fishing hours. The survey looked for presence/absence of sardine eggs and a total of six sample jars were collected from the survey, covering the entire west coast of Vancouver Island. Each sample represented one of the sardine sectors identified for biomass estimation and included from 1-2 days of continuous CUFES operation. All eggs collected by CUFES were retained. Preliminary analysis indicates that CUFES did not encounter any sardine eggs or larvae during this period of operation.

We also conducted plankton surveys off the west coast of Vancouver Island during 2004. During a May/June survey, sardine eggs were found in seven bongo tows. In the July/August survey, sardine eggs were found in one bongo. In a September survey, sardine eggs were found in two bongo tows. Eggs were first identified by Moira Galbraith (IOS) and confirmed by Morgan Busby, Alaska Fisheries Science Centre, Seattle.

Table 2. Species associated with sardine catch (in kg), Cruise 2004-19, July 21 – August 3, 2004.

Set	Sardine	Coho	Chinook	Sockeye	Chum	Juvenile salmon	Jack Mackerel	Chub Mackerel	Dogfish	Herring	Wolf Eel	Whitbait Smelt	Sandlance
7	0.234	56.14	4.34				332.44						
8	0.392	78.6	21.28				397.52						
28	6.48		2.78			0.698							
31	7500		23.3	7.94		0.044			102.96				
32	0.802	8.26				0.420							
35	16.88			1.82		1.001				0.386			
37	462.02	45.4	19.64	7.3						0.124		trace	trace
39	7000							0.224	56.78				
40	0.232	17.26				0.809					0.064		
52	0.203	14.28				0.040							
60	1.087					2.220			15.5		0.094		
71	1851.94	0.99			4.1								

Table 3. Summary of biological samples obtained from sardines by set during research cruise 2004-19, July 21 – August 3, 2004.

Year	Set	# fish sampled	Otoliths	Stomach	Length	Sex	Weight	Maturity
2004	31	150	50	28	150	150	150	150
2004	32	4			4	4	4	4
2004	35	107	50		107	107	107	107
2004	37	100			100	100	100	100
2004	39	250	50		250	250	250	250
2004	40	1			1		1	
2004	52	1			1	1	1	1
2004	60	5			5	5	5	5
2004	71	150	50	25	150	150	150	150

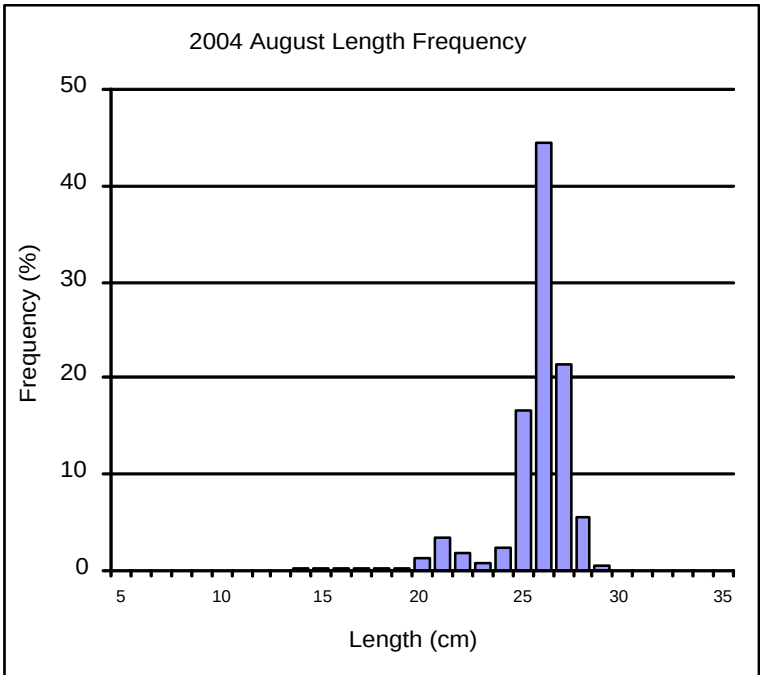

Figure 7a. Sardine length frequency during research cruise 2004-19.

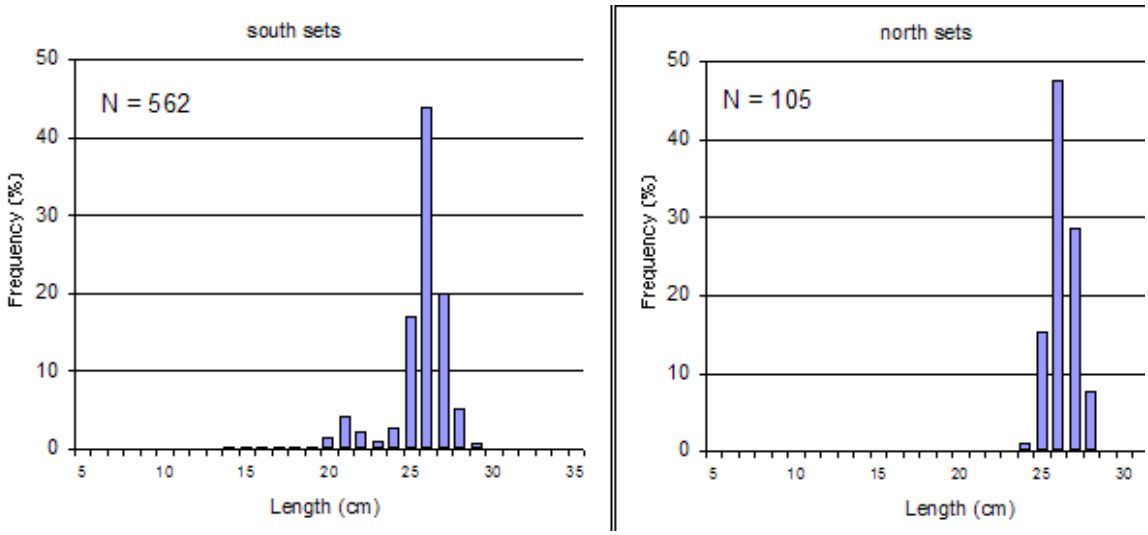

Figure 7b. Sardine length frequency by area during research cruise 2004-19.

5. IMECOCAL, January survey in South Baja California and Gulf of California.

Objectives: To estimate spawning biomass of Pacific sardine fin the south Baja California, Mexico and in the Gulf of California and to investigate the migration of Pacific sardine between the Gulf and West of Baja California.

No report.

6. Future Plans and Recommendations

Mexico

1. Ichthyoplank samples will be taken but no budget to collect adult samples. Research vessel BIP XI will be available for taking trawl samples but there is no budget to operate the vessel. One possibility is for US to charter this vessel to collect trawl samples, in particular for the coast wide survey (from BC to BC) in 2006.

2. IMECOCAL CUFES samples need to be sorted and identified for fish eggs.

3. Retrospective estimates of spawning biomass of sardine off Baja California of 2003 and 2004 are needed.

4. The allocation of quota of commercial catch based on the stock assessment of Pacific sardine conducted is currently determined by U.S. scientists of SWFSC. Mexican scientists at the meeting voiced the need for better communication and collaboration between US and Mexican scientific groups, so that information from Mexican water can be incorporated. A bilateral meeting was suggested to deal with the stock assessment, in particular, the quota allocation

Canada

1. A scientific workshop was again proposed to address specific sardine population related issues in the near future. Recruitment prediction will be included with the original proposal for predictive economic-oceanographic model for sardine biomass estimates during the industry panel discussion so that fishery agency can assist fishermen to look for hot spot. The goal is to develop a predictive economic-oceanographic-biological model. Hopefully Tim, Sandy and Don will take the lead to organize such a workshop in 2006.

2. Conduct surveys in inlets/estuaries.

3. Egg identification and data analysis for CUFES surveys.

US

1. A ‘BC to BC’ Coast wide surveys in April, 2006 to obtain estimates of total biomass off American continent from northern Baja California to British Columbia. The working group propose to conduct trawl surveys off NW (Oregon, Washington and WCVI) during April when cruises of CalCOFI and IMECOCAL ichthyoplankton surveys are conducted. Another set of estimates can be obtained for July-August each year without extra ship time.

2. Extend the survey pattern off shore in California water for 2005 bi-ennial hake survey conducted by Northwest Fisheries Science Center form Point Conception to Canada to obtain trawl samples for adult sardine during night time and sardine eggs using CUFES and CalVET nets. NW center may have time after hake survey is over to take some trawls for sardine and anchovy.

3. Continue NW trawl-acoustic surveys in February-March in 2005.

4. Organize a workshop to evaluate NW trawl surveys conducted by SWFSC and to discuss coast-wide survey to consider other survey methods like LIDAR, acoustic, and proper time to do the survey.

5. During DEPM survey in April 2005, it may be possible to ask CPS observers to collect adult samples (March-May) in S Cal Bight and Monterey to increase sample size.

6. Need to collect adult samples in area with low density of eggs during the DEPM survey.

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