RED SEA URCHIN ASSESSMENT SURVEYS

DISTRICTS 101, 102, AND 104

2001

By

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and

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ABSTRACT

A population assessment survey was conducted in portions of commercial fishing Districts 101, 102, and 104 in Southeast Alaska to estimate red sea urchin biomass and size distribution in 2001. The survey was conducted by ADF&G divers during July and August 2001 in five subdistricts that were subsequently opened to commercial fishing (101-29 experimental, 102-20, 102-50, 102-70, and 104-30 experimental). Commercially available red urchin biomass estimated during this survey was 12.1 million kg (26.6 million pounds). Total red urchin biomass for all areas of Southeast Alaska opened to commercial fishing is estimated at 58.3 million kg (128.8 million pounds) with a 90% lower confidence bound of 36.9 million kg (81.6 million pounds). In addition, two control sites (101-27 and 104-30 control) were surveyed, but not opened to commercial harvest. Control site biomass (combined) is estimated at 2.9 million kg (6.5 million pounds). Subdistrict 102-10 was surveyed to record evidence of near total elimination of the red sea urchin population since last surveyed in 1998.

INTRODUCTION

Red sea urchin surveys are usually completed by district once every three years. Typically annual district groupings have been 101, 102, and 103/104. However, this is not a rigid schedule and subdistricts from non-scheduled districts are often included in a year, particularly control or experimental areas, which require more intensive surveying. During 2001, red sea urchin assessment surveys focused on District 102. This was the third year, since red urchin assessment commenced in 1994, that surveys were conducted in District 102. Additionally, experimental and control areas were surveyed in District 101, near Ketchikan, and District 104, near Craig (Figure 1).

Subdistricts 102-10, 102-20, 102-50, and 102-70 were previously surveyed in 1995 and again in 1998. By regulation, commercial red sea urchin fisheries in Southeast Alaska can only be conducted within three years of the latest biomass survey; hence, surveys were required in 2001 prior to allowing a commercial fishery in these areas during the 2001–2002 season.

Annual surveys of experimental sites in Subdistricts 101-29 and 104-30 continued with the intention of further improving estimates of the biomass of red urchins along shorelines of Baker, Suemez, and Dall islands in commercial fishing Subdistrict 104-30 and along the shoreline of West Gravina Island in 101-29. Another goal of surveys in these areas is to observe population response to a higher level of exploitation (20% harvest rate instead of 6%). Subdistrict 101-29 has been previously surveyed in 1995, 1997, 1998, 1999, and 2000. Subdistrict 104-30 was surveyed each year during 1996–2000 (Larson and Woodby 1997; Larson et al. 1998; Hebert and Larson 1999; and Hebert and Larson 2000) but prior to the survey in 1997 the subdistrict was divided into an experimental fishing portion and a fishery evaluation control area. Additional transect pairs were added to experimental and control areas to improve the precision of biomass estimates. A second control area, Subdistrict 101-27, has been surveyed all years for the period 1997–2000. All experimental and control areas will continue to be surveyed annually to closely monitor population response to fishing pressure and environmental variability.

It is the policy of the Alaska Department of Fish and Game, Southeast Region, to provide for the development of new fisheries only when new funding sources are made available. This policy was adopted to prevent the reallocation of staff and other resources from established fisheries. Red urchin stock assessment and research conducted during 2001 was funded through a Nearshore Marine Fisheries research grant provided to ADF&G through the National Oceanic and Atmospheric Administration (NOAA). The Division of Commercial Fisheries received the federal Nearshore Fisheries grant to fund surveys and research on red and green urchins in Southeast Alaska for the period July 1, 1999 through June 30, 2002.

Significant geographic expansion of the red urchin fishery is not anticipated. Through observations made during surveys of other species, density of red urchins are low in subdistricts not currently in the rotation of assessment surveys, hence there were no new areas surveyed in 2001. The increasing geographic range and abundance of sea otters following their reintroduction in Southeast Alaska in the mid 1960s (Pitcher 1989) has dramatically reduced the extent of commercially viable populations of red sea urchins on the outer coast.

METHODS

The *R/V Sundance* was used as support vessel for all biomass assessment surveys in 2001. Surveys were conducted using six divers and two skiffs. Red urchin assessment of selected subdistricts were done concurrently with sea cucumber assessments.

Biomass Estimates

Urchin biomass was calculated as the product of estimated population size and the average mass of urchins for each subdistrict. The calculations begin with estimates of urchin population densities made by scuba divers counting urchins on meter-wide transect pairs.

Shoreline Density Estimates

Shoreline transects were paired and the location of each transect pair was systematically distributed along the shoreline in each subdistrict (Figure 1). The distance between transect pairs was equal to the total shoreline length divided by the number of transect pairs in each subdistrict. The first transect pair in each subdistrict was located randomly in the first distance interval at one boundary of the subdistrict. All transect pair locations were marked on nautical charts for operational use during the surveys (Figures 1-9); latitudes and longitudes in Appendix 1). Transects within a pair were separated by 5 to 10 meters, with each diver on a team taking a census count of one of the paired transects while descending from shore. Transects extended from zero to 10 m depth (33 ft below mean lower low water, MLLW, corrected for tide height), 12.2 m (40 ft), 15.25 m (50 ft), or 17.1 m depth (56 ft) oriented perpendicular to shore. Reference dive depths were adjusted according to what depths red urchins commonly occurred in a particular geographic location (Table 1). Typically the vast majority of urchins occur above 10 m MLLW (ADF&G unpublished data), however significant numbers are observed deeper in exposed coastal areas

(e.g. Subdistrict 104-30). Once a reference depth was established for a subdistrict, surveys were completed to that depth for all transects, where possible. Transect length varied depending on bottom slope. During past surveys, dives were limited to 10 meters below MLLW mainly for safety concerns, however if urchins were observed below 10 meters depth, then dive depths were increased to 15 m at the discretion of the divers. The adjustment in methodology in 1999 to systematic deeper surveys is an attempt to recognize that the red urchin population is naturally shifted to deeper water in areas exposed to direct ocean swell and surge.

Two divers swam parallel to one another on each transect pair, with each diver holding a meter rod (2.1 cm diameter white plastic pipe) in a horizontal position, perpendicular to the census path. Transect direction was maintained by reference to a compass mounted on the rod. Each diver counted the number of sea urchins seen under the rod, and wrote the count on the slate attached to the rod. Only urchins larger than 59 mm were counted and urchins near this size class boundary were checked against a 60 mm long mark on the plastic rod (Appendix 2). The beginning and ending times for each transect were recorded to allow for standardization of depths to MLLW. Divers also recorded data on substrate, vegetation, and the presence of other species of interest.

Average density, $\bar{d}$, was estimated in units of urchins per meter of shoreline length for each subdistrict:

$$\bar{d} = \left(\frac{\sum_{t} \Sigma c_i / m}{n_t} \right), \tag{1}$$

where c is the count of sea urchins ≥ 60 mm diameter on each transect i for i = 1 to m (m is at most 2 transects per pair), and n_t is equal to the number of transect pairs.

Shoreline lengths in each subdistrict (Table 2) and previously reported by Hebert and Larson, 1999; Larson et al. 1998; Woodby et al. 1996; Woodby and Larson 1996; and Larson and Woodby 1996 were measured with a hand held map wheel, dividers on the largest scale nautical charts available (usually a scale of 1:40,000), or using ArcView (ESRI 1998) GIS computer software using digitized NOAA Nautical Charts. Shoreline was measured as that shoreline of non-closed areas which was deemed to be urchin habitat. Shoreline lengths for the research control area and experimental fishing area in 104-30 were measured as 43,874 m and 71,505 m, respectively.

Urchin Sizes and Weights

Average size of urchins was estimated for each area to convert densities to biomass and to monitor changes in urchin size. Urchins were collected from at least one sample depth chosen arbitrarily on each transect pair. Divers chose a location and collected all visible urchins surrounding the sample location until 30 urchins were obtained. When urchins were scarce, divers had to search for urchins outside of the chosen depth. Urchins were placed in mesh bags with a buoyed line extending to the surface. Bags were retrieved by the tender in the dive skiff.

Outside test (shell) diameters were measured to the nearest millimeter with calipers, excluding the spines (Appendix 3). If conditions permitted, urchins were measured immediately aboard the skiff and returned to the general area from which they were removed.

Average mass (g) was estimated from average test diameter (mm) for each area using the relationship:

$$\text{mass} = 0.00124 \text{ x diameter}^{2.696}. \quad (2)$$

Equation 2 was estimated from 113 urchins sampled from the test fishery in District 1 on December 20, 1995 using a log transformed regression (Woodby et al. 1996). The equation was applied to each urchin sampled for size.

The average mass (W_t) for each subdistrict was estimated as:

$$\overline{W_t} = \left(\frac{\sum_{j=i}^{\Sigma w_i / \Sigma o_i}}{n_j} \right), \quad (3)$$

Where w_i is the estimated weight (based on Equation 2) of all urchins in sample i, o_i is the count of all urchins greater than 60 mm in the sample, and n_j is the total number of weight samples taken in subdistrict j.

Population Size and Biomass

The population size of urchins ≥ 60 mm diameter in each subdistrict was calculated as the product of average density (urchins per meter of shoreline) and the total available habitat (meters of urchin-compatible shoreline).

Total biomass (b) for each subdistrict was calculated as:

$$b_j = \bar{d}_j W_j l_t, \quad (4)$$

where l is the length of shoreline in a subdistrict. The lower bound of the biomass estimate was calculated as the percent precision (Equation 5) times the biomass.

A sample goal of 15 to 25 transect pairs was established for each subdistrict. This sample size was expected to achieve 60 to 70% precision (defined in Equation 5 below) based on information from prior urchin surveys. This sampling goal is greater in experimental and control areas to increase the precision of the estimate. In non-control areas where precision from past surveys fell below the target, the number of transect pairs was increased to between 18 and 35. The certainty in the estimate of biomass is expressed as the percent precision in Table 2. The index is equal to the lower bound of the one-sided 90% confidence interval expressed as a percent of the average biomass:

$$\text{Percent precision} = 100 \left(1 - t_\alpha \frac{SE}{\bar{b}_j \sqrt{n_j}} \right), \quad (5)$$

where t is the t-value from Student's distribution for a one-sided interval with significance level $\alpha = 10\%$, SE is the standard error of the biomass among n transect pairs (Table 2). The t-value is approximately 1.32 to 1.38 for the various subdistricts.

RESULTS AND DISCUSSION

The biomass estimate for commercial harvest areas surveyed in 2001 is 12,067 metric tons (13,304 short tons). The 90% lower bound estimate of biomass is 8,106 mt (8,937 st). Of the total biomass estimated for commercial areas, 4,154 metric tons were estimated for non-experimental District 1 areas and 4,979 mt were estimated for experimental (20% allowable harvest rate) areas 101-29 and 104-30 exp. (Table 2). Control areas in 101-27 and 104-30 totaled 2,934 mt. Substantial changes in biomass have been observed for most commercially harvested subdistricts since last surveyed in 1998 (Table 2). Not including control areas, there was an overall net decrease in total biomass of commercially harvested areas of 4,700 mt, when 2001 and 1998 surveys are compared directly (i.e. using reference depths as used for quota determination). However, if adjustments are made to compare surveys completed using the same reference depth, then there was an overall net decrease of 4,287 mt. Average densities across subdistricts, open to commercial harvest, ranged from 48 (102-20) to 148 (104-30 exp) urchins per meter of shoreline for urchins 60 mm test diameter or larger.

Total precision (a combination of density precision and weight precision) of the surveys ranged from 61 to 77%, discounting 102-10 which was zero due to lack of urchins found (Table 2). This result may be partially explained by patchy distribution of urchins, or variation in urchin weights sampled among transects. Weight precision usually accounts for a very small amount (less than 5%) of overall precision. In Subdistrict 102-10 no urchins were sampled due to extremely low density, and weight precision was not calculated. This was the fourth year where variation in weight among transects was accounted for in biomass/quota calculations.

Recruitment and Size Distributions

Divers collected a total of 3,838 red sea urchins, among all surveyed subdistricts, to estimate average size and size distributions (Figures 10–17 and Appendix 3). In general, the size distribution of urchins indicates the majority of the urchins are mature (>50 mm) individuals. Although partially a result of our inability to collect very small urchins (1–5 mm), a small proportion of juvenile urchins (5–50 mm) was usually observed in most areas.

District 2

District 2 is characterized overall by a relatively small biomass with little recent recruitment. Most subdistricts appear to have a large proportion of older or larger urchins, which is typical of red urchin populations. There is a clear difference in population structure among subdistricts, with modes more pronounced in the most northern subdistricts (Figures 10–13). These clearly bimodal distributions are evidence of successful recruitment.

Subdistrict 102-10 has a narrow range of sizes and little evidence of recruitment during the past two years (Figure 10). The size distribution is considerably different to that found in 1998 when most of urchins sampled were less than 70 mm. Since then it appears that urchins in the 15-60 mm size range have grown and produced a population with most urchins in 65-110 mm range. This amount of apparent growth is

consistent with general conceptions of red urchin growth rate. The average size has increased since 1998, which is likely due to growth and an absence of newly recruited urchins.

Subdistrict 102-20 has a bell-shaped size distribution centered around about 95 mm (Figure 11). There is no evidence of recent strong recruitment, however recruitment has appeared strong during previous surveys. Since last surveyed there appears to have been growth in the 30–50 mm component, which has filled in a now strong 70–100 mm segment of the population. Average size has remained stable since last surveyed, but samples indicate the population has narrowed in size range.

Subdistrict 102-50 has a more typical red urchin size distribution, with two discernable modes (Figure 12). There has been little change in the size distribution during the past three surveys, with distribution shape, size range, and modes remaining stable.

Subdistrict 102-70 urchins are distributed in a very typical pattern, with two clear modes, suggesting recruitment during last two years (Figure 13). The bulk of the population is distributed in a dense bell shaped curve with a size range of 60–135 mm. This is the northernmost area on Prince of Wales Island in District 2 and appears to be the healthiest population, with evidence of good recruitment, broad range of sizes, and increasing biomass (see below).

Control and Experimental Areas

Size distributions in District 4 control and experimental areas (104-30 control and 104-30 experimental) are similar with a broad range of sizes and strong recruitment in the past two years. The average size of urchins in Subdistrict 104-30 control was very similar in 1998, 1999, 2000, and 2001 (between 90 mm and 91 mm). The size distribution in Subdistrict 104-30 experimental has remained stable and looks very similar to that of 2000 (Figure 14). In both areas there has been little change in population structure between surveys (Figures 14 and 15). Although, for the past three seasons, quotas have been based on experimental harvest rates of 20% in 104-30 experimental the actual harvest rate has varied around this level. During the 1996–1997, 1997–1998, 1998–1999, 1999–2000, and 2000–2001 seasons the harvest rates in 104-30 experimental have been approximately 26, 6, 17 , 16, and 4% respectively. These harvest rates have not had a detectable negative impact on size or size distribution of urchins in this area. The size range in 104-30 experimental is one of the broadest in Southeast Alaska and recruitment remains consistently strong.

Control and experimental areas in District 1 (101-27 and 101-29, respectively) have also been stable for at least three years of surveys (Figures 16 and 17). The bulk of the biomass in these areas have broad ranged size distributions, but urchins from each area are centered around different ranges. In Subdistrict 101-29, most urchins occur within 70–115 mm, whereas in Subdistrict 101-27, urchins are much larger with most within range of 100–150 mm. Average size has remained stable over several years of surveys, however, and recruitment is evident in recent years. Unlike 104-30 experimental area, 101-29 has not been harvested at an elevated level. Actual harvest has been below 3% for the past three seasons.

Urchin Density, Population Size, and Biomass

Estimates of biomass are compared to estimates from the previous survey (1998) without accounting for changes in methodology between surveys (Table 2). In addition, the percent change in biomass is reported after accounting for methodology changes. Both comparisons provide useful information. Comparison without adjustments for method changes provides information about how the resource available to the fishery has changed, whereas adjusted comparisons are useful for monitoring the health of the population. Adjustments include calculating biomass using the depths and shoreline used for the previous survey.

District 2

Comparing biomass after adjusting for depth differences indicates that three areas historically open to commercial harvest (102-10, 102-20, and 102-50) decreased. Only Subdistrict 102-70 increased. In areas where decreases were observed, the extent of decrease is greatest in the southernmost area (Subdistrict 102-10) and is less in northern reaches of that shoreline (102-50) (see Table 2). The decreases observed are largely due to reductions in urchin density. This pattern of decline is probably closely related to the expansion of sea otters from Cape Chacon north along the east coast of Prince of Wales Island. Average weight of urchins also declined between surveys, but to a lesser extent than urchin density. It is likely that reduction in average size is due to removal of larger urchins from the population.

Harvest effort has been very low in District 2 for several years. During the 2000-2001 season, over 96% of the guideline harvest level remained unharvested. The reason for low fishing effort is linked to presence of urchins of unmarketable quality. The combination of low interest level by industry in the area and the expansion of sea otters makes this area a candidate for discontinuing urchin biomass surveys.

Experimental Areas

Comparison of 2001 and 2000 biomass estimates of Subdistrict 101-29 without adjusting for different methods, indicates an overall decrease (Table 2). This is due to reducing survey depth from 50 ft mllw (done in 2000) to 33 ft mllw (done in 2001), which accounted a smaller segment of the population. Fishing effort and harvest level are typically low in this area and the guideline harvest level is rarely attained, and so the survey effort was reduced to conserve resources. When 2000 and 2001 surveys are compared using observations to depths of 33 ft mllw only, a 6% decrease is observed, suggesting the population did not experience a large decline between surveys. This decrease is attributed to a slight decrease in average size, which may be due to recruitment between surveys. Urchin density increased slightly in the area. The harvest rate during 2000–2001 was approximately 1% of surveyed biomass.

Biomass in the experimental section of 104-30 decreased substantially since 2000 (-44%). This is due to a large decrease in density from 268 urchins per meter of shoreline to 148 urchins/meter shoreline. The average weight remained stable between surveys. Harvest rate during 2000–2001 was approximately 4% of surveyed biomass, which suggests that the decrease is not attributable to the commercial fishery. This

area has experienced large fluctuations in density over the past few years (161 urchins per meter in 1999, 268 urchins per meter in 2000) and current decline may be a natural oscillation due to environmental causes and recruitment pulses. However, the adjacent control area, where no harvest occurs, indicated a stable population (see below). There have been observations of sea otters approaching the area from the north side. Since the control area is situated to the south of the experimental area, it is very possible that otters have begun to expand into this area.

Control Areas

Urchin biomass in Subdistrict 101-27 control area decreased 119 mt (-18%). The decrease in 101-27 suggests unfavorable environmental conditions in the area of Gravina Island during 2000-2001, and corroborates evidence of declining population (with little harvest) in Subdistrict 101-29. Decline in average urchin density in Subdistrict 101-27 was responsible for the overall reduction in biomass. Average weight remained stable at about 0.5 kg.

In Subdistrict 104-30 control area, urchin biomass has remained stable since last surveyed in 2000. Density declined slightly (156 u/m to 152 u/m), but average weight increased from 0.34 kg to 0.36 kg. During future surveys Subdistrict 104-30 will be carefully monitored for presence of sea otters.

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Table 1. Southeast Alaska red sea urchin survey reference depths (MLLW) to which surveys were conducted in Districts 101, 102 and 104 during 2001.

Subdistrict	Reference depth (ft)	Reference depth (m)
101-27	33	10
101-29	33	10
102-10	33	10
102-20	33	10
102-50	33	10
102-70	33	10
104-30 control	33	10
104-30 experimental	50	15.25

Table 2. Population size and biomass estimates of red urchins from management units (subdistricts) and two control areas (101-27, 104-30 con) in Districts 101, 102, and 104, Southeast Alaska, 2001.

Subdistrict	101-27	101-29	102-10	102-20	102-50	102-70	104-30 con	104-30 exp	Totals/Averages
Transects	19	20	16	19	16	18	20	25	153
Sampled urchins >59 mm	515	483	93	494	411	473	384	519	3,372
Average density (urchins>59 mm)	33.1	126.8	0.7	48.1	60.5	51.5	151.8	148.2	77.6
Standard Deviation	30.4	110.2	2.6	58.7	64.9	36.8	179.1	157.6	80.0
Percent Precision[a]	70.7	71.4	-33.4	61.1	62.5	76.5	63.3	71.2	55.4
Shoreline length (m)	31,105	47,874	57,598	71,228	111,916	36,133	43,874	71,506	471,234
Proportion urchins>59 mm	0.935	0.929	0.886	0.932	0.888	0.906	0.860	0.738	0.884
Average mass/count>59 mm (lbs)[b]	1.160	0.621	0.538	0.678	0.804	0.740	0.792	0.680	0.752
Average biomass (lbs/m)[c]	38.38	78.76	0.36	32.60	48.6	38.1	120.2	100.8	57.2
Population size (urchins>59 mm)	1,028,953	6,069,466	38,015	3,424,642	6,770,918	1,859,766	6,657,880	8,263,201	34,112,840
Population size (all urchins)[d]	1,100,880	6,534,414	42,920	3,674,211	7,627,579	2,052,426	7,742,590	11,195,827	39,970,849
Biomass (lbs)[e]	1,193,916	3,770,676	20,460	2,322,306	5,440,489	1,376,858	5,275,586	7,207,627	26,607,917
Lower Bound [f]	843,951	2,692,747	-6,833	1,419,697	3,398,574	1,053,850	3,340,569	5,132,099	17,874,653
Biomass (metric tons)	541	1,710	9	1,053	2,467	624	2,392	3,269	12,067
Lower bound (metric tons)	383	1,221	-3	644	1,541	478	1,515	2,327	8,106
% change biomass est. (actual)[g]	-18%	-24%	-98%	-45%	-17%	34%	4%	-44%	-28%
% change biomass (comparable)[g]	-18%	-6%	-98%	-45%	-17%	34%	4%	-44%	
Quota (lbs)	control	538,549	0	85,182	203,914	63,231	control	1,026,420	1,917,296

[a] Percent precision = the one-sided 90% lower confidence bound as a percent of the mean.
[b] Average mass = average mass of all urchins divided by the count of urchins >59 mm.
[c] Average biomass = the product of average mass and average density.
[d] Population size (all urchins) = population size (urchins >59 mm) divided by proportion of urchins > 59 mm.
[e] Biomass = the product of average biomass (lbs/meter shoreline) and shoreline length.
[f] Lower bound biomass = biomass times percent precision.
[g] Actual is change since 1998 survey without adjustments for changes in methods; comparable accounts for differences in survey depth and shoreline used since 1998 survey.

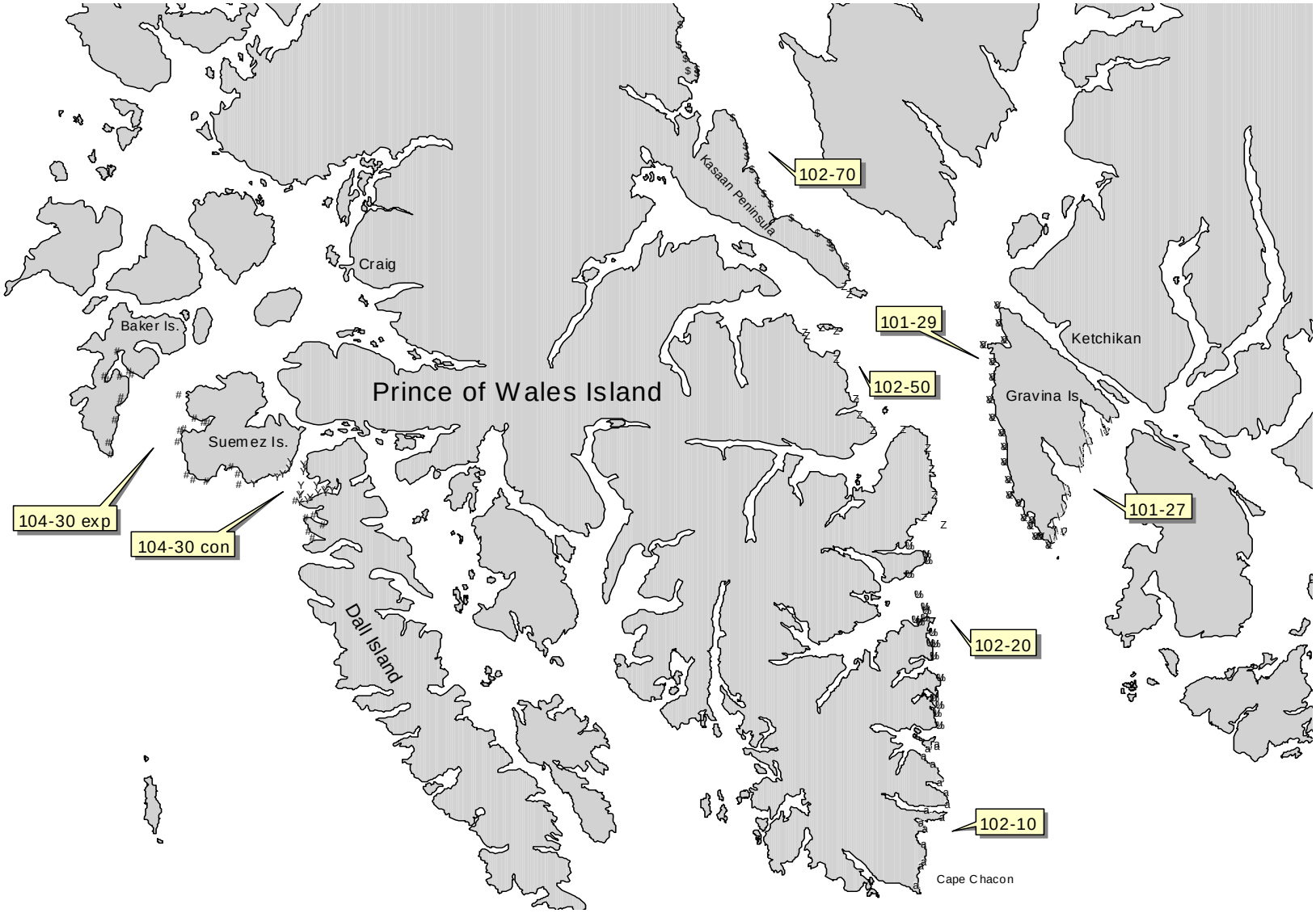


Figure 1. Map of southern Southeast Alaska showing transect locations in fishing and control areas.

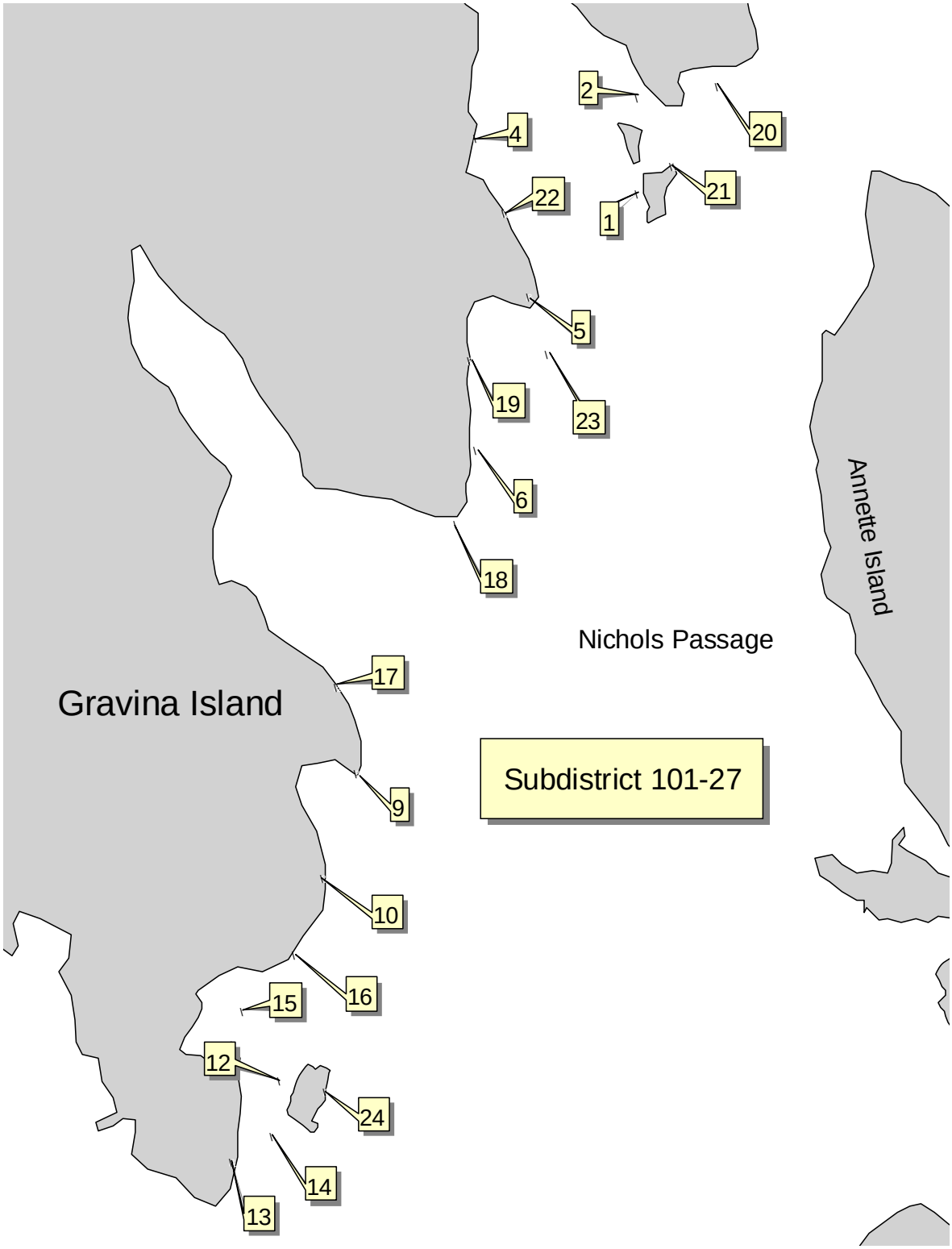


Figure 2. Map of transect pair locations in Statistical Area 101-27.

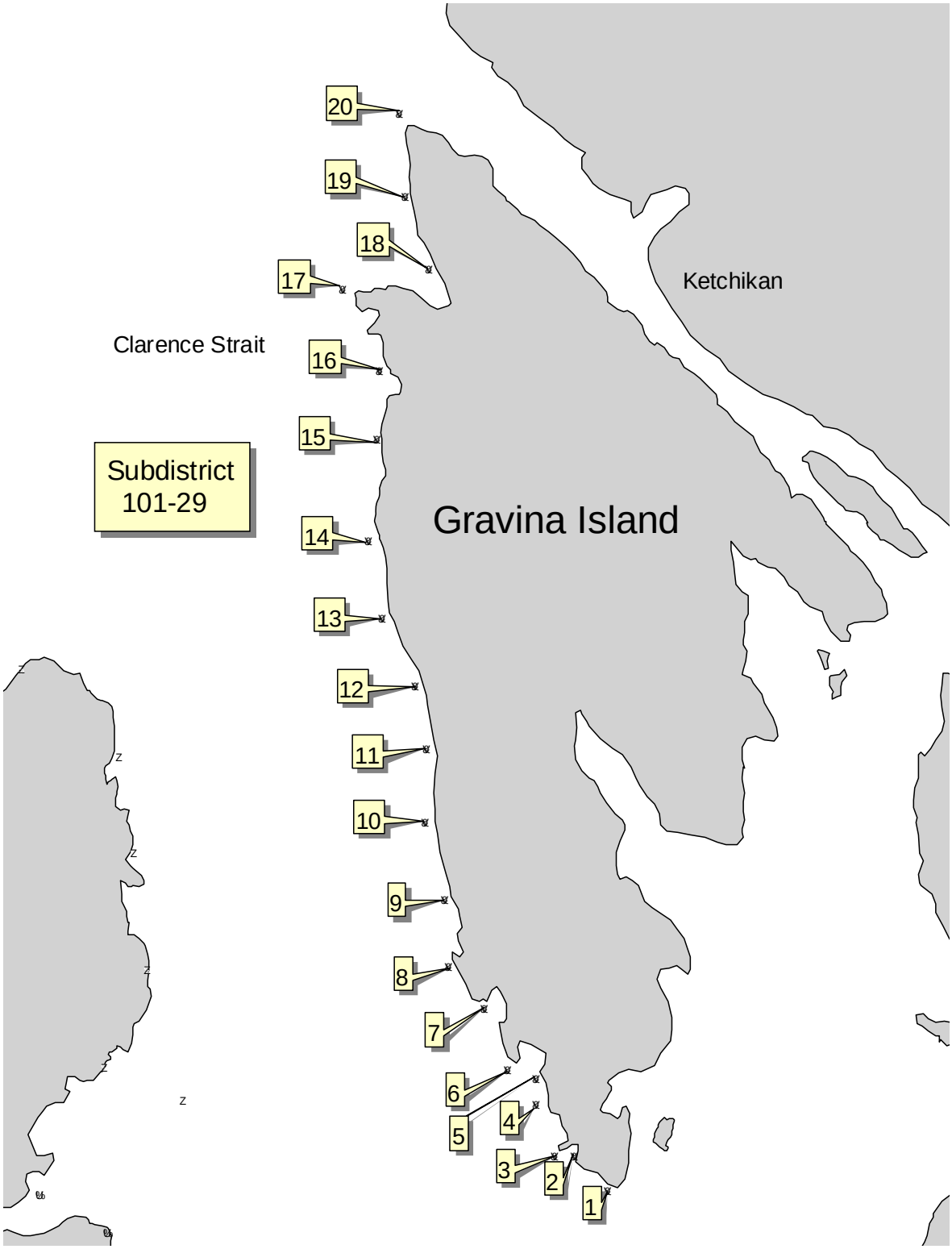


Figure 3. Map of transect pair locations in Statistical Area 101-29.

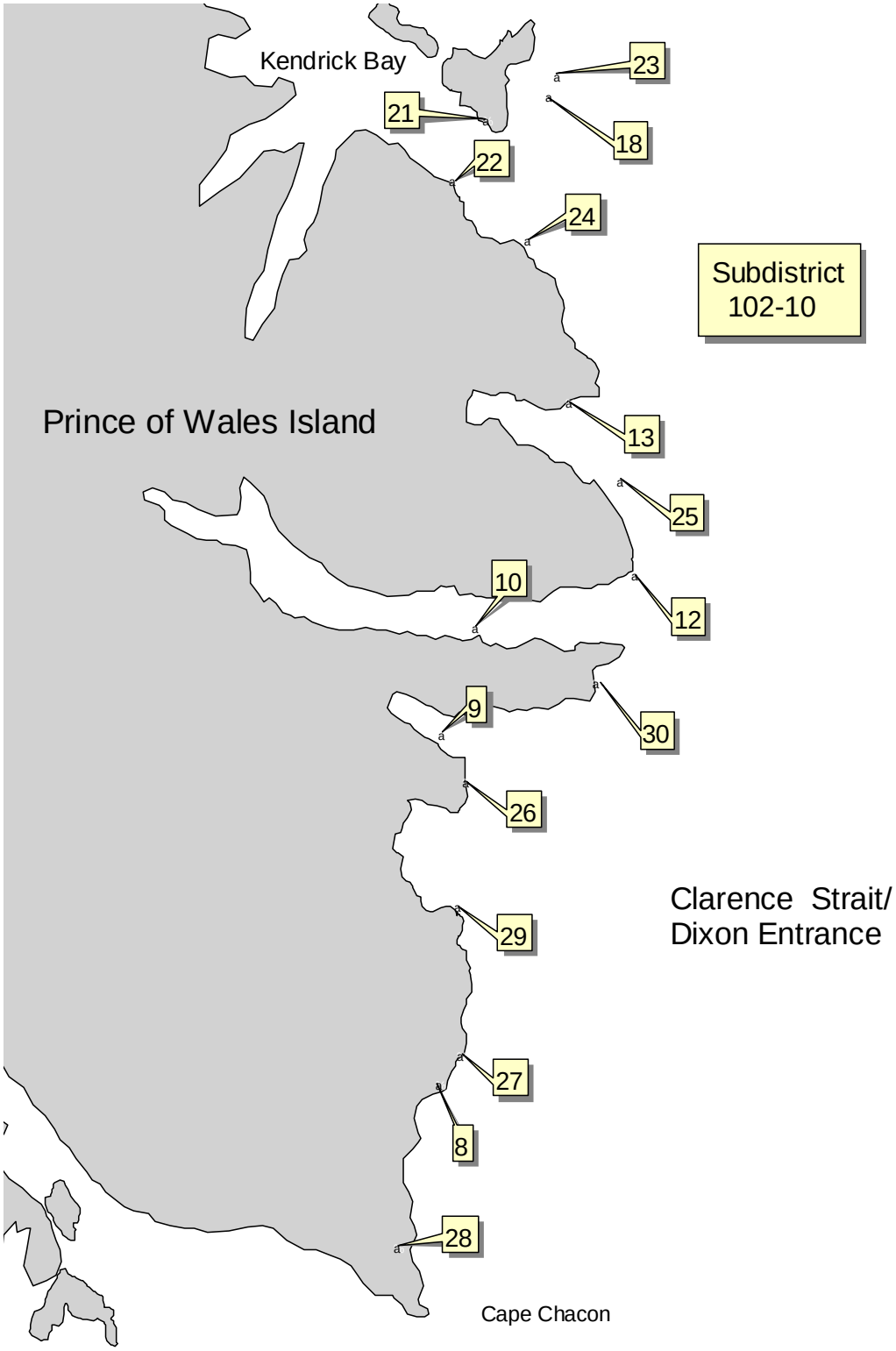


Figure 4. Map of transect pair locations in Statistical Area 102-10.

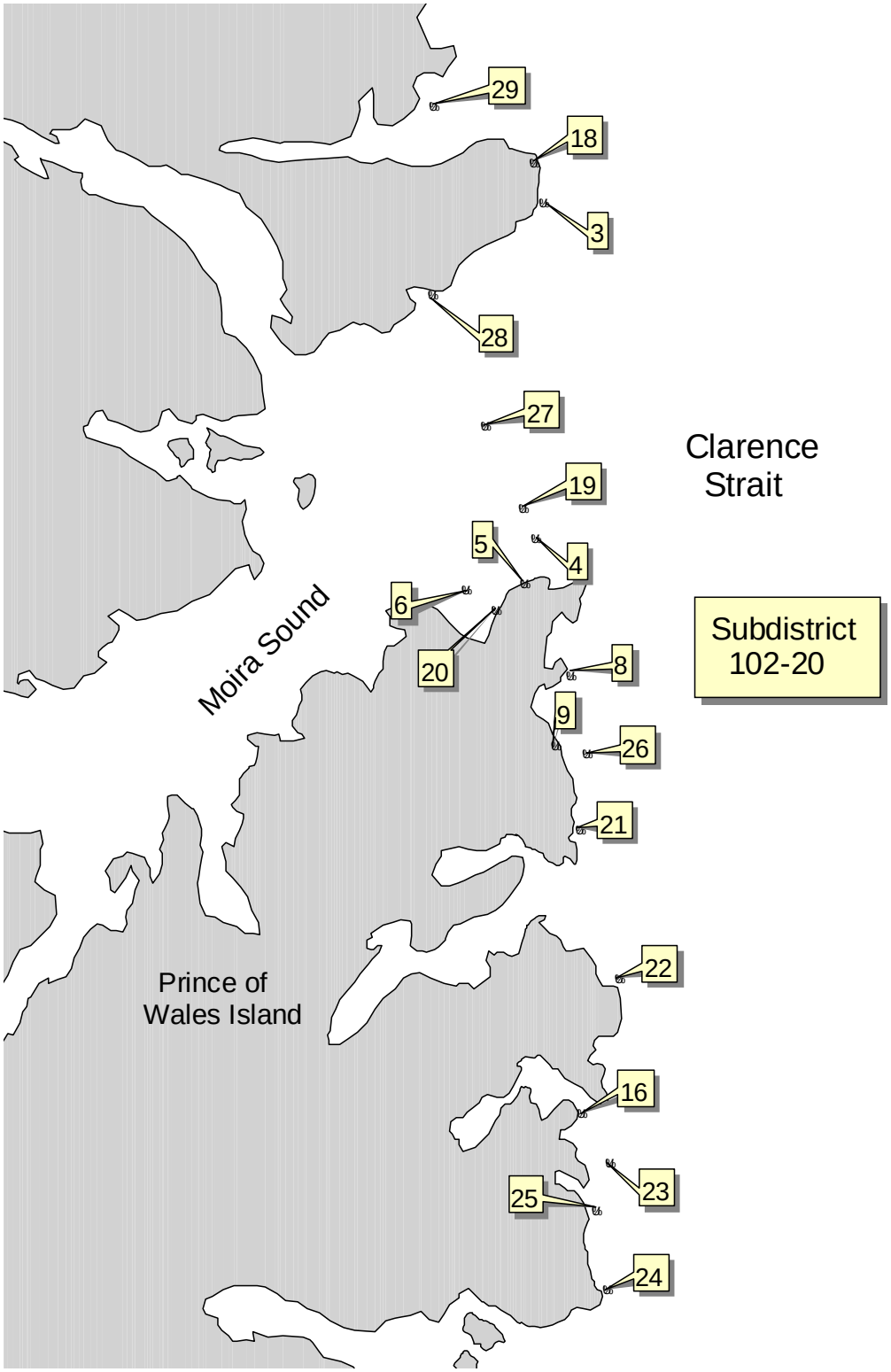


Figure 5. Map of transect pair locations in Areas 102-20.

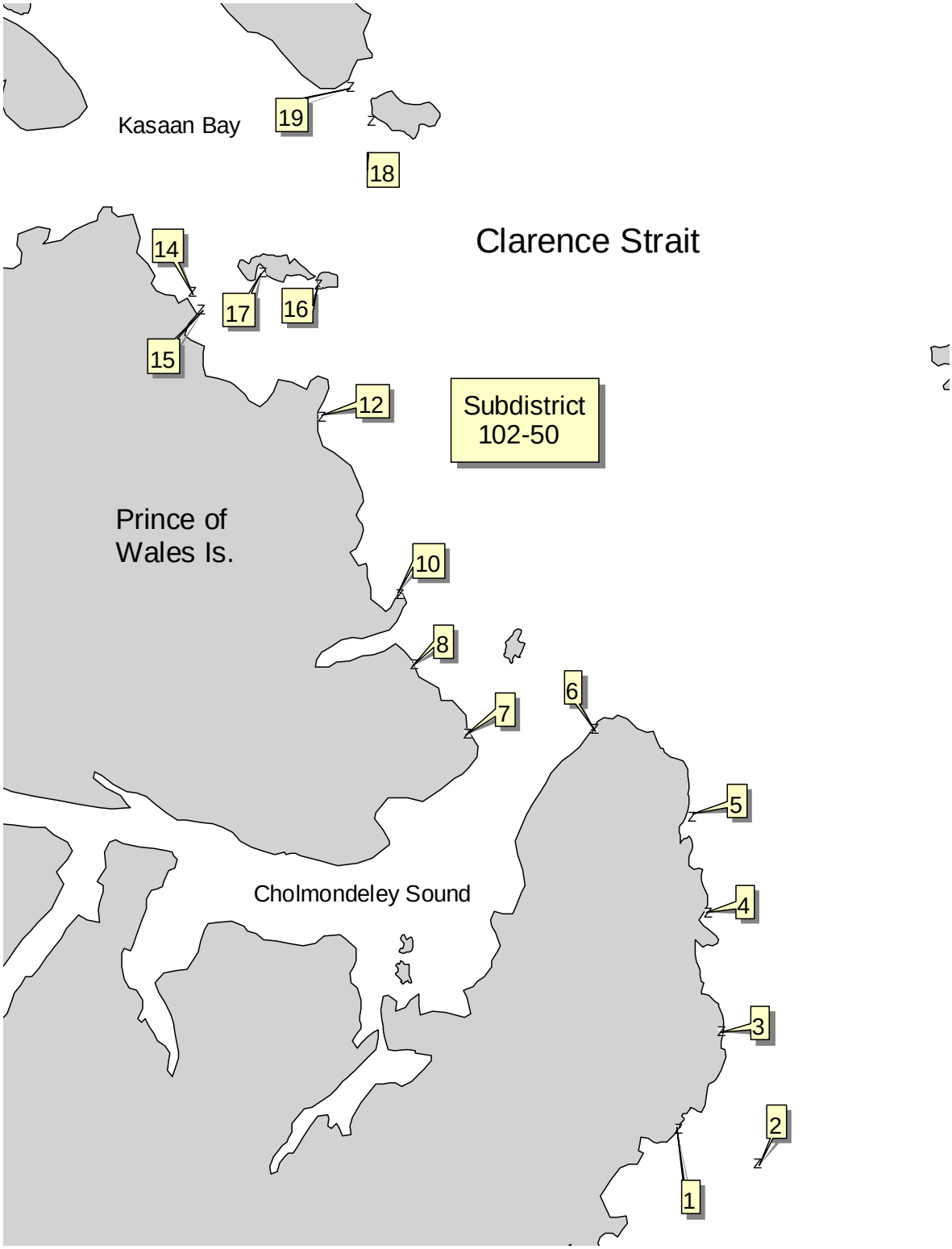


Figure 6. Map of transect pair locations in Statistical Area 102-50.

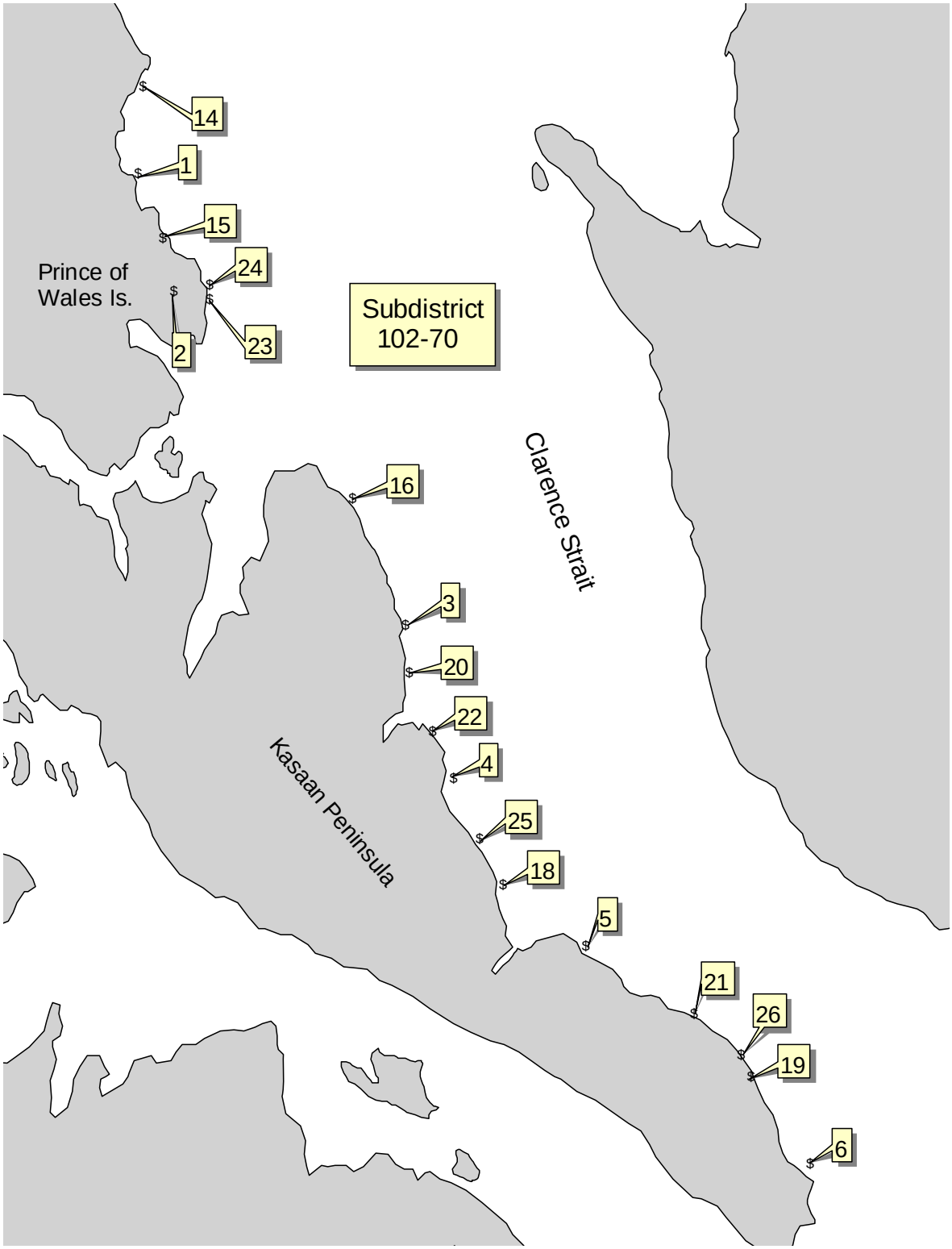


Figure 7. Map of transect pair locations in Statistical Area 102-70.

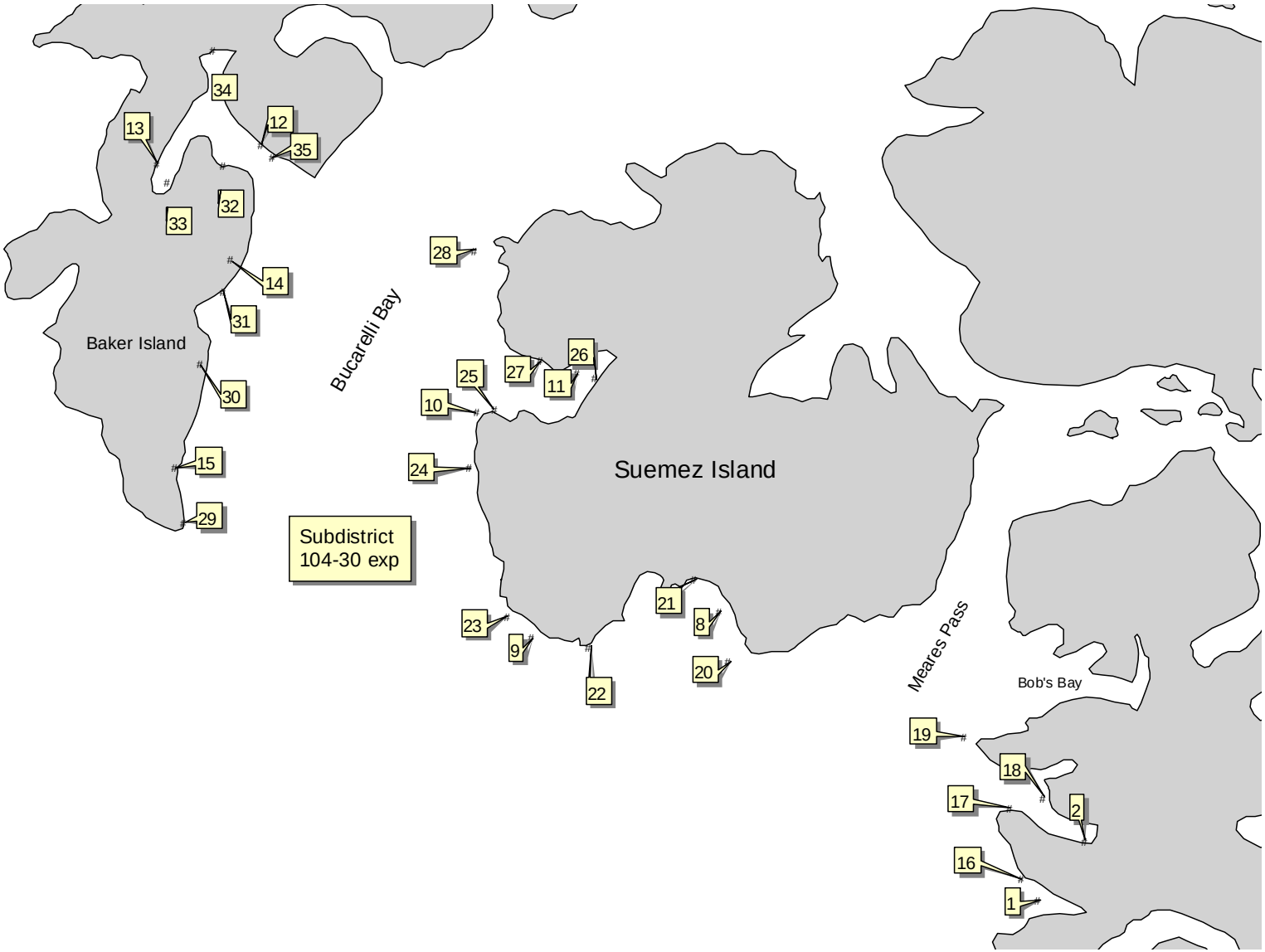


Figure 8. Map of transect pair locations in Statistical Area 104-30 experimental.

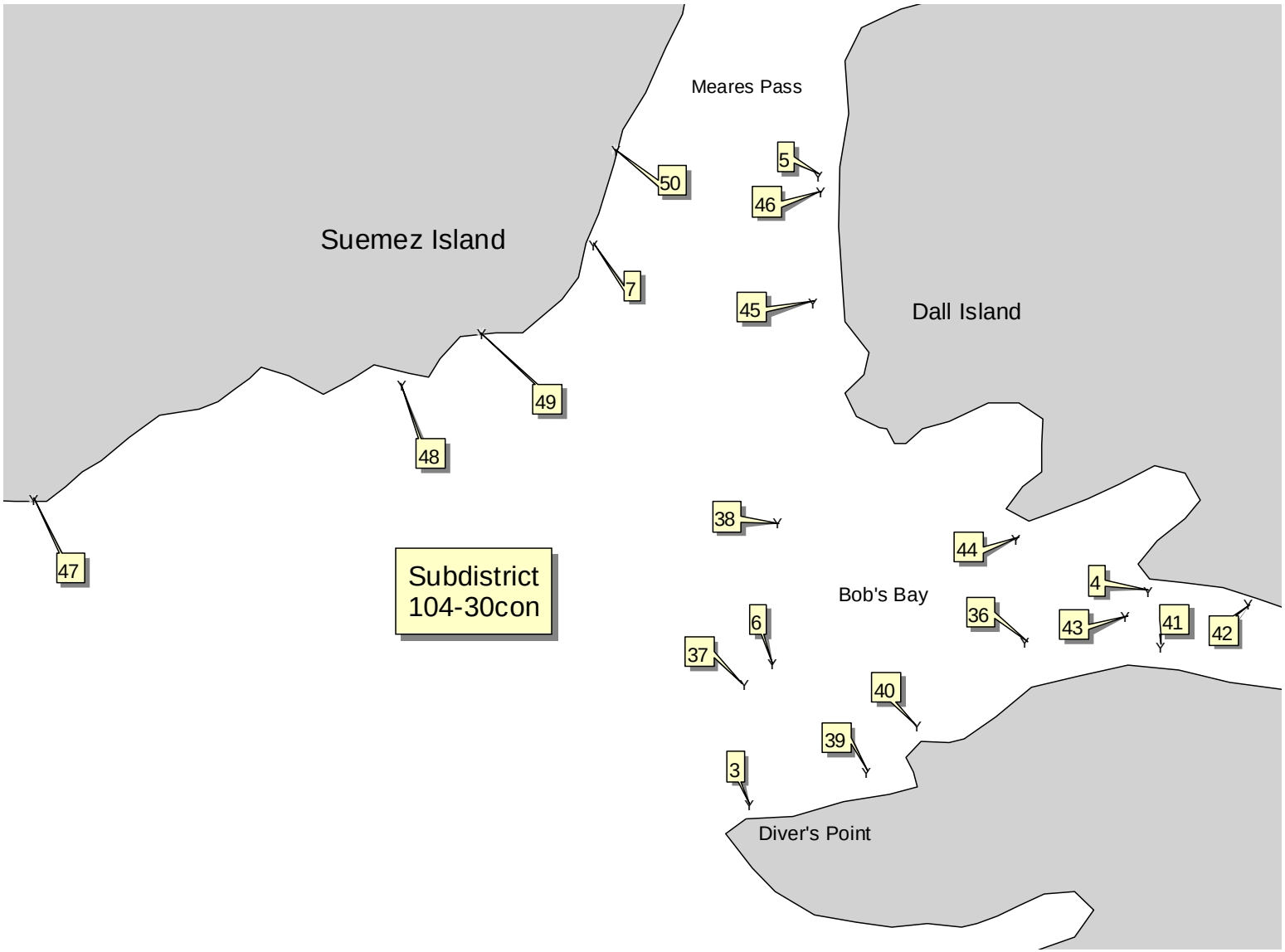


Figure 9. Map of transect pair locations in Statistical Area 104-30 control.

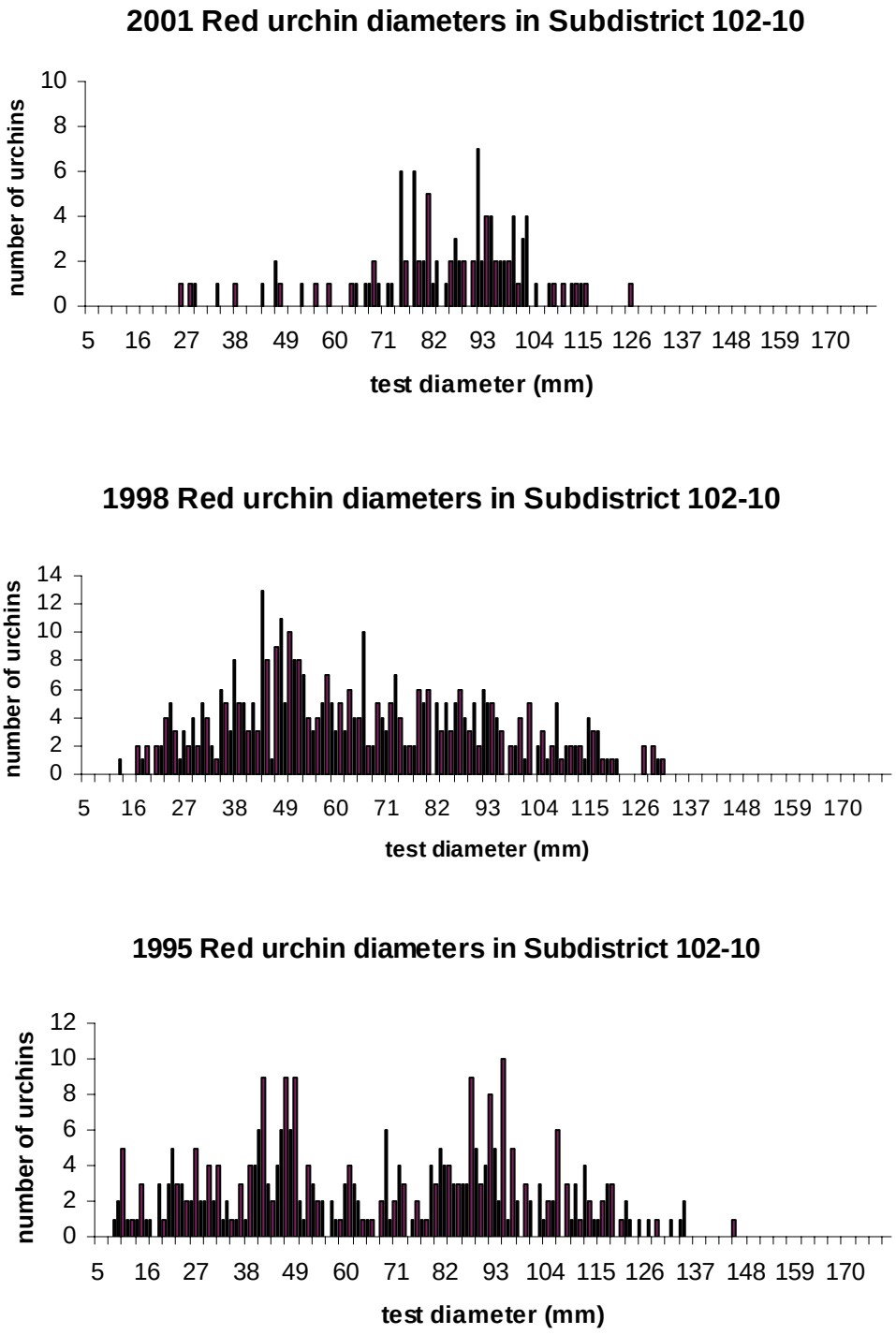
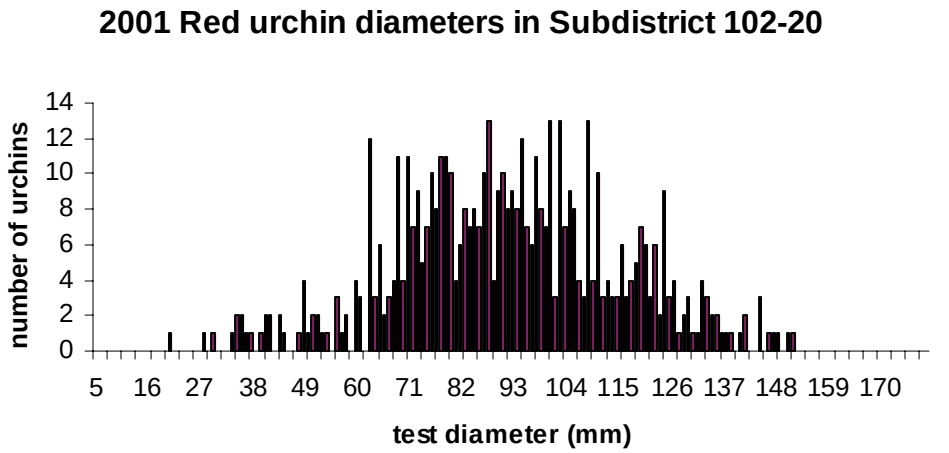
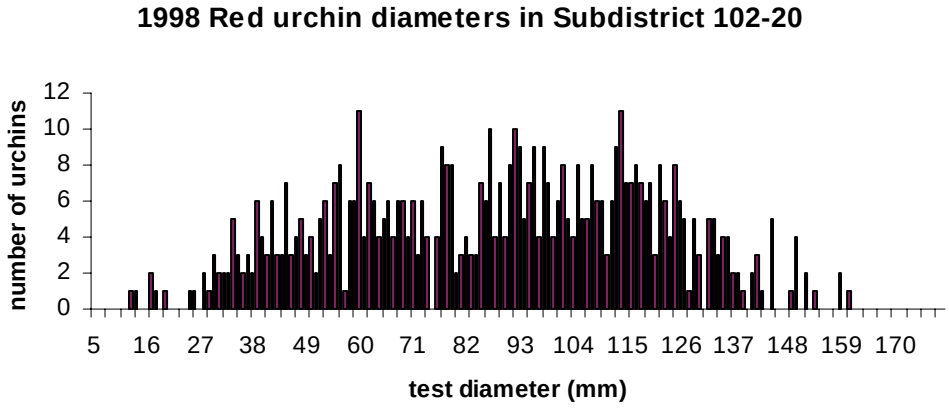


Figure 10. Red urchin size distributions in Subdistrict 102-10 in 1995, 1998, and 2001.





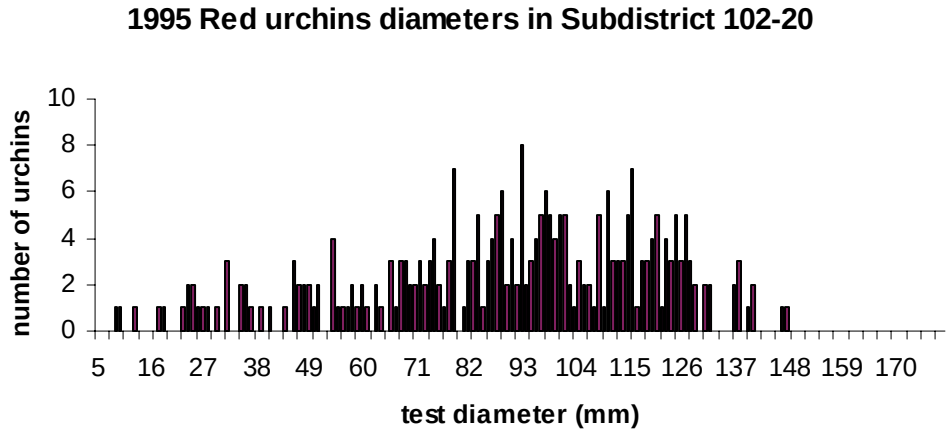
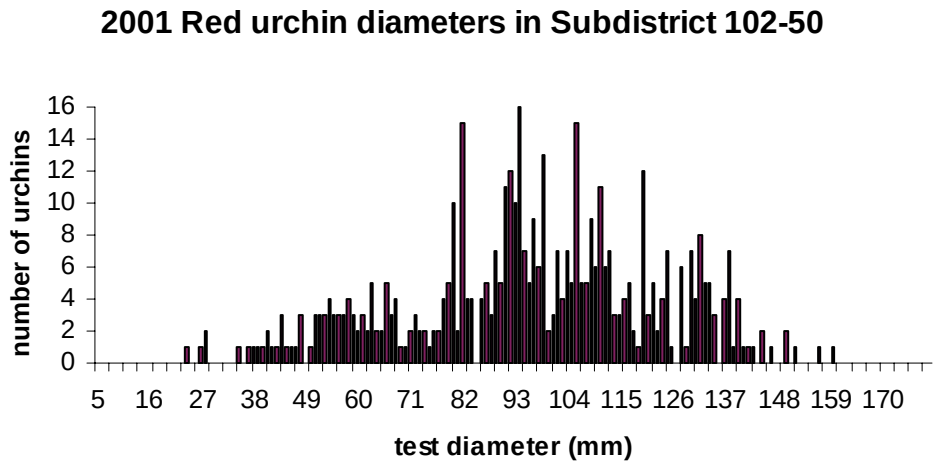
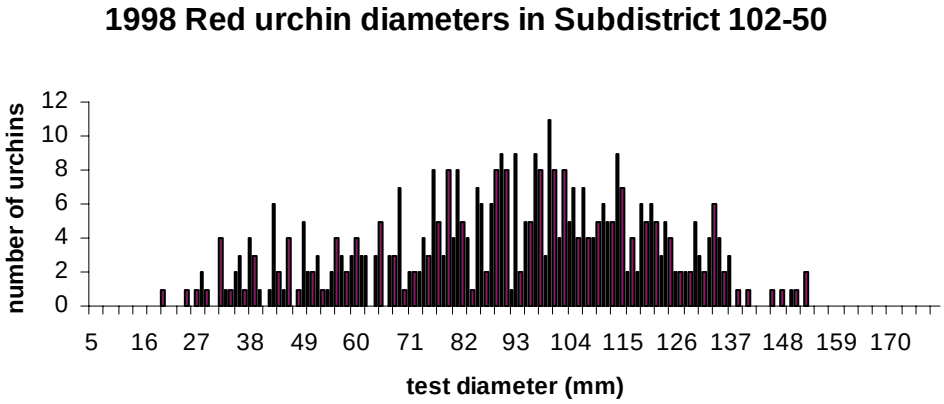


Figure 11. Red urchin size distributions in Subdistrict 102-20 in 1995, 1998, and 2001.





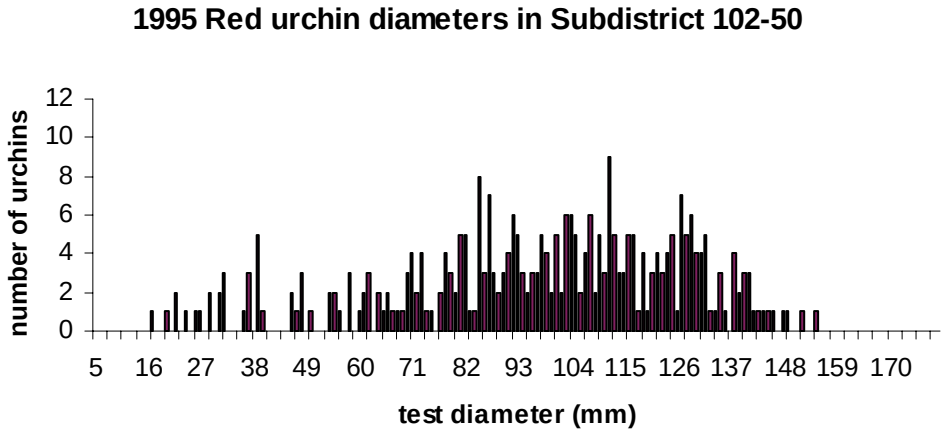


Figure 12. Red urchin size distributions in Subdistrict 102-50 in 1995, 1998, and 2001.

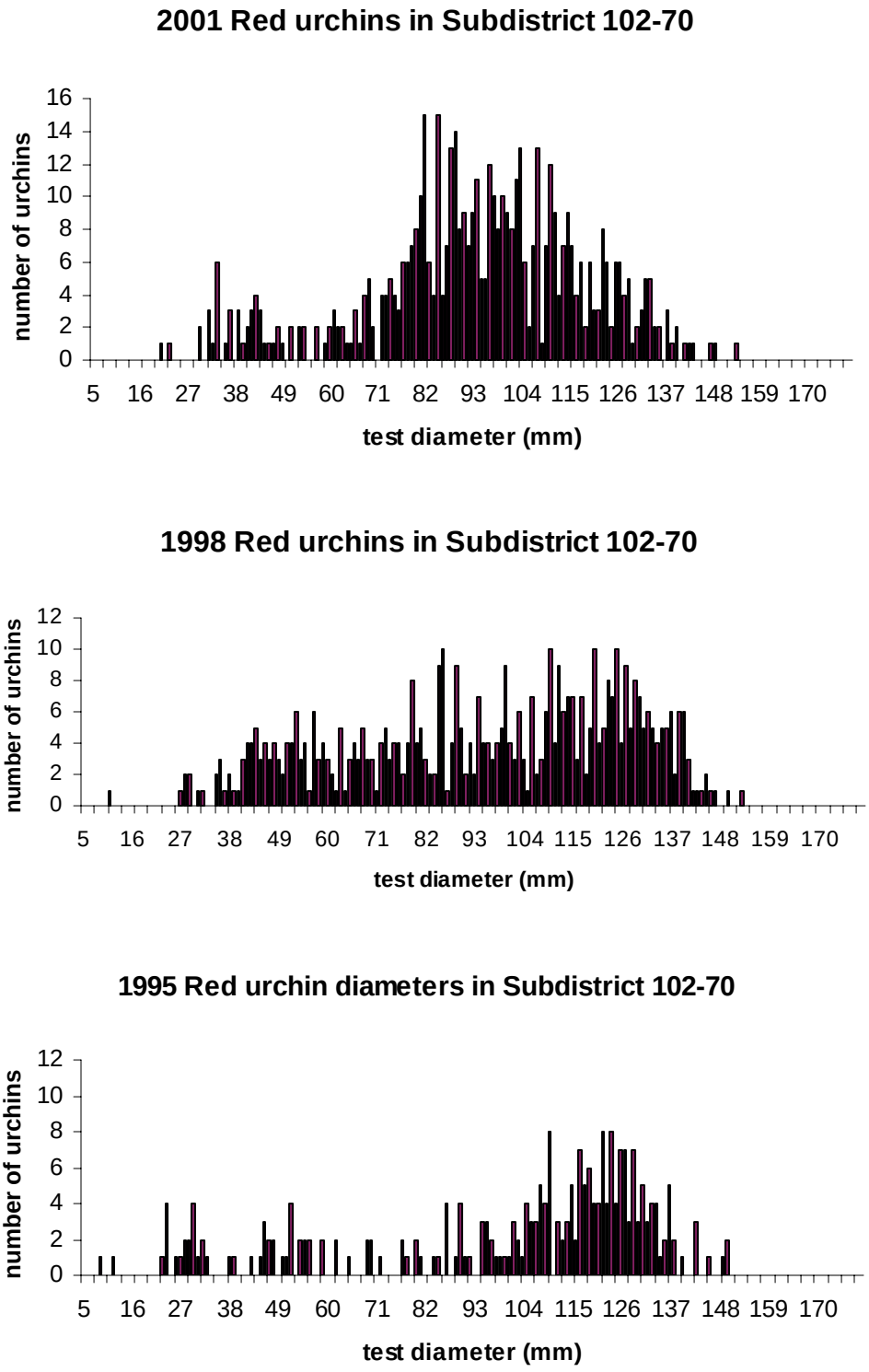
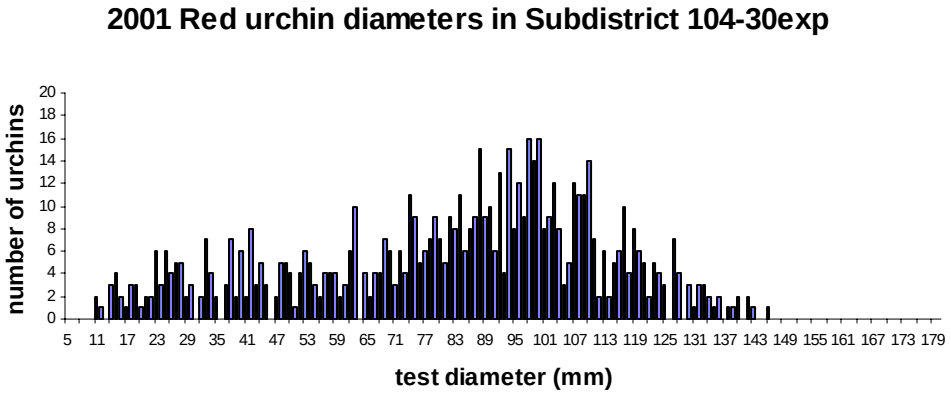
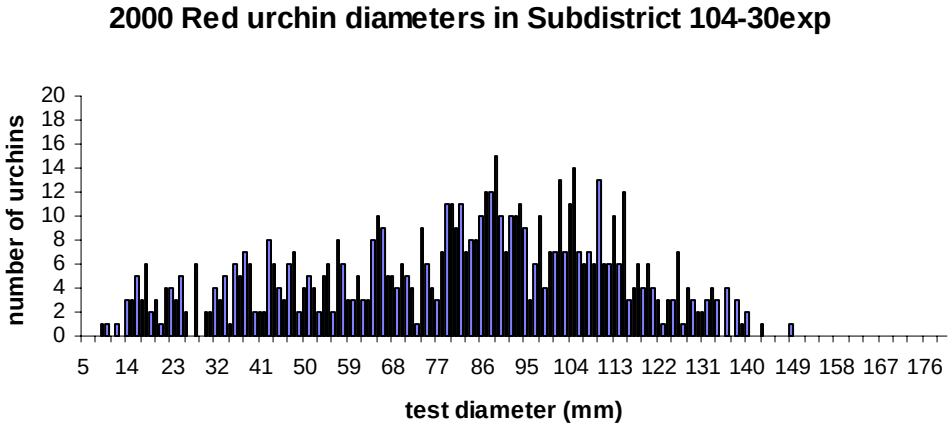


Figure 13. Red urchin size distributions in Subdistrict 102-70 in 1995, 1998, and 2001.





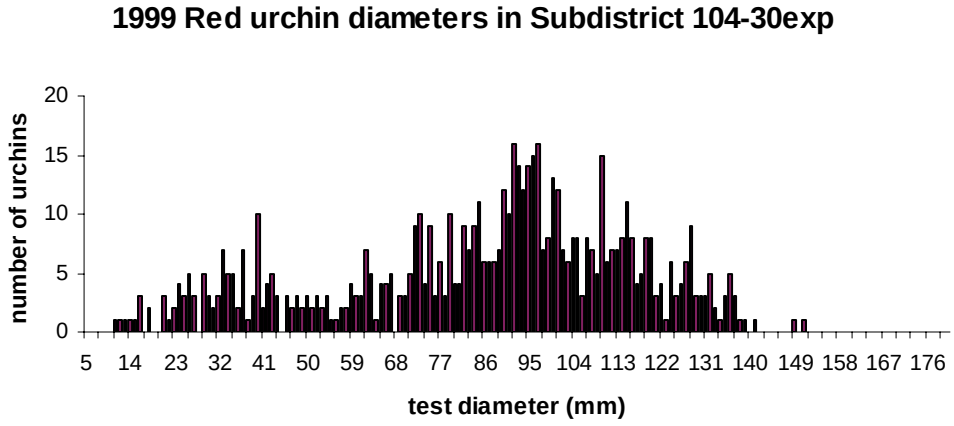
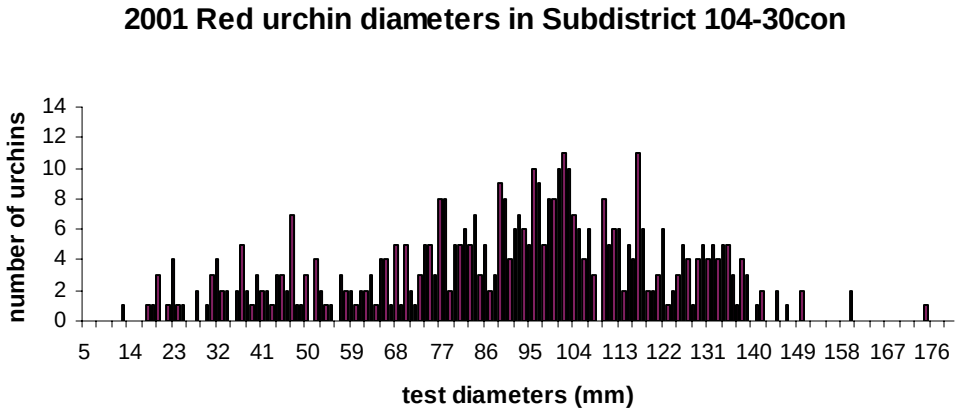
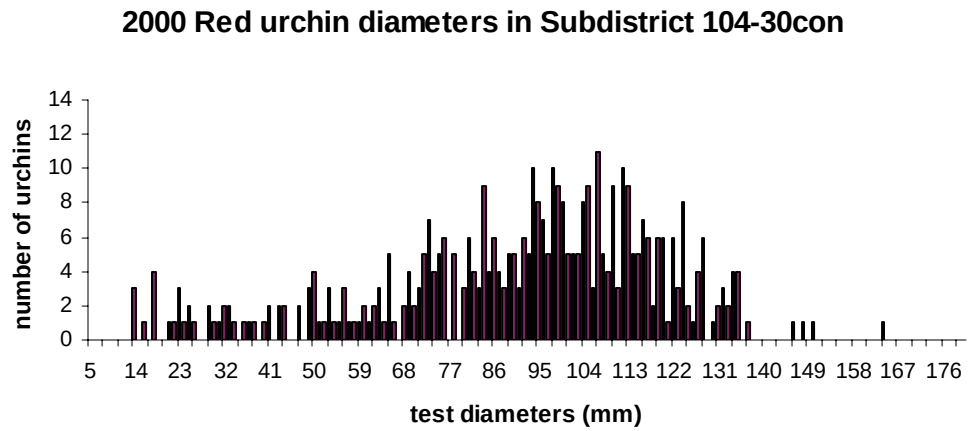


Figure 14. Red sea urchin size distributions in Subdistrict 104-30 experimental area during 1999–2001.





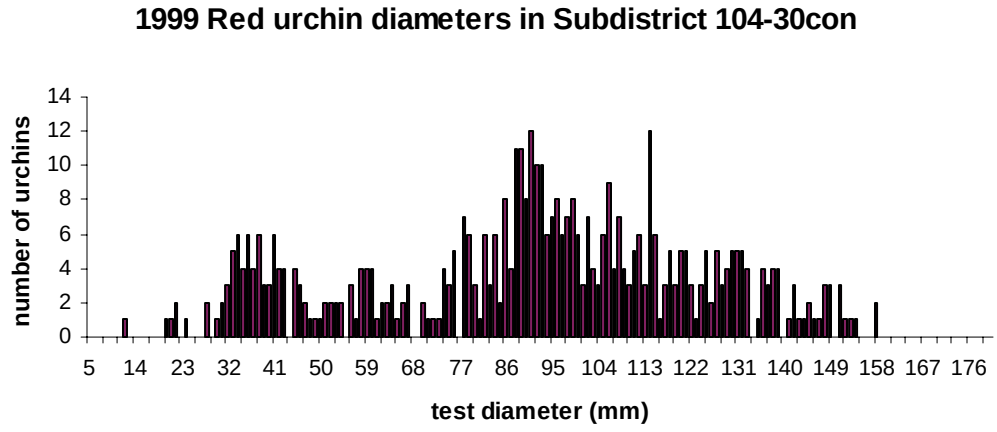


Figure 15. Red sea urchin size distributions in Subdistrict 104-30 control area during 1999–2001.

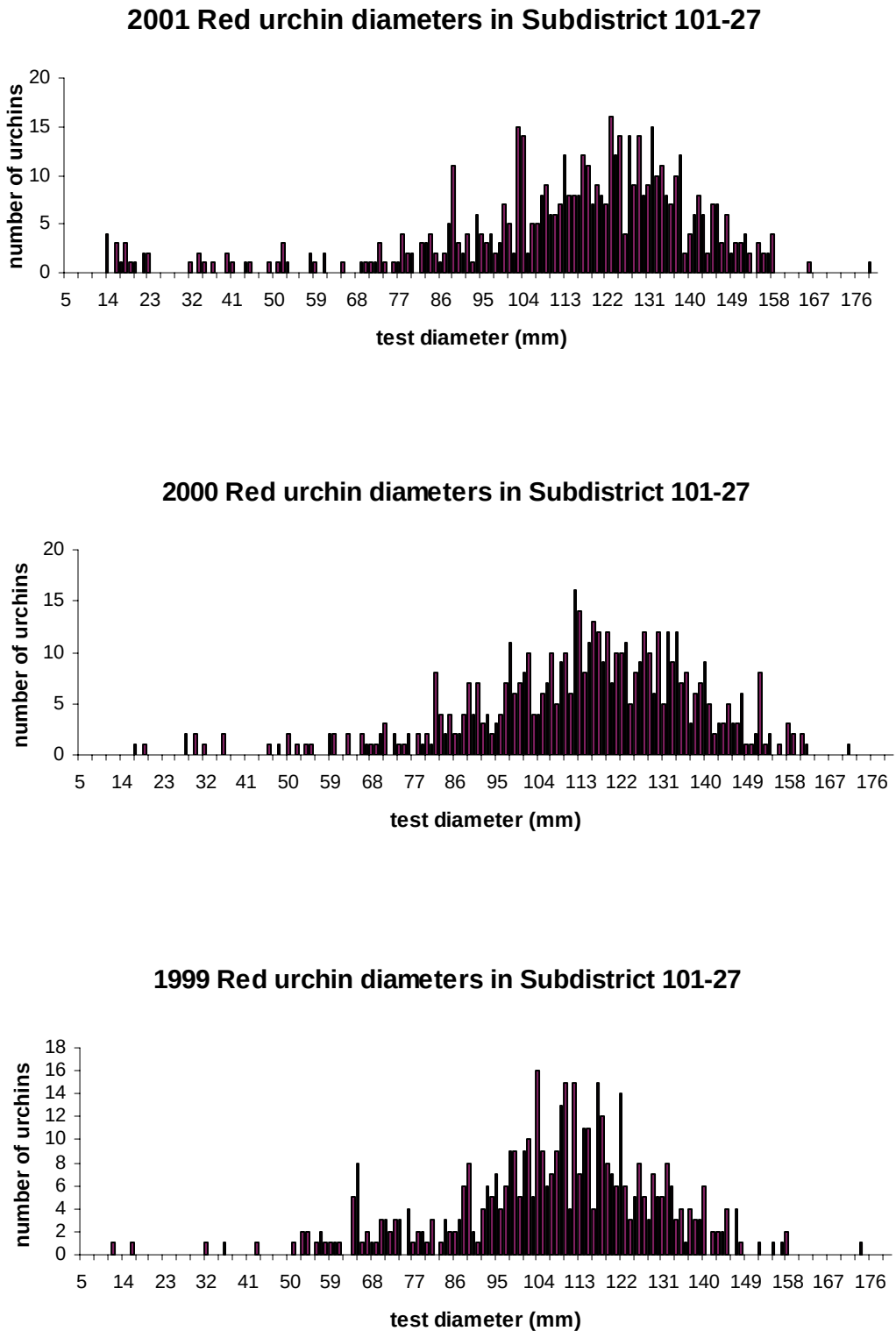
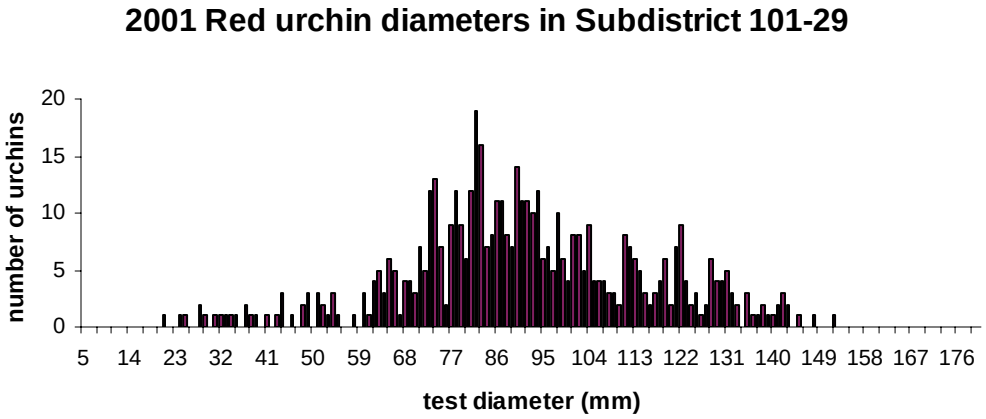
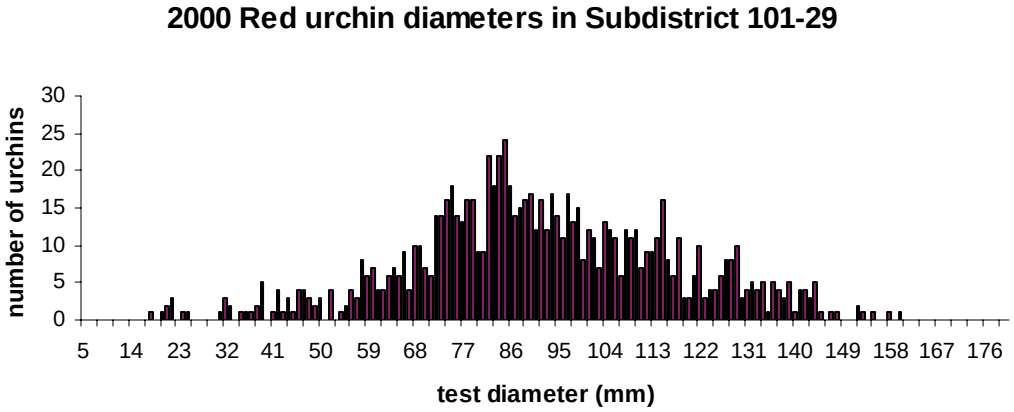


Figure 16. Red sea urchin size distributions in Subdistrict 101-27 control area during 1999–2001.





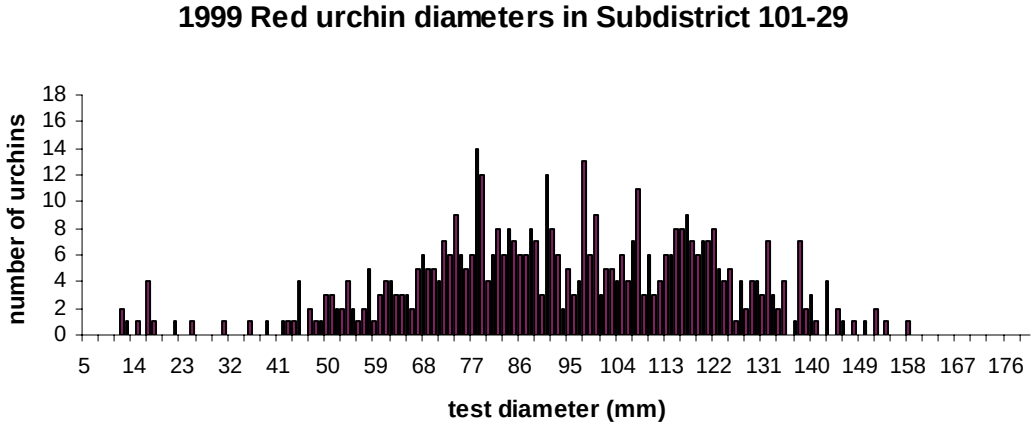


Figure 17. Red sea urchin size distributions in Subdistrict 101-29 experimental area during 1999–2001.

APPENDIX

Appendix 1. Latitude and longitudes of urchin transect pairs completed in Southeast Alaska, 2001.

Subdistrict 101-27		
Transect #	Latitude	Longitude
1	55.2700	-131.6450
2	55.2832	-131.6450
4	55.2777	-131.6842
5	55.2556	-131.6711
6	55.2345	-131.6840
9	55.1897	-131.7130
10	55.1752	-131.7212
12	55.1472	-131.7318
13	55.1359	-131.7434
14	55.1395	-131.7336
15	55.1568	-131.7407
16	55.1646	-131.7281
17	55.2018	-131.7179
18	55.2242	-131.6888
19	55.2469	-131.6855
20	55.2849	-131.6254
21	55.2738	-131.6366
22	55.2673	-131.6771
23	55.2479	-131.6666
24	55.1457	-131.7207

Subdistrict 101-29		
Transect #	Latitude	Longitude
1	55.1290	-131.7524
2	55.1387	-131.7686
3	55.1387	-131.7783
4	55.1531	-131.7874
5	55.1603	-131.7872
6	55.1629	-131.8013
7	55.1801	-131.8124
8	55.1918	-131.8300
9	55.2103	-131.8317
10	55.2319	-131.8415
11	55.2523	-131.8410
12	55.2698	-131.8465
13	55.2886	-131.8624
14	55.3101	-131.8691
15	55.3383	-131.8647
16	55.3576	-131.8636
17	55.3802	-131.8816
18	55.3857	-131.8397
19	55.4059	-131.8513
20	55.4286	-131.8543

Subdistrict 102-10		
Transect #	Latitude	Longitude
8	54.7241	-132.0054
9	54.7778	-132.0048
10	54.7943	-131.9958
12	54.8023	-131.9531
13	54.8289	-131.9707
18	54.8758	-131.9761
21	54.8721	-131.9930
22	54.8629	-132.0018
23	54.8788	-131.9738
24	54.8537	-131.9819
25	54.8168	-131.9571
26	54.7707	-131.9983
27	54.7287	-131.9997
28	54.6991	-132.0163
29	54.7514	-132.0005
30	54.7859	-131.9634

Subdistrict 102-20		
Transect #	Latitude	Longitude
3	55.1098	-131.9947
4	55.0458	-131.9972
5	55.0373	-132.0008
6	55.0361	-132.0200
8	55.0199	-131.9856
9	55.0063	-131.9905
16	54.9364	-131.9817
18	55.1172	-131.9976
19	55.0515	-132.0012
20	55.0322	-132.0102
21	54.9903	-131.9825
22	54.9620	-131.9693
23	54.9267	-131.9726
24	54.9027	-131.9732
25	54.9177	-131.9769
26	55.0048	-131.9803
27	55.0672	-132.0137
28	55.0921	-132.0314
29	55.1279	-132.0308

Appendix 1. (page 2 of 3)

Subdistrict 102-50		
Transect #	Latitude	Longitude
1	55.1636	-131.9981
2	55.1541	-131.9596
3	55.1907	-131.9770
4	55.2234	-131.9835
5	55.2502	-131.9912
6	55.2744	-132.0383
7	55.2729	-132.1003
8	55.2920	-132.1256
10	55.3115	-132.1332
12	55.3604	-132.1706
14	55.3946	-132.2334
15	55.3898	-132.2293
16	55.3965	-132.1724
17	55.3999	-132.1990
18	55.4418	-132.1469
19	55.4511	-132.1568

Subdistrict 102-70		
Transect #	Latitude	Longitude
1	55.7515	-132.4797
2	55.7187	-132.4622
3	55.6260	-132.3477
4	55.5834	-132.3243
5	55.5364	-132.2592
6	55.4759	-132.1486
14	55.7757	-132.4776
15	55.7337	-132.4675
16	55.6611	-132.3738
18	55.5537	-132.2999
19	55.4999	-132.1774
20	55.6128	-132.3458
21	55.5175	-132.2057
22	55.5964	-132.3347
23	55.7165	-132.4445
24	55.7205	-132.4448
25	55.5665	-132.3114
26	55.5062	-132.1827

Appendix 1. (page 3 of 3)

Subdistrict 104-30 con		
Transect #	Latitude	Longitude
3	55.1837	-133.2320
4	55.1998	-133.1807
5	55.2312	-133.2231
6	55.1944	-133.2291
7	55.2260	-133.2520
36	55.1960	-133.1965
37	55.1928	-133.2327
38	55.2050	-133.2284
39	55.1861	-133.2170
40	55.1896	-133.2105
41	55.1956	-133.1791
42	55.1989	-133.1678
43	55.1979	-133.1837
44	55.2038	-133.1977
45	55.2217	-133.2239
46	55.2300	-133.2229
47	55.2068	-133.3239
48	55.2154	-133.2767
49	55.2193	-133.2664
50	55.2332	-133.2491

Subdistrict 104-30 exp		
Transect #	Latitude	Longitude
1	55.1381	-133.2056
2	55.1544	-133.1838
8	55.2173	-133.3538
9	55.2103	-133.4416
10	55.2720	-133.4672
11	55.2828	-133.4202
12	55.3450	-133.5672
13	55.3401	-133.6158
14	55.3137	-133.5818
15	55.2570	-133.6077
16	55.1442	-133.2130
17	55.1633	-133.2185
18	55.1660	-133.2029
19	55.1831	-133.2396
20	55.2036	-133.3501
21	55.2262	-133.3656
22	55.2078	-133.4150
23	55.2162	-133.4527
24	55.2570	-133.4707
25	55.2729	-133.4586
26	55.2815	-133.4118
27	55.2861	-133.4372
28	55.3162	-133.4684
29	55.2416	-133.6038
30	55.2853	-133.5957
31	55.3051	-133.5855
32	55.3393	-133.5855
33	55.3351	-133.6111
34	55.3709	-133.5900
35	55.3417	-133.5621

Appendix 2. Red sea urchin transect survey data collected in Southeast Alaska, 2001. Sides "a" and "b" are counted urchins >59 mm within 1-meter width paired transects to depth.

Subdistrict: 101-27			
transect no.	side a	side b	maximum depth (mllw, ft.)
1	37	21	33
2	32	16	33
4	7	7	33
5	4	32	33
6	56	139	33
9	23	15	33
10	61	61	33
12	63	96	33
13	0	0	33
14	0	48	33
14	0	30	33
16	1	1	33
17	1	0	34
18	10	49	33
19	0	0	33
20	46	124	33
21	57	15	33
22	12	28	33
23	20	56	33
24	75	53	33

Subdistrict: 101-29			
transect no.	side a	side b	maximum depth (mllw, ft.)
1	37	47	34
2	10	15	33
3	91	136	33
4	170	247	33
5	7	0	33
6	317	139	33
7	76	43	33
8	349	233	33
9	422	397	33
10	163	202	33
11	0	0	33
12	310	221	33
13	95	105	33
14	62	86	33
15	78	102	33
16	100	84	33
17	184	138	33
18	0	0	33
19	58	60	33
20	112	175	33

Subdistrict: 102-10			
transect no.	side a	side b	maximum depth (mllw, ft.)
8	0	0	33
9	0	0	33
10	0	21	28
12	0	0	33
13	0	0	32
18	0	0	33
21	0	0	33
22	0	0	32
23	0	0	33
24	0	0	33
25	0	0	33
26	0	0	33
27	0	0	33
28	0	0	33
29	0	0	33
30	0	0	33

Subdistrict: 102-20			
transect no.	side a	side b	maximum depth (mllw, ft.)
3	102	95	34
4	103	81	33
5	64	49	33
6	20	5	33
8	63	77	33
9	2	1	33
16	6	7	33
18	198	275	33
19	6	19	33
20	0	1	33
21	16	15	33
22	83	64	33
23	0	0	33
24	91	32	33
25	0	1	33
26	0	7	33
27	62	31	33
28	98	115	33
29	25	13	33

Subdistrict: 102-50			
transect no.	side a	side b	maximum depth (mllw, ft.)
1	5	6	27
2	239	175	33
3	218	134	33
4	185	107	33
6	82	57	8
7	17	13	33
8	23	3	33
10	17	35	33
12	71	53	33
13	0	0	10
14	4	9	33
15	18	0	33
16	75	71	33
17	38	41	33
18	14	34	33
19	75	117	33

Subdistrict: 102-70			
transect no.	side a	side b	maximum depth (mllw, ft.)
1	23	14	33
2	0	0	33
3	99	125	33
4	46	56	33
5	50	44	33
6	75	74	33
14	17	24	33
15	108	76	37
16	40	6	33
18	2	1	33
19	132	100	33
20	12	22	33
21	27	39	33
22	23	26	33
23	84	61	33
24	87	94	33
25	94	65	33
26	37	70	33

Subdistrict: 104-30 con

transect no.	side a	side b	maximum depth (mllw, ft.)	transect no.	side a	side b	maximum depth (mllw, ft.)
3	35	16	50	41	0	0	
3	70	59	40	42	0	0	
3	709	603	33	43	0	0	
4	0	0		44	43	85	33
5	36	32	50	45	30	23	40
5	46	53	40	45	75	159	50
5	255	147	33	45	91	76	33
6	1	2	50	46	15	4	50
6	5	145	40	46	40	399	40
6	93	18	33	46	303	33	33
7	0	525	40	47	46	97	50
7	0	0	50	47	64	42	40
7	428	1	33	47	262	35	33
36	0	0	40	48	20	24	50
36	0	0	50	48	22	75	40
36	25	22	33	48	61	20	33
37	14	26	50	49	0	0	33
37	18	174	40	49	0	0	40
37	161	19	33	49	0	0	50
38	10	31	50	50	7	106	40
38	47	12	40	50	15	7	50
38	361	526	33	50	145	16	33
39	0	63	40				
39	0	0	50				
39	47	0	33				
40	0	0	40				
40	0	0	50				
40	34	32	33				

Subdistrict: 104-30 exp

transect no.	side a	side b	maximum depth (mllw, ft.)
1	11	21	40
1	29	205	50
1	214	28	33
2	0	0	
8	0	15	50
8	16	267	40
8	94	1	33
9	5	4	40
9	10	10	33
9	15	6	50
10	18	49	40
10	19	14	50
10	57	15	33
11	0	0	
12	0	42	50
12	0	0	40
12	10	0	33
13	0	0	
14	426	325	27
15	6	38	40
15	16	45	33
15	29	54	50
16	7	80	50
16	64	11	40
16	363	640	33
17	1	344	50
17	6	12	40
17	392	1	33
18	0	0	40
18	0	89	50
18	57	0	33
19	32	43	40
19	43	27	50
19	151	87	33
20	76	107	50
20	121	95	40
20	206	215	33
21	0	0	
22	12	35	40
22	16	14	33
22	25	35	50
23	3	25	50
23	17	26	40
23	38	22	33
24	8	16	50
24	11	127	40
24	96	47	33
25	99	139	26
26	0	0	43
26	0	4	53
26	1	0	33
27	0	0	50
27	1	0	40
27	56	78	33
28	45	119	40
28	47	20	50
28	132	21	33
29	0	0	33
29	0	42	40
29	7	0	50
30	15	17	50
30	63	15	40
30	252	280	33
31	4	4	50
31	27	26	40
31	98	87	33
32	0	0	
33	0	0	
34	0	0	
35	0	0	

Appendix 3. Red sea urchin test diameters in millimeters by subdistrict and transect, collected in Southeast Alaska, 2001. First row are transect numbers.

Subdistrict 101-27																			
Sample no.	1	2	4	5	6	9	10	12	13	14	16	17	18	19	20	21	22	23	24
1	131	127	141	138	120	143	58	142	140	18	145	153	78	114	107	89	89	121	89
2	123	109	137	96	104	103	132	115	146	113	115	138	113	123	113	129	16	114	124
3	148	136	158	179	14	131	52	141	134	82	136	137	79	84	69	129	22	104	104
4	104	118	155	101	123	132	129	117	132	51	118	127	80	109	115	124	16	105	135
5	119	84	153	107	121	148	145	123	141	112	156	125	83	89	120	138	35	116	100
6	129	94	147	120	74	121	142	128	137	114	148	127	94	34	112	138	103	124	109
7	132	85	133	108	103	138	137	137	143	131	148	110	23	124	111	135	123	117	110
8	112	113	139	103	112	133	20	132	144	112	134	78	14	61	103	130	53	126	103
9	129	108	120	89	18	126	132	129	147	71	131	101	80	49	107	131	106	99	114
10	109	103	140	118	104	132	92	128	120	128	149	146	89	22	104	119	70	103	94
11	130	93	145	104	120	134	94	113	129	73	152	137	82	34	119	124	40	101	132
12	124	123	138	94	100	127	132	136	158	116	141	134	115	94	95	109	103	113	104
13	130	86	152	104	114	135	123	109	138	92	138	127	44	89	103	104	117	108	125
14	141	90	139	117	131	128	95	116	143	123	146	146	122	126	96	129	106	116	102
15	128	95	142	105	113	120	119	128	132	120	151	133	59	116	127	130	125	136	123
16	109	90	157	98	117	129	127	116	158	147	145	133	14	143	116	118	128	107	125
17	113	97	137	89	117	91	125	127	134	123	146	138	89	88	114	146	151	111	113
18	123	106	141	125	125	115	133	122	152	108	142	23	17	121	135	115	115	117	119
19	125	101	151	85	118	99	140	131	146	135	142	32	79	87	122	117	73	19	103
20	117	88	148	118	129	127	145	127	157	97	149	72	134	129	18	16	106	114	137
21	121	83	135	78	65	90	108	131	143	125	132	121	118	111	40	61	92	110	37
22	118	89	155	76	115	124	127	112	158	130	150	145	127	78	136	110	108	109	100
23	130	87	166	84	124	118	156	123	155	125	132	145	152	88	52	14	102	77	118
24	127	106	133	108	123	133	125	124	142	129	125	135	142	84	111	121	119	101	104
25	128	129		88	122	124	137	134	117	132	142	108	89	73	103	96	111	117	107
26	127	110		99	131	135	126	134	150	116	150	148	125	98	103	88	138	113	100
27	124	112		132	111	138	136	122		124		136	144	91	123	138	134	120	100
28	95	100		119	58	122	133	121		123		140	113	104	117	45	125	100	110
29	123	82		104	114	133	130	122		103		134		97	103	97	134		
30	130	83		104		132		109		113		41			92		133		
31										143					52		137		
32																	118		
33																	129		
Average	123	101	144	106	105	125	119	125	142	111	141	119	89	92	101	108	99	108	109
Minimum	95	82	120	76	14	90	20	109	117	18	115	23	14	22	18	14	16	19	37
Maximum	148	136	166	179	131	148	156	142	158	147	156	153	152	143	136	146	151	136	137
Depth (mllw)	22			35	30		10	17		13	29		20	25				10	

Appendix 3. (page 2 of 8)

Subdistrict 101-29																	
Sample no.	1	2	3	4	6	7	8	9	10	12	13	14	15	16	17	19	20
1	123	125	88	97	54	78	51	91	95	105	108	82	81	78	77	143	77
2	88	115	87	73	100	48	71	73	90	64	86	131	102	82	94	138	83
3	79	112	98	83	94	65	34	84	81	93	85	122	93	81	141	112	32
4	82	130	94	115	31	79	69	77	119	109	79	62	62	90	78	115	122
5	129	131	78	78	91	66	43	68	121	82	83	103	37	91	82	111	73
6	94	119	84	75	72	74	124	122	89	97	122	106	87	81	92	130	112
7	90	117	95	82	103	73	106	103	128	78	88	105	77	95	83	132	112
8	105	111	84	90	100	107	86	74	86	77	89	73	54	79	74	109	74
9	104	141	74	62	111	77	94	114	89	52	78	119	87	120	83	123	66
10	75	131	104	97	81	75	87	78	94	81	101	123	90	85	84	117	80
11	83	128	87	41	35	75	64	73	81	83	82	91	104	61	74	137	86
12	138	121	82	109	96	71	102	54	113	29	93	91	122	74	70	128	72
13	119	104	84	87	38	82	85	93	88	119	99	114	66	73	85	121	73
14	91	89	125	93	49	71	97	102	85	80	87	46	90	75	79	142	80
15	125	143	79	132	94	69	24	112	122	25	100	101	71	82	82	135	98
16	135	96	102	112	85	108	73	81	102	78	93	86	77	98	89	121	101
17	128	118	121	82	33	126	55	69	79	71	87	99	51	112	73	145	104
18	122	86	91	83	95	96	107	73	87	89	82	105	74	88	98	121	106
19	128	117	89	119	93	72	60	111	92	73	91	99	65	78	90	136	104
20	90	114	108	110	90	28	77	122	114	60	94	131	101	78	74	140	91
21	80	99	67	68	79	53	63	90	104	88	91	130	94	90	81	96	90
22	97	132	103	75	92	70	72	44	99	95	96	102	68	118	93	152	95
23	113	116	92	60	113	114	86	94	91	81	85	127	133	98	142	142	83
24	110	121	92	68	111	101	90	83	96	92	93	94	48	106	63	129	120
25	124	116	129	78	93	86	65	111	92	88	87	101	83	86	63	129	104
26	113	148	111	77	82	71	66	65	83	66	102	111	86	37	83	127	107
27	88	135	83	92	98	80	74	74	76	139	82	118	71		51	101	99
28	98	113	90	133	52	98	65	83	82		94	131	58		130	118	63
29	92	122	82	87	21	123	62	82	76		80	85	49		72		39
30	92	128		96		98	82	64	113		84	103	101		92		100
31	69	104		28		44	74				75				44		102
32				107			86				81				84		
33				98			83								63		
34							79								81		
35							74										
36							49										
37							70										
38							65										
Average	103	119	93	87	79	80	74	85	96	81	90	103	79	86	84	127	89
Minimum	69	86	67	28	21	28	24	44	76	25	75	46	37	37	44	96	32
Maximum	138	148	129	133	113	126	124	122	128	139	122	131	133	120	142	152	122
Depth (mllw)	22	22	10	33	10	33	4	10	20	9	13	33	22	10	9	20	11

Appendix 3. (page 3 of 8)

Subdistrict 102-10							
Sample no.	10	22	24	Sample no.	10	22	24
1	78	102	78	21	81	126	92
2	75	96	94	22	80	92	97
3	79	87	98	23	75	92	115
4	53	97	85	24	44	109	113
5	105	99	94	25	47	69	92
6	75	87	94	26	98	102	92
7	100	99	100	27	28	101	38
8	65	88	103	28	83	116	81
9	69	92	95	29	83	72	48
10	81	88	100	30	78	82	
11	75	103	59	31	78	68	
12	93	89	94	32	95	75	
13	87	93	103	33	78	92	
14	76	89	86	34	80	114	
15	34	91	67	35	81	96	
16	26	91	81	36	100		
17	73	108	111	37	75		
18	78	95	102	38	86		
19	79	64	103	39	70		
20	56	47	95	40	29		
				41	76		
				Average	73	90	92
				Minimum	26	47	59
				Maximum	105	108	111
				Depth (mllw)	43	45	53

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Subdistrict 102-20																	
Sample no.	3	4	5	6	8	16	18	19	21	22	23	24	25	26	27	28	29
1	107	69	105	28	90	77	49	104	60	120	44	88	107	99	79	84	82
2	116	71	106	97	76	125	71	134	127	64	79	106	101	83	69	76	51
3	125	111	85	128	82	112	82	106	90	80	73	79	69	125	69	69	41
4	101	125	125	88	80	87	95	151	108	71	73	86	96	145	71	79	42
5	130	94	93	104	101	64	70	148	129	83	87	91	104	123	66	97	52
6	110	81	111	134	109	67	87	105	104	100	65	99	103	113	77	88	30
7	97	102	61	142	76	78	93	131	101	76	118	86	109	133	77	94	120
8	84	61	113	116	71	83	103	51	105	94	71	74	79	127	85	58	101
9	99	111	108	96	109	76	87	121	116	72	87	88	106	139	85	78	118
10	94	100	98	120	111	82	84	125	85	93	63	86	101	123	84	73	94
11	103	77	85	122	91	98	95	116	101	79	88	88	98	78	63	78	109
12	103	61	123	108	93	48	94	109	86	69	69	84	95	44	78	96	104
13	92	77	109	50	106	53	109	152	109	93	125	98	115	129	89	112	147
14	119	88	137	99	90	91	124	76	111	102	60	73	117	134	98	86	100
15	100	63	121	133	76	84	91	100	96	74	126	65	100	92	71	72	103
16	105	68	95	110	101	92	101	114	95	73	73	71	71	127	76	75	99
17	85	71	95	113	109	78	77	135	111	70	104	77	78	133	101	91	130
18	133	103	56	100	95	69	79	57	76	68	73	77	120	109	80	90	149
19	127	116	58	98	107	105	92	120	85	84	63	72	117	87	73	80	93
20	120	78	54	123	98	72	103	96	83	69	81	119	103	142	75	80	98
21	103	75	40	123	99	101	109	98	105	75	63	103	87	141	68	80	97
22	88	79	36	118	102	76	98	138	41	65	66	68	136	115	78	109	124
23	106	72	36	110	90	103	119	123	111	71	60	88	74	145	70	79	92
24	103	117	34	118	106	65	89	121	37	80	49	105	78	132	106	105	114
25	110	92	35	135	88	88	95	83	95	104	63	91	121	95	69	122	107
26	119	60	35	120	79	81	90	85	125	75	56	88	93	111	90	42	92
27	109	67	21	115	111	72	103	99	96	80	92	93	86	63	63	78	91
28	126	63	63	111	116	83	81	114	87	63	65	101	136	56	82	89	88
29	105	87	126	122	91	121	130		101	75		90	97	45	67	80	95
30	94	96		125	87	72	79		121	63			90	49	98	65	95
31					119	75	91		38	113				49	83	70	145
32					112	69			93					52	74	86	97
33						80								83	82	94	91
34						74									89		99
35						64											
36						73											
Average	107	85	82	110	96	82	93	111	95	81	76	87	100	104	79	83	97
Minimum	84	60	21	28	71	48	49	51	37	63	44	65	69	44	63	42	30
Maximum	133	125	137	142	119	125	130	152	129	120	126	119	136	145	106	122	149
Depth (mllw)	23	32	20	28	36	6	33	10	24	20	34	33	36	19	32	20	21

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Subdistrict 102-50															
Sample no.	1	2	3	4	6	7	8	10	12	14	15	16	17	18	19
1	62	89	99	54	89	111	132	93	111	95	111	28	114	94	99
2	86	94	94	28	98	99	137	99	102	115	108	48	95	101	102
3	94	89	94	38	82	95	120	114	87	111	82	60	128	58	99
4	96	113	121	39	87	71	138	138	107	120	57	62	128	63	95
5	106	128	82	63	78	102	139	98	84	135	53	48	110	97	125
6	107	80	94	57	84	93	128	103	113	111	95	50	124	77	79
7	109	132	109	54	82	125	132	94	98	120	56	52	107	103	92
8	111	140	73	61	93	97	150	110	68	94	79	48	132	82	106
9	117	122	82	54	113	89	142	92	112	43	90	92	83	93	109
10	120	111	79	58	102	93	108	91	109	44	106	120	64	111	92
11	132	90	93	56	138	100	99	91	84	44	97	63	91	92	69
12	133	120	90	72	130	82	131	89	116	46	125	42	86	123	134
13	134	95	55	54	98	98	160	125	88	55	113	116	117	99	133
14	134	84	97	68	83	91	112	108	99	59	118	57	97	114	109
15	140	99	83	58	138	120	147	109	111	66	66	59	128	67	104
16	140	94	80	65	117	99	76	109	92	59	112	90	125	58	118
17	152	89	103	60	134	106	138	108	106	150	113	91	138	90	68
18		111	80	63	115	94	145	96	124	72	106	51	106	78	74
19		97	91	105	130	106	124	101	104	101	83	105	91	86	82
20		110	81	72	120	104	131	130	94	137	122	121	104	70	105
21		99	89	82	131	122	128	110	102	99	116	106	109	93	87
22		107	51	61	135	97	132	116	104	129	103	106	105	80	91
23		80	96	80	78	76	115	81	94	141	82	56	130	67	82
24		82	27	64	134	65	122	109	104	120	106	130	37	41	67
25		87	47	52	130	87	140	132	24	117	93	88	44	51	80
26		97	88	80	133	86	130	79	92	135	131	113	41	35	94
27		82	99	68	137	92	132	106	92	102	93	71	61	53	94
28		107	82	98	125	96	157	95	91	123	112	55	40	92	120
29		117	120	66	145	53	143	106	97	122	110	112	78	96	106
30		82	63	66	92	79	124	105	108	138	133	52	113	73	111
31		133		80	119	74	137	92	102	112	104			75	45
32		120			91	106		100		66	93			110	94
33		80				91		77			94				
34						125		121			126				
Average	116	102	85	64	111	95	131	104	97	99	100	76	98	82	96
Minimum	62	80	27	28	78	53	76	77	24	43	53	28	37	35	45
Maximum	152	140	121	105	145	125	160	138	124	150	133	130	138	123	134
Depth (mllw)	27	17	33	11	21	28	13	24	33	28	33	7	25	34	29

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Subdistrict 102-70																
Sample no.	1	3	4	5	6	14	15	16	19	20	21	22	23	24	25	26
1	92	40	43	104	94	89	84	78	110	102	53	88	122	114	144	82
2	125	30	34	81	104	123	100	128	85	115	97	124	95	108	108	101
3	108	30	36	110	97	85	111	115	94	94	42	110	81	93	88	88
4	95	42	32	74	106	104	121	108	80	99	51	125	126	110	108	93
5	138	39	44	77	95	127	108	93	69	98	42	120	104	101	132	75
6	23	34	54	70	113	81	105	120	115	105	37	97	76	113	115	86
7	98	32	66	69	107	103	75	131	94	101	43	85	134	95	129	136
8	104	34	78	62	97	104	76	91	88	126	48	84	104	104	134	74
9	98	45	89	85	99	107	60	111	123	114	69	88	108	128	111	134
10	61	33	85	80	102	104	82	117	100	88	57	103	116	128	111	103
11	108	81	98	102	102	66	64	100	90	89	61	108	101	73	82	123
12	92	46	94	102	100	82	73	119	112	100	91	82	112	121	44	85
13	105	44	105	78	60	41	65	101	117	88	85	103	83	117	39	113
14	117	43	124	66	110	81	94	120	72	74	85	94	93	112	57	98
15	114	70	107	49	90	37	63	104	88	115	89	88	96	114	116	100
16	98	85	116	82	53	120	82	126	111	97	85	98	94	98	87	89
17	92	72	100	112	118	37	75	82	89	93	43	127	134	116	93	99
18	80	94	143	67	89	34	90	80	135	78	87	101	34	89	115	72
19	120	90	41	84	21	81	92	92	133	87	86	111	77	120	118	121
20	92	108	98	81	105	73	80	97	149	115	100	77	110	73	103	103
21	115	87	106	82	129	87	96	127	133	104	99	102	112	54	116	127
22	114	112	91	68	118	82	61	82	118	107	89	85	90	100	118	77
23	91	128	101	79	109	74	76	140	133	99	132	82	77	112	96	138
24	134	131	95	62	127	81	103	129	136	123	99	113	34	154	108	108
25	108	140	114	68	111	80	59	104	132	103	129	32	107	133	129	84
26	122	123	124	68	78	91	86	90	97	83	135	99	101	112	87	111
27	96	138	96	74	110	111	79	83	148	93	97	68	81	124	123	99
28	98	85	115	79	124	133	82	88	97	82	97	89	79	114	85	91
29	89	80	111	83	88	122	90	75	126	116		92	69	93	126	97
30	102	142	91	90	89	118	83	77	103	104		79		103	48	91
31	103	139	94	86		51	87	39	69	91		105				126
32			93				72	47	107	101		130				88
33							94	89	119	111		85				97
34							112	85	102	116		88				81
35							82		124	107		78				83
36							63		123							127
37																111
38																79
39																80
40																89
41																100
42																123
43																79
Average	98	75	86	77	95	85	82	97	106	98	78	93	92	105	100	97
Minimum	1	3	4	5	6	14	15	16	19	20	21	22	23	24	25	26
Maximum	138	142	143	112	129	133	121	140	149	126	135	130	134	154	144	138
Depth (mllw)	35	10	26	28	19	12	18	14	26	26	22	26		10	23	6

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Subdistrict 104-30 con															
Sample no.	3	5	6	7	36	37	38	39	40	44	45	46	47	48	50
1	103	118	32	98	70	89	37	103	93	112	105	36	136	106	48
2	87	105	47	84	57	67	96	96	90	138	84	97	95	129	103
3	94	97	32	78	96	84	126	133	91	142	99	36	127	90	44
4	112	103	18	132	110	81	126	116	99	135	116	90	133	104	150
5	92	112	40	75	80	52	92	131	110	125	117	83	110	103	127
6	92	90	32	82	79	75	107	100	118	160	108	93	126	34	94
7	89	98	47	117	77	78	97	139	115	134	94	31	135	41	80
8	96	120	57	101	62	129	137	139	138	147	92	102	99	103	66
9	96	122	77	129	105	105	132	134	120	104	107	100	116	76	78
10	96	98	52	103	101	85	135	89	81	122	80	70	136	93	40
11	63	90	76	82	70	28	95	131	104	129	30	73	135	112	112
12	88	110	123	33	121	58	105	134	118	106	100	102	78	101	39
13	84	128	102	90	59	102	78	160	95	175	66	71	117	121	47
14	107	115	122	80	110	124	40	111	84	110	20	63	111	53	44
15	85	78	100	65	78	82	68	134	113	131	119	101	122	59	76
16	86	97	125	117	135	99	25	132	95	117	73	70	115	73	41
17	102	93	74	78	24	66	122	130	104	117	66	70	114	97	55
18	84	96	122	77	50	134	101	131	105	117	96	106	118	108	108
19	99	99	145	97	65	83	95	64	130	125	102	94	133	102	52
20	89	89	138	103	89	96	89	89	81	127	93	45	130	92	52
21	84	99	77	99	86	68	110	102	98	113	82	87	121	101	83
22	107	118	97	116	90	77	86	136	117	145	71	96	97	100	47
23	86	100	126	113	90	79	81	141	133	130	63	85	100	102	104
24	104	77	94	94	72	88	89	114	113	139	62	32	38	104	74
25	102	74	37	77	98	23	13	46	91	117	91	92	138	115	47
26	103	82	65	74	22	75	23	44	23	127	91	101	117	118	86
27	82	65	77	93	20	31	33	97	28	150	106	69	100	111	37
28	19	61	124	74	31		46		23		101	61	111	113	42
29	117	57	132	75	50		34		20		111	88	107	107	81
30	115	58	113	103	54		43		101		101	68	112		132
31	110	45		119	83		42					80	130		126
32		68		47			37								102
33		49					53								45
34		38					47								142
35		50													93
36		83													75
37		68													37
38		60													
Average	90	85	81	88	74	78	77	111	93	126	87	76	113	94	75
Minimum	3	5	6	7	20	23	13	39	20	44	20	31	38	34	37
Maximum	117	128	145	132	135	134	137	160	138	175	119	106	138	129	150
Depth (mllw)		7	3	21	3	16	7	12	28	31	32	17	40	50	12

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Subdistrict 104-30 exp																					
Sample no.	1	8	9	10	12	14	15	16	17	18	19	20	22	23	24	25	27	28	29	30	31
1	71	99	89	32	79	70	86	94	107	96	83	99	94	55	92	124	37	102	83	45	85
2	63	28	88	40	100	43	88	60	53	106	107	111	90	101	100	143	118	23	69	81	120
3	59	98	90	28	128	34	30	96	84	11	97	116	58	88	91	130	24	65	78	102	49
4	65	104	87	19	104	70	20	86	72	12	132	100	118	98	99	115	108	74	102	54	67
5	61	116	96	18	72	40	82	51	93	17	106	123	119	94	92	110	107	94	115	18	117
6	107	99	98	26	58	56	122	100	35	15	84	97	102	92	135	98	94	90	87	42	88
7	87	117	63	23	23	78	74	52	48	11	95	78	40	146	116	69	101	91	96	97	114
8	95	103	76	16	38	45	63	110	40	14	82	108	103	92	117	103	101	112	101	103	86
9	108	119	50	16	42	111	96	99	54	15	74	110	84	104	136	49	124	100	99	42	120
10	117	118	89	27	53	108	78	101	94	74	52	99	98	101	121	71	130	133	107	22	58
11	103	128	75	23	38	33	68	88	87	100	80	99	75	90	142	82	118	73	127	57	18
12	98	133	88	21	53	40	82	90	94	98	63	107	92	119	119	41	103	82	110	104	23
13	60	97	54	26	44	140	87	79	88	100	83	110	97	100	115	94	134	49	125	88	22
14	109	88	100	26	50	74	83	96	55	92	101	84	111	108	142	117	93	90	120	82	25
15	63	127	50	32	102	45	63	111	77	95	69	105	109	113	125	79	99	84	96	100	48
16	119	99	100	33	57	63	72	88	103	97	62	109	92	43	117	83	97	81	33	105	62
17	98	138	104	110	70	72	15	109	95	115	89	108	93	120	131	87	109	79	24	95	62
18	99	88	61	82	113	48	69	104	86	98	57	80	119	116	87	81	99	74	23	104	79
19	107	123	24	53	65	30	83	124	107	92	47	110	93	107	121	83	103	110	29	41	103
20	102	110	27	65	62	69	76	123	119	87	89	84	91	84	110	100	136	95	27	85	75
21	97	109	26	92	66	81	119	82	69	112	76	84	33	21	89	88	80	92	28	88	75
22	94	139	35	84	63	56	39	94	75	94	90	29	71	14	121	38	128	96	72	102	74
23	91	124	27	78	58	85	57	63	85	96	98	107	74	15	127	70	108	77	33	70	98
24	86	128	44	70	104	140	127	77	88	113	59	106	109	14	113	101	116	79	38	62	80
25	120	132	43	42	105	127	78	49	108	79	134	82	113	38	127	132	40	100	47	86	96
26	100	96	44	90	77	79	75	123	123	94	94	94	127	25	107	89	121	68	44	52	59
27	113	111	54	89	76	34	66	120	100	92	108	95	103	25	74	102	106	110	68	81	99
28	67	121	42	117	86	89	63	19		86	110	110	88	48	115	114		75	87	33	97
29	33	133	39	109	98	72	68	59		98	103	107	109	54	108	91		98	73	77	111
30	61	111	53	117	62	44	67	108		90	94	90		53	92	75		76	78	100	116
31	48	117		95		69	79			85	73	109		42		74		80	84	30	122
32		125				27	84			89	98			55				130	99	37	74
33						28	77			109	91			52					80	92	67
34						42	28			103	110								96	102	
35						34	19			106	85								117	98	
36						38					80								75	38	
37						73					25								34	25	
38						83					25										
39						37					49										
40											50										
41											42										
Average	84	109	62	53	70	63	69	86	81	78	80	96	91	72	110	89	99	85	75	70	77
Minimum	1	8	9	10	12	14	15	16	17	11	19	20	22	14	24	25	24	23	23	18	18
Maximum	120	139	104	117	128	140	127	124	123	115	134	123	127	146	142	143	136	133	127	105	122
Depth (mllw)	10	32	50	26	5	21	28		10	22	33	43	37	28	49	13	28	7	50	25	19

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