RED SEA URCHIN ASSESSMENT SURVEYS

DISTRICTS 101, 103, AND 104

1999

By

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ABSTRACT

A population assessment survey was conducted in portions of commercial fishing Districts 101, 103, and 104 in Southeast Alaska to estimate red sea urchin biomass and size distribution in 1999. The survey was conducted by ADF&G divers during July 1999 in nine subdistricts that were subsequently opened to commercial fishing (101-29 experimental, 103-30, 103-40, 103-50, 104-10, 104-20, 104-30 experimental, 104-35, and 104-40). Commercially available red urchin biomass estimated during this survey was 22.3 million kg (49.3 million pounds). Total red urchin biomass for all areas of Southeast Alaska opened to commercial fishing is estimated at 49.9 million kg (110.4 million pounds) with a 90% lower confidence bound of 27.9 million kg (61.7 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 4.0 million kg (8.9 million pounds).

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 1999, red sea urchin assessment surveys focused on Districts 103 and 104. This was the second year, since red urchin assessment commenced in 1994, that surveys were concentrated in Districts 103 and 104. Additionally, experimental and control areas were surveyed in District 101, near Ketchikan, and District 104, near Craig (Figure 1).

Subdistricts 103-30, 103-40, 103-50, 104-10, 104-20, 104-35, and 104-40 were previously surveyed in 1996. 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 1999 prior to allowing a commercial fishery during the 1999-2000 season.

Annual survey 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. Subdistrict 101-29 has been previously surveyed in 1995, 1997, and 1998. Subdistrict 104-30 was surveyed in 1996, 1997 (Larson and Woodby 1997; Larson et al. 1998), and 1998 (Hebert and Larson 1999) 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 the experimental and control areas to improve the precision of biomass estimates. A second control area, comprised of Subdistrict 101-27, was surveyed for the third year. 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 1999 was funded through Nearshore Fisheries grant

money 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 1999. 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.

The department has plans to coordinate with the Southeast Alaska Regional Dive Fisheries Association (SARDFA) to conduct red sea urchin reconnaissance in late 1999 or 2000. Reconnaissance surveys will explore the extent of red sea urchins in selected areas, for example in deeper water than is currently surveyed or explore outer island areas, such as Forrester Island. Results of reconnaissance surveys will determine whether biomass surveys are expanded in future years.

METHODS

The *R/V Sundance* was used as support vessel for all biomass assessment surveys in 1999. 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. A new method of calculating biomass was implemented this year, which involved the inclusion of a variance component for weight samples.

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 1-13; 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. Subdistricts 104-10, 104-20, 104-30). Once a reference depth was established for a subdistrict, surveys were completed to that depth for all transects in that subdistrict. 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 60 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:

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

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, 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 (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. Urchins were collected at 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

$$\text{mass} = 0.00124 \times \text{diameter}^{2.696} \tag{2}$$

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:

$$\overline{W}_t = \left(\frac{\sum_{j=i}^{\Sigma w_i / \Sigma o_i}}{n_j} \right) \tag{3}$$

Were w_i is the estimated weight (based on equation 2 above) 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:

$$b_j = \bar{d}_j W_j l_t \tag{4}$$

were *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. 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:

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

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 1999 is 22,302 metric tons (24,644 short tons). The 90% lower bound estimate of biomass is 10,979 mt (12,131 st). Of the total biomass estimated for commercial areas, 2,053 metric tons were estimated for Subdistrict 101-29, 16,370 metric tons for Districts 3 and 4, and 3,879 metric tons for Subdistrict 104-30 experimental (Table 2). Control areas in 101-27 and 104-30 totaled 4,029 mt. Substantial changes in biomass have been observed for most commercially harvested subdistricts since last surveyed in 1996 (Table 2). Not including experimental areas, there was an overall net decrease in total biomass of commercially harvested areas of 3,152 mt, when 1999 and 1996 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 5,624 mt. Average densities across subdistricts, open to commercial harvest, ranged from less than 1 (103-70) to 222 (104-20) 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 16 to 71% (Table 2). This result may be partially explained by patchy distribution of urchins, or variation in urchin weights sampled among transects. Weight precision accounted for a very small amount (less than 5%) of overall precision, in most instances, however in Subdistrict 103-30 it accounted for 13% of overall precision. In Subdistrict 103-70 no urchins were sampled due to extremely low density, and weight precision was not calculated. This was the second year where variation in weight among transects was accounted for in biomass/quota calculations.

Recruitment and Size Distributions

Divers collected a total of 3,015 red sea urchins, among all surveyed subdistricts, to estimate average size and size distributions (Appendix 4). In general, the size distribution of urchins indicates the majority of the urchins are mature (>50 mm) individuals (Figures 14-24). 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. Most subdistricts had bimodal or amodal distributions of test diameters, depending on population size. Amodal distributions were most apparent in areas of low biomass, while bimodal distributions were observed in areas of large standing biomass. This may be partially due to an inability to detect modes in areas where low density of urchins prevented adequate sampling.

District 3

District 3 is characterized by relatively low and declining biomass with some recruitment occurring in the past two years (Figures 14-27). Although Subdistrict 103-30 was the only subdistrict where biomass increased, sampling revealed an amodal distribution with no obvious recent pulse of recruitment and an average size of 94 mm (Figures 15 and 17-19). In 1996 a significant proportion of the population was greater than 110 mm and the average size was 96 mm. The 1999 survey indicated there are fewer large urchins in the population than in 1996 and the range of sizes is narrower.

Subdistrict 103-40 has a broad range of sizes and evidence of recruitment during the past two years (Figure 14). The size distribution is similar to that found in 1996 however in 1999 there was a larger proportion of urchins in the 60-80 mm range. Average size of urchins for 1999 and 1996 were 97 mm and 103, respectively. During the 1996 survey, only beds 103-40-001 and 103-40-004 were surveyed, whereas in 1999 the entire subdistrict was surveyed, excluding the closed waters around the village of Hydaburg. This may partially account for observed differences in population size structure.

Subdistrict 103-50 had a broad range of sizes and an average size of 81 mm in 1999 (Figure 15). The size of urchins has decreased since 1996 as evidenced from a shift in size distribution and decreased average size from 90 mm in 1996. It is possible that some larger urchins have been cropped by sea otters. A substantial segment of the population occurs in the 40-50 mm range, which is consistent with expected growth of young-of-year urchins observed in 1996. A small amount of recruitment was observed in 1999.

District 4

Overall, population structure appears to be stable in the southern end of District 4 (104-10 and 104-20), however in northern areas (104-35 and 104-40) there have been major shifts in distribution of size classes (Figures 16-19). Subdistrict 104-10 has a broad range of sizes with recent recruitment (Figure 16). The size distribution in Subdistrict 104-10 is consistent with growth of a large proportion of 50-70 mm urchins observed in 1996 into the 70-90 mm size range. There appears to be recent recruitment in 1999. The average size of urchins in 1999 was 90 mm, unchanged from 1996.

In Subdistrict 104-20 there appears to be little change in the structure of the mature population (>60 mm) since 1996 (Figures 16 and 21). The average size of urchins decreased from 88 mm to 83 mm, which is probably due to a large proportion of 20-45 mm urchins in 1999. These urchins suggest a strong recruitment event in the past two years.

The size distribution of Subdistrict 104-35 is dominated by two modes at 48 mm and 105 mm (Figures 16 and 22). This is a result of urchins from a very strong recruitment event in 1996 growing into the 40-60 mm size range. The average size in 1996 and 1999 was 67 mm and 74.5 mm, respectively.

Subdistrict 104-40 has undergone a shift in size distribution from a broad range of sizes and strong recruitment in 1996 to a narrow range and smaller urchins in 1999 (Figures 16 and 23). The average size has decreased from 70 mm to 63 mm between 1996 and 1999. The decline of large urchins in this area is most likely due to sea otters.

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 1999 and 1998 (increase from 90 mm to 91 mm) and the average size in Subdistrict 104-30 experimental increased from 76 mm to 86 mm. In both areas there has been little change in population structure between surveys (Figures 16 and 24). 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 1996-97, 1997-98, and 1998-99 seasons the harvest rates in 104-30 experimental have been approximately 26%, 6%, and 17% respectively. These harvest rates have not had a detectable negative impact on size or size distribution of urchins in this area. The one noticeable change in 104-30 control is the growth of a pulse of 15-30 mm urchins in 1998 to the 28-47 mm size range in 1999. These areas appear to be stable and there is no indication that sea otters have impacted them.

Control and experimental areas in District 1 (101-27 and 101-29, respectively) have also been stable for three years of surveys (Figures 14 and 26-27). Both areas have a broad range of sizes with a small amount of recent recruitment. The average size in 101-27 decreased from 113 mm to 107 mm between 1998 and 1999. Average size in 101-29 increased from 87 mm to 94 mm, despite harvest. Experimental harvest rates of 20% have not been reached and the low level of harvest (2.8%) during 1998-99 season may have been too low to detect any impact on the stock.

Urchin Density, Population Size, and Biomass

Estimates of density, population size, and biomass are compared to estimates from the previous survey (1996) without accounting for changes in methodology between surveys (Tables 2a and 2b). 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 adjusting makes comparisons useful for monitoring health of population. Adjustments include calculating biomass using the depths and shoreline used for the previous survey.

Districts 3 and 4

Comparing 1999 and 1996 estimates of biomass in areas open to commercial harvest without adjusting for different methods indicates four areas (103-50, 103-70, 104-35, and 104-40) decreased (Tables 2a and 2b). Two areas (104-10 and 104-20) increased substantially, but this was primarily due to surveying to a greater depth. One area (104-35) decreased, but at far less than it would have if surveyed to the same depth as in 1996. One area (103-40) increased because of an additional section of shoreline included in the subdistrict that has been previously closed. Overall, for all areas surveyed in 1999 (without adjusting for methodology) there was no net biomass change.

Comparing biomass after adjusting for depth differences indicates that only two areas open to commercial harvest (101-29 and 103-30) increased. All other decreased. The 1999 biomass estimates for District 3 (103-40, 103-50, and 103-70) were 29% to 100% less than previous surveys in 1996 (Table 2). Biomass decreases in District 4 (104-10, 104-20, 104-35, and 104-40) were all substantial, ranging from 17% to 78% reductions. Overall, considering all areas together surveyed in 1999 there was an 18% reduction in biomass. All biomass estimates are made using a method of calculation revised in 1998 (see Methods) for both 1999 and 1996 data.

The reason for the decline in Districts 3 and 4 is unknown at this time, however sea otter predation is highly suspect in some areas. We found evidence of sea otter presence in 103-30, 103-50, 103-70, 104-35, and 104-40. Highest reduction in biomass appears to be in areas where signs of sea otters were present and follow a progression of higher declines moving from southern Dall Island to the north. This is consistent with known sea otter expansion from Sea Otter Sound to areas to the south. Typical evidence found was broken urchin tests with urchins only in crevices, large craters in geoduck beds, shells of freshly killed abalone and observations of sea otters in the area. One large group (40-50 individuals) of sea otters were observed foraging at Outer Point on Baker Island (104-35).

Control and Experimental Areas

The biomass estimate for Subdistrict 101-29 was 805 mt higher than in the prior survey made in 1998. This represents a 65% increase in biomass. Subdistrict 101-27 control area experienced an increase of 51 mt (9%) in biomass. The reason for the increase in Subdistrict 101-29 may be due to growth and recruitment as a result of harvesting (2.8% harvest rate) during the 1998-99 season, when only 14% of the quota was taken. The increase in 101-27 suggests favorable environmental conditions in the area of Gravina Island may also have contributed to positive population growth.

Urchin biomass has increased substantially (25%) in the 104-30 control area since last surveyed in 1997. Biomass in the experimental section of 104-30 decreased slightly (-3%). Unlike the experimental area in 101-29, the harvest was relatively heavy (18% harvest rate) in 104-30 experimental and 90% of the quota was taken during the 1998-99 season.

These results suggest that a sustainable harvest rate for red sea urchins in Southeast Alaska may lie between 3% and 18%, although appropriate harvest rates probably differ depending on location.

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Table 1. Reference depth (MLLW) to which surveys were conducted and on which biomass calculations were based (if appropriate) during 1999 Southeast Alaska red sea urchin survey of Districts 1, 3, and 4.

Subdistrict	Reference depth (ft)	Reference depth (m)
101-27	33	10
101-29	33	10
103-30	33	10
103-40	33	10
103-50	33	10
103-70	33	10
104-10	56	17.1
104-20	56	17.1
104-30 control	33	10
104-30 experimental	40	12.2
104-35	50	15.25
104-40	40	12.2

Table 2a. Population size and biomass estimates of red urchins from management units (subdistricts) and two control areas (101-27, 104-30con) in Districts 101, 103, and 104, Southeast Alaska, 1999.

Subdistrict	101-27	101-29	103-30	103-40	103-50	103-70
Transects	20	20	15	44	20	15
Count of urchins ≥ 60 mm	2,016	6,203	289	539	1,584	1
Average density (urchins>60/m)	45.3	124.3	7.1	6.0	34.3	0.03
Standard deviation	46.6	114.5	16.6	14.1	82.8	0.1
Percent precision[a]	68.2	70.8	15.9	50.8	27.4	na
Shoreline length (m)	31,105	47,874	160,939	292,522	171,310	113,713
Proportion urchins >60 mm	0.968	0.901	0.890	0.890	0.802	0.0
Average mass/count>60 mm (lbs)[b]	0.950	0.762	0.755	0.851	0.600	0.0
Average biomass (lbs/m)[c]	43.02	94.77	5.33	5.08	20.56	0.0
Population size (urchins>60 mm)	1,409,057	5,950,738	1,137,356	1,748,404	5,867,368	3,753
Population size (all urchins)[d]	1,456,239	6,602,395	1,277,928	1,963,175	7,315,920	3,753
Biomass (lb.)[e]	1,338,235	4,537,162	858,429	1,487,089	3,522,541	0
Lower bound[f]	913,164	3,210,831	136,811	755,466	966,056	na
Biomass (metric tons)	606	2,053	388	673	1,594	0
Lower bound (metric tons)	413	1,453	62	342	437	na
% change biomass (actual)[g]	+ 9%	+ 65%	+ 11%	+ 3%	- 29%	- 100%
% change biomass (comparable)[g]	+ 9%	+ 65%	+ 11%	- 38%	- 29%	- 100%
Quota (lbs)	na	642,166	8,209	45,328	57,963	0

[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 >60 mm.

[c] Average biomass = the product of average mass and average density.

[d] Population size (all urchins) = population size (urchins >60 mm) divided by proportion of urchins > 60 mm.

[e] Biomass = the product of average biomass (lbs/meter shoreline) and shoreline length.

[f] Lower bound biomass = biomass times percent precision.

[g] Actual represents change since 1996 survey without adjustments for changes in methodology; comparable accounts for differences in survey depth and shoreline used since 1996 survey.

Table 2b. Population size and biomass estimates of red urchins from management units (subdistricts) and two control areas (101-27 and 104-30con) in Districts 101, 103, and 104, Southeast Alaska, 1999.

Subdistrict	104-10	104-20	104-30 con.	104-30 exp.	104-35	104-40	Survey Total/Mean
Transects	15	15	20	30	15	15	224
Count of urchins ≥ 60 mm	2,375	6,675	7,368	10,488	3,414	868	41,820
Average density (urchins>60/m)	78.5	222.5	157.5	171.5	113.8	25.7	82.2
Standard deviation	85.1	369.0	167.1	203.4	146.9	57.4	109.2
Percent precision[a]	60.9	40.3	65.3	68.8	53.9	21.0	49.5
Shoreline length (m)	55,745	151,864	43,874	71,506	42,596	40,559	1,223,607
Proportion urchins >60 mm	0.856	0.784	0.797	0.800	0.648	0.496	0.735
Average mass/count>60 mm (lbs)[b]	0.758	0.688	0.956	0.699	0.651	0.569	0.687
Average biomass (lbs/m)[c]	59.54	153.03	150.61	119.88	74.13	14.65	61.72
Population size (urchins>60 mm)	2,569,854	31,319,368	6,910,155	11,480,243	3,578,064	635,435	79,347,569
Population size (all urchins)[d]	3,002,768	39,971,801	8,864,063	14,355,792	5,523,636	1,280,956	100,455,126
Biomass (lb.)[e]	3,319,334	23,239,280	6,608,021	8,516,721	3,157,850	594,089	57,178,761
Lower bound[f]	2,019,994	9,367,103	4,316,865	5,941,050	1,701,997	124,701	29,454,038
Biomass (metric tons)	1,502	10,516	2,990	3,879	1,429	269	25,873
Lower bound (metric tons)	914	4,239	1,953	2,688	770	56.4	13,328
% change biomass (actual)[g]	+ 53%	+ 11%	+ 25%	+ 3%	- 28%	- 78%	- 0.3%
% change biomass (comparable)[g]	- 41%	- 17%	+ 25%	- 3%	- 47%	- 78%	- 18%
Quota (lbs)	121,200	562,026	na	1,188,210	102,120	7,482	2,734,704

[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 >60 mm.

[c] Average biomass = the product of average mass and average density.

[d] Population size (all urchins) = population size (urchins >60 mm) divided by proportion of urchins > 60 mm.

[e] Biomass = the product of average biomass (lbs/meter shoreline) and shoreline length.

[f] Lower bound biomass = biomass times percent precision.

[g] Actual represents change since 1996 survey without adjustments for changes in methodology; comparable accounts for differences in survey depth and shoreline used since 1996 survey.

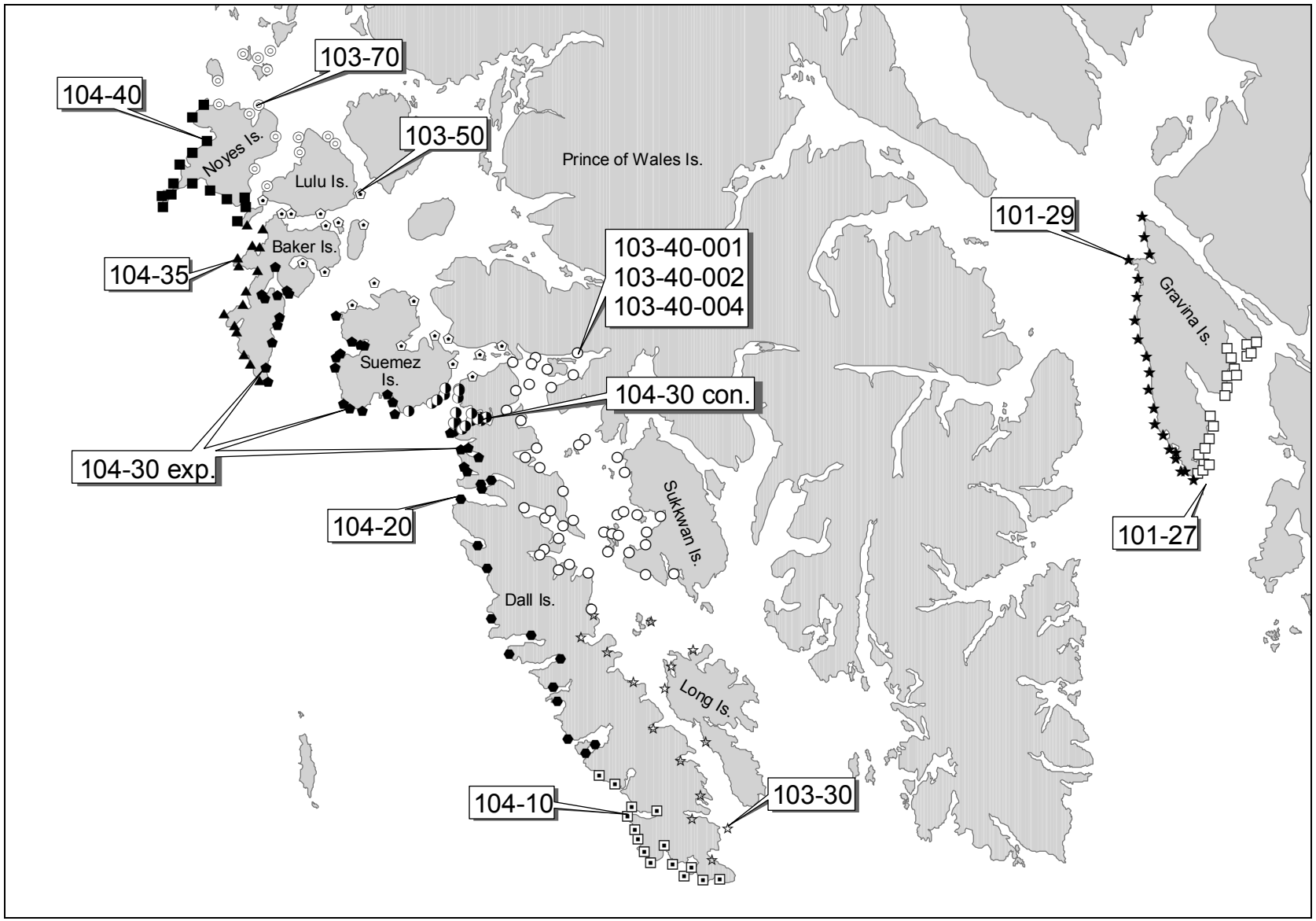

Figure 1. Map of southern Southeast Alaska showing transect locations in fishing and control areas.

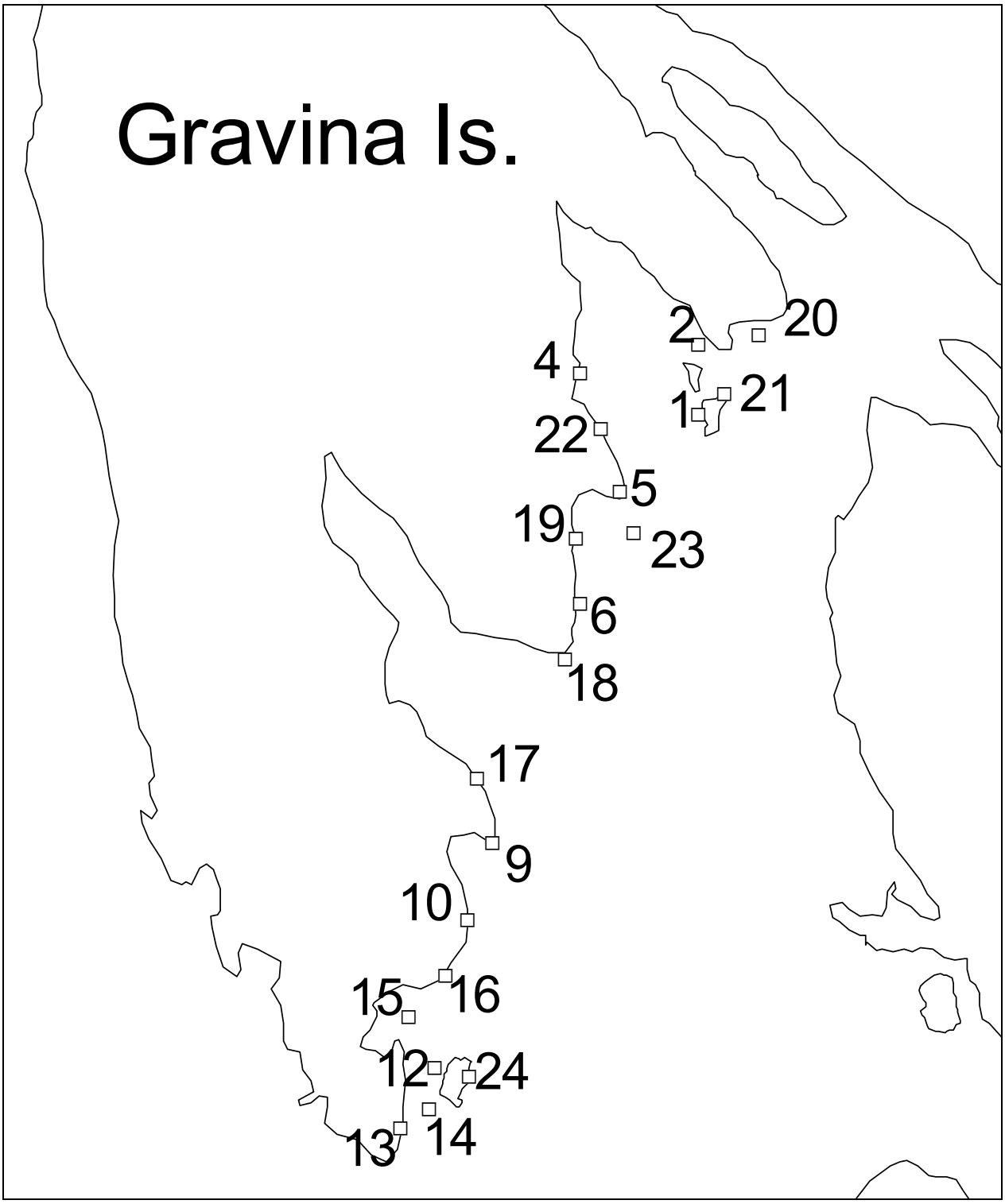

Figure 2. Map of transect pair locations in Statistical Area 101-27.

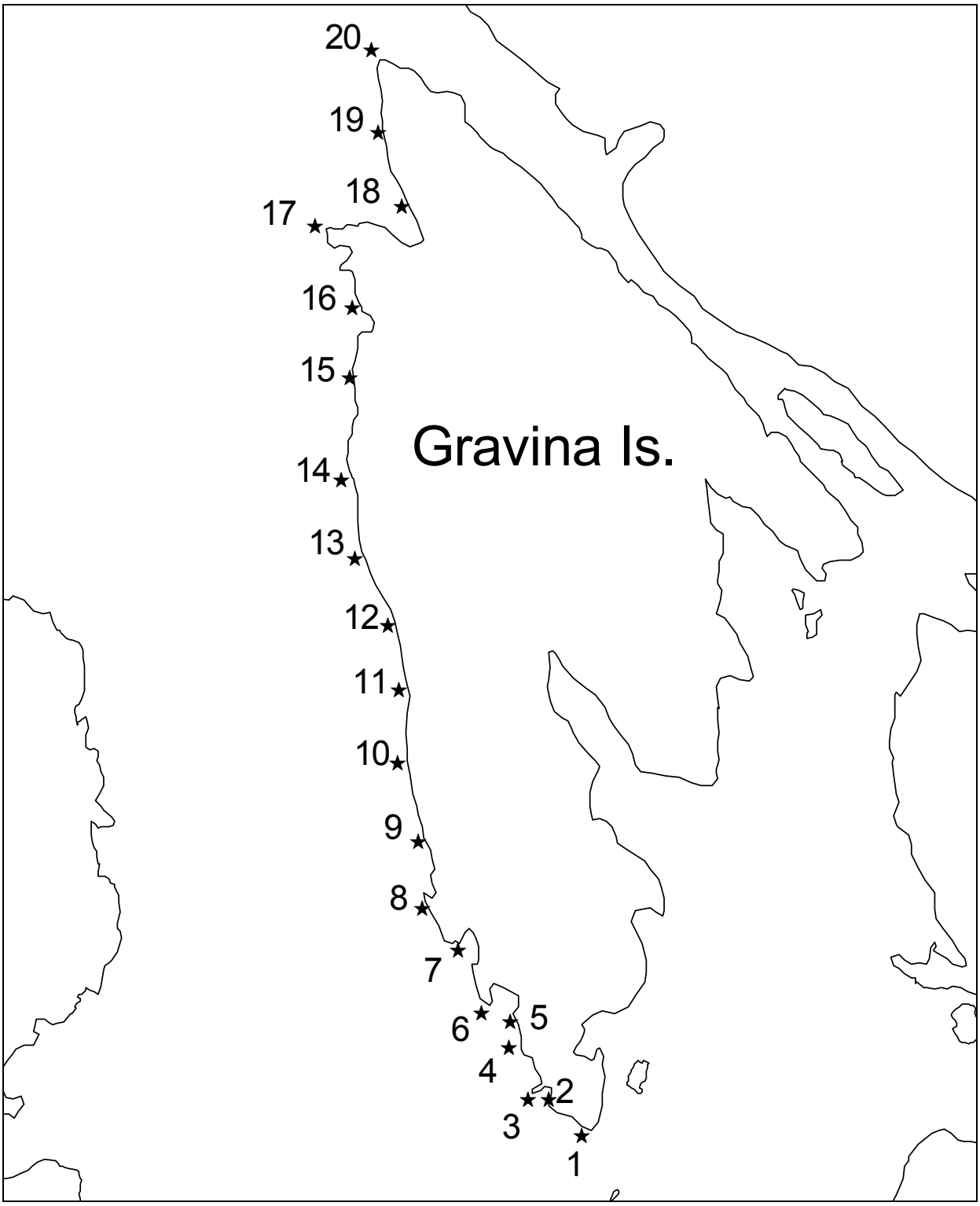

Figure 3. Map of transect pair locations in Statistical Area 101-29.

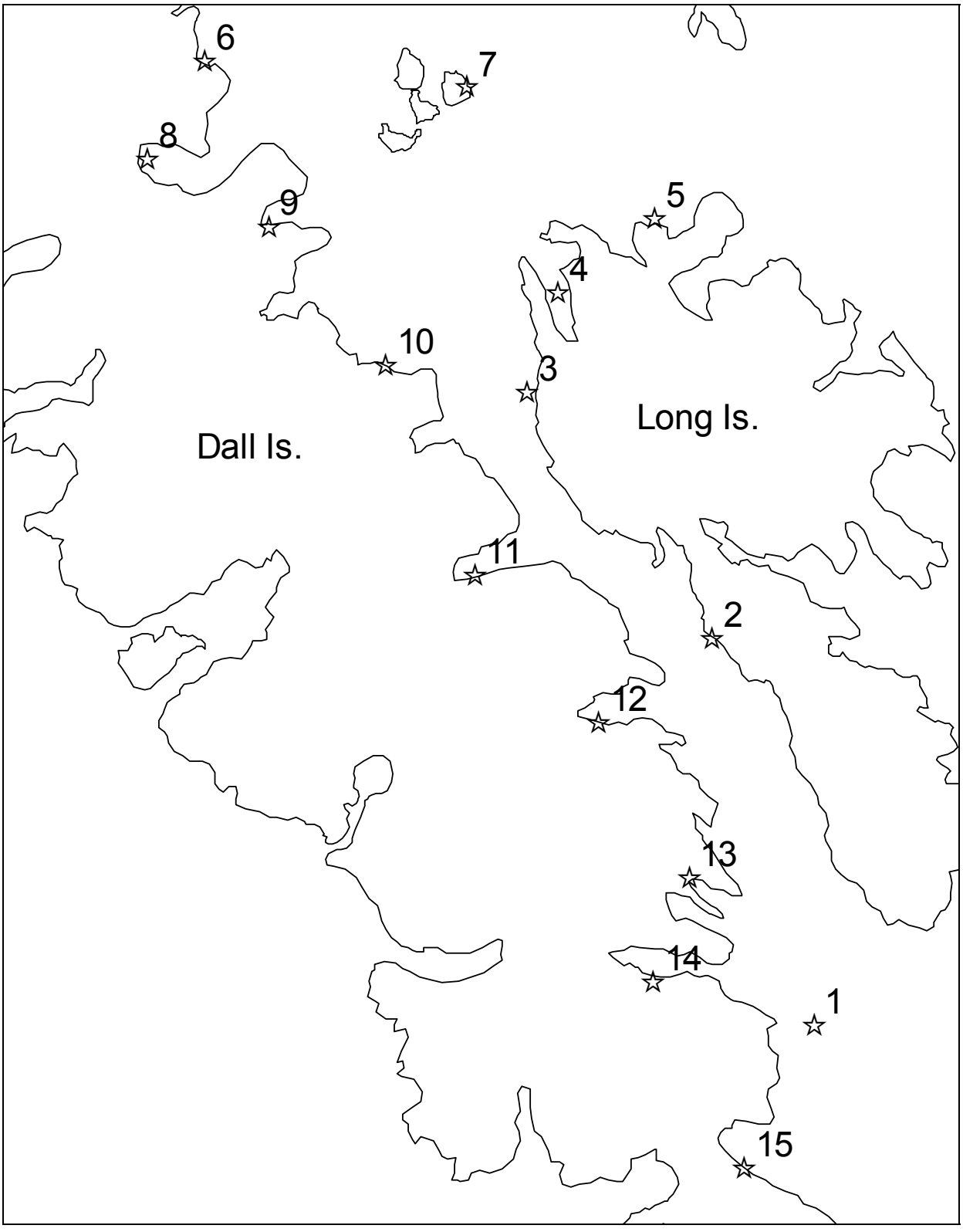

Figure 4. Map of transect pair locations in Statistical Area 103-30.

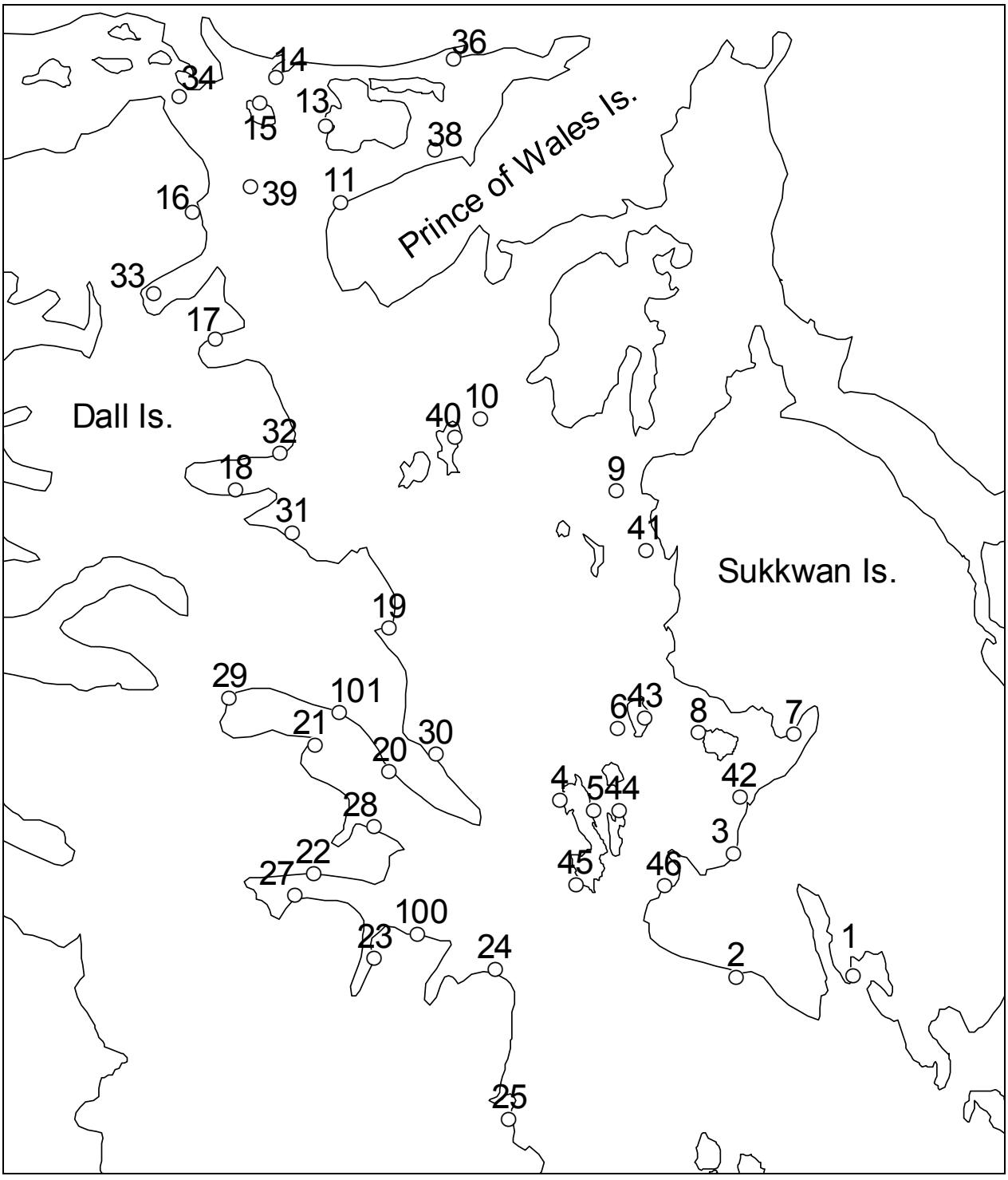

Figure 5. Map of transect pair locations in Areas 103-40-001, 002, 004.

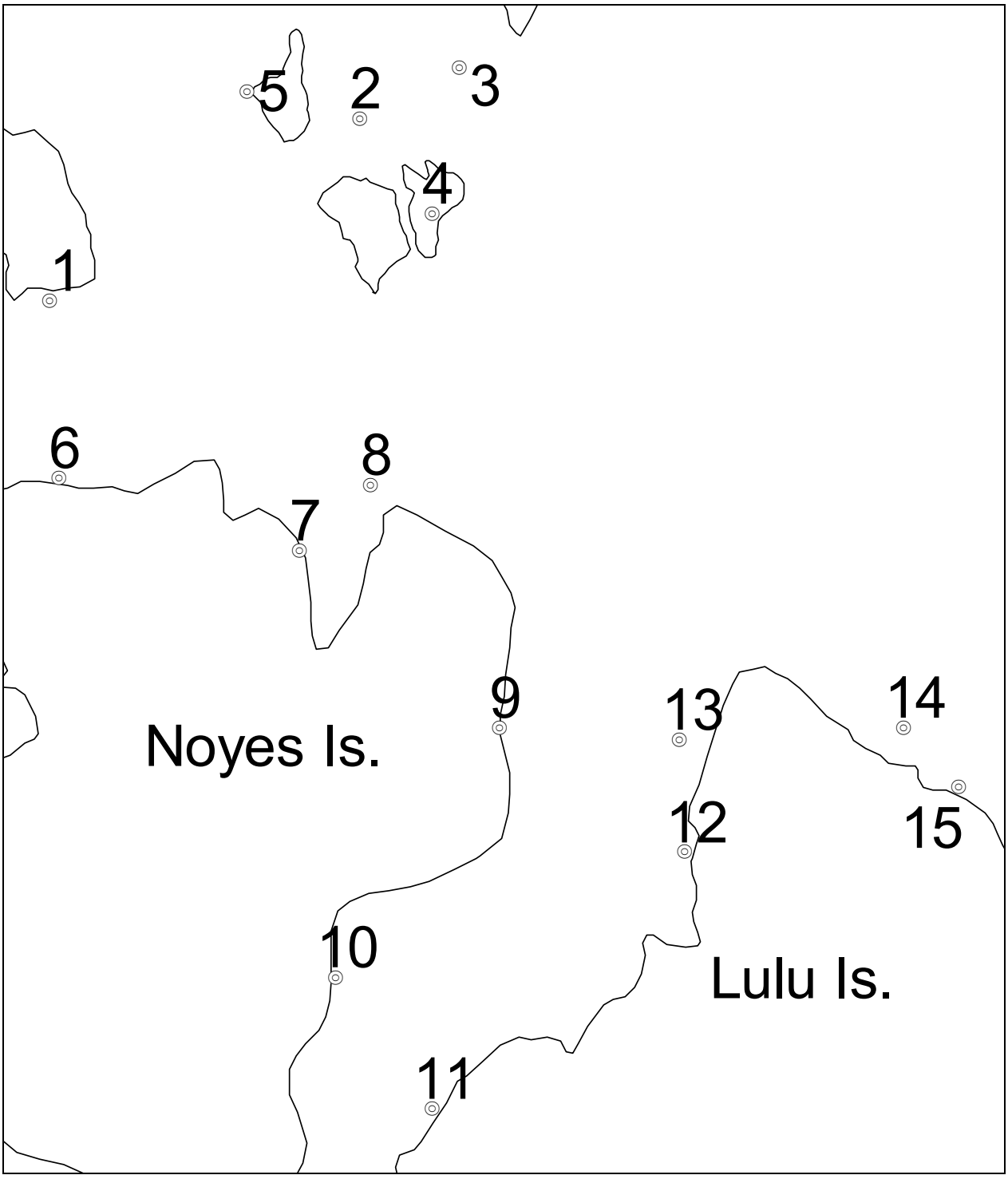

Figure 6. Map of transect pair locations in Statistical Area 103-70.

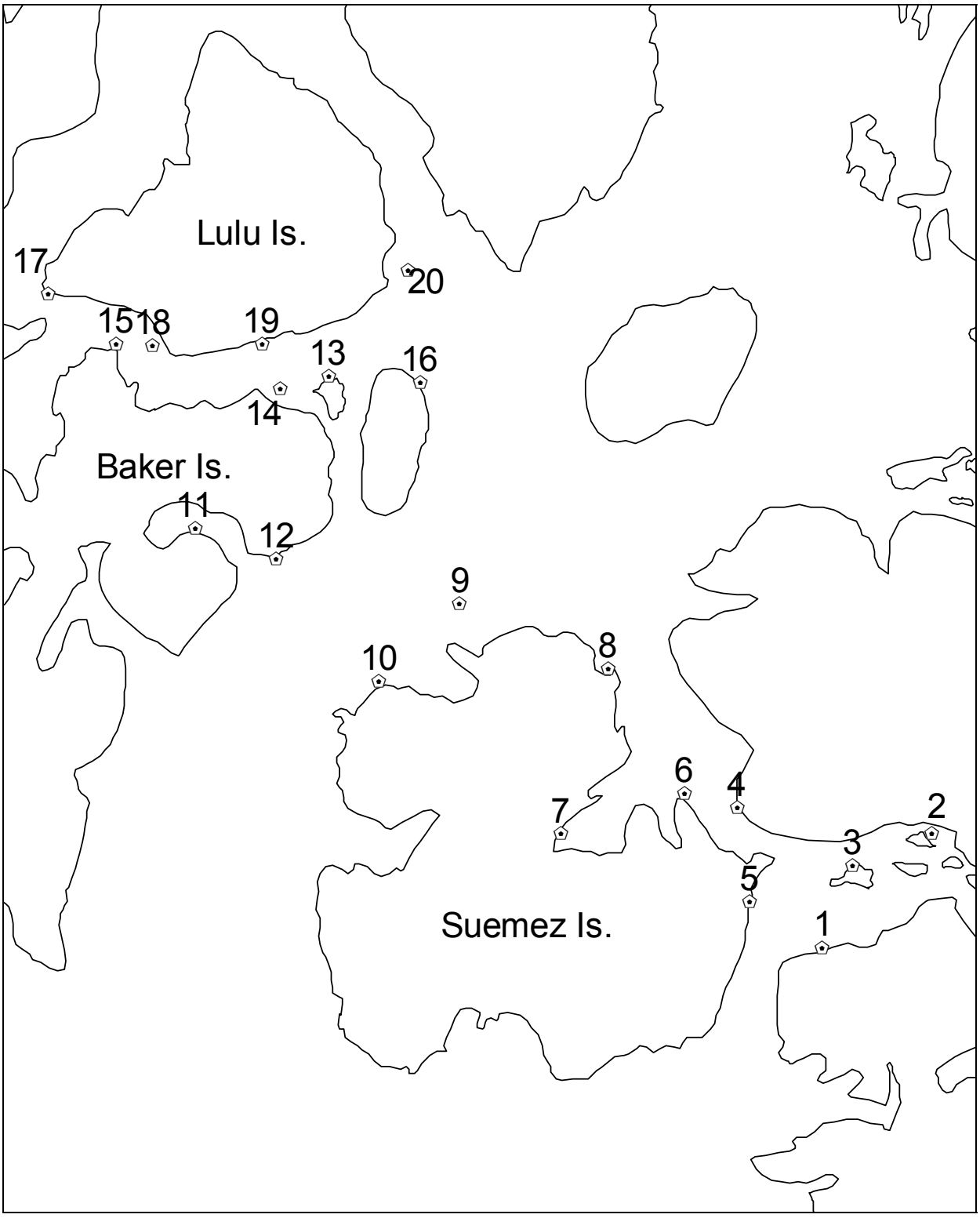

Figure 7. Map of transect pair locations in Statistical Area 103-50.

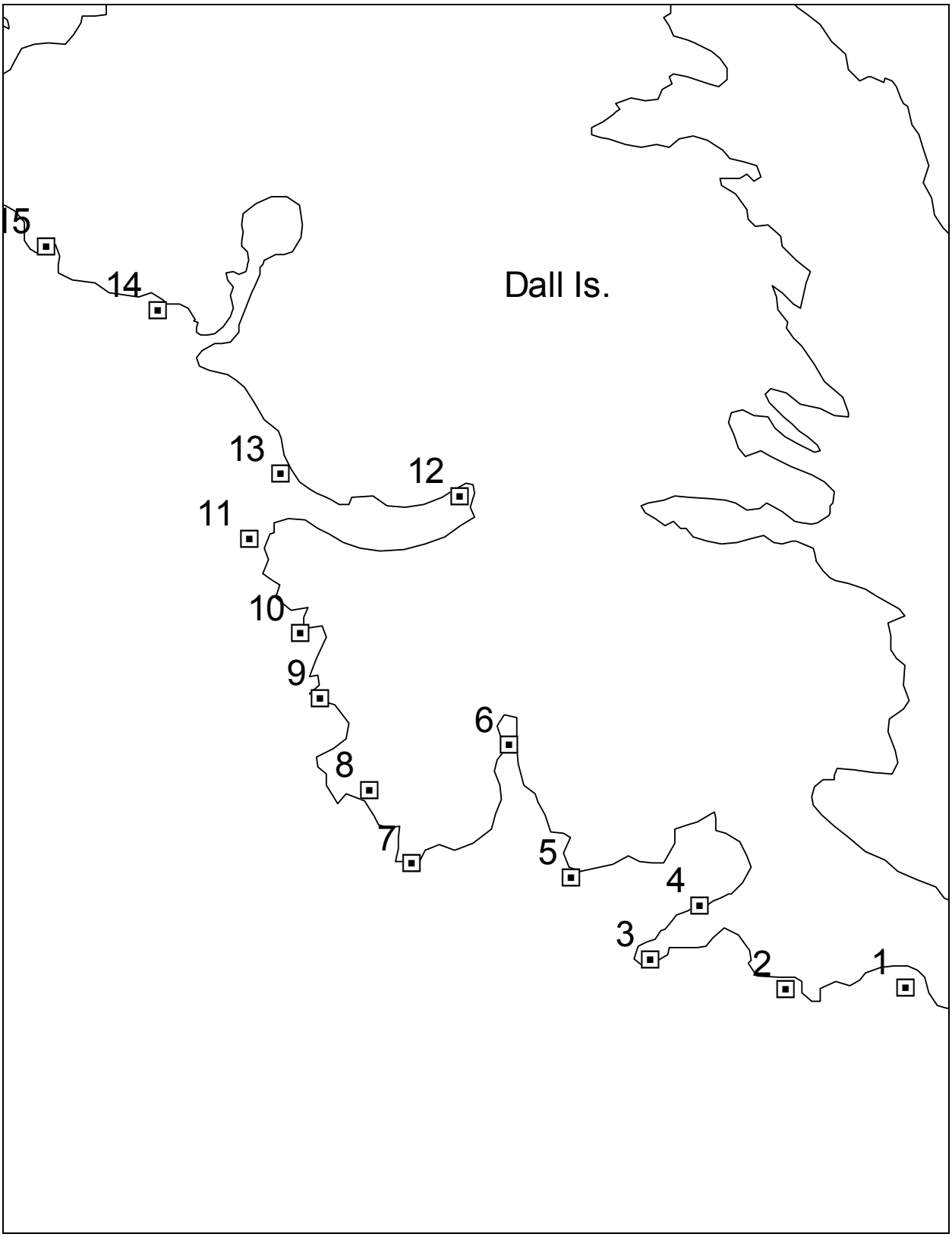

Figure 8. Map of transect pair locations in Statistical Area 104-10.

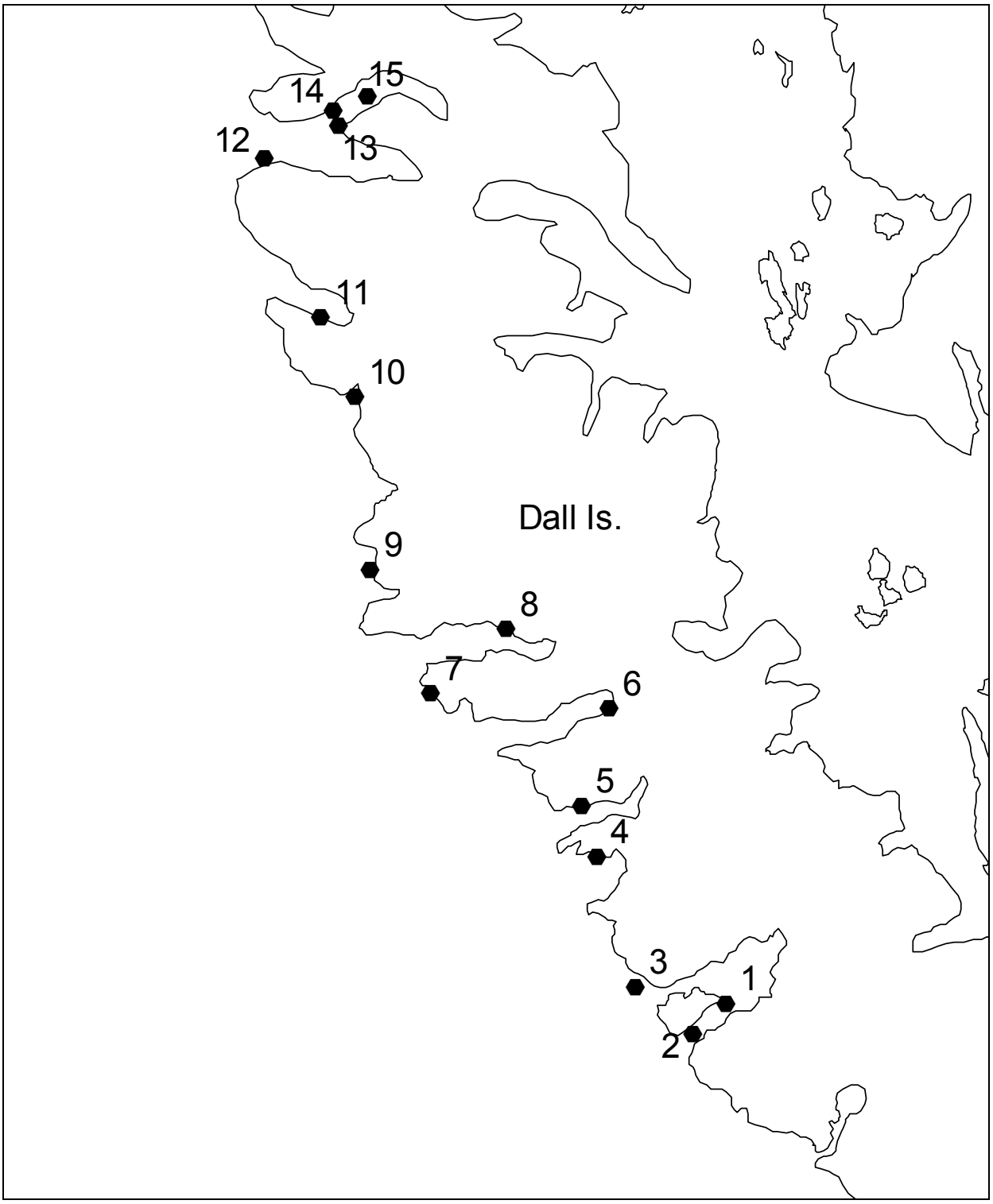

Figure 9. Map of transect pair locations in Statistical Area 104-20.

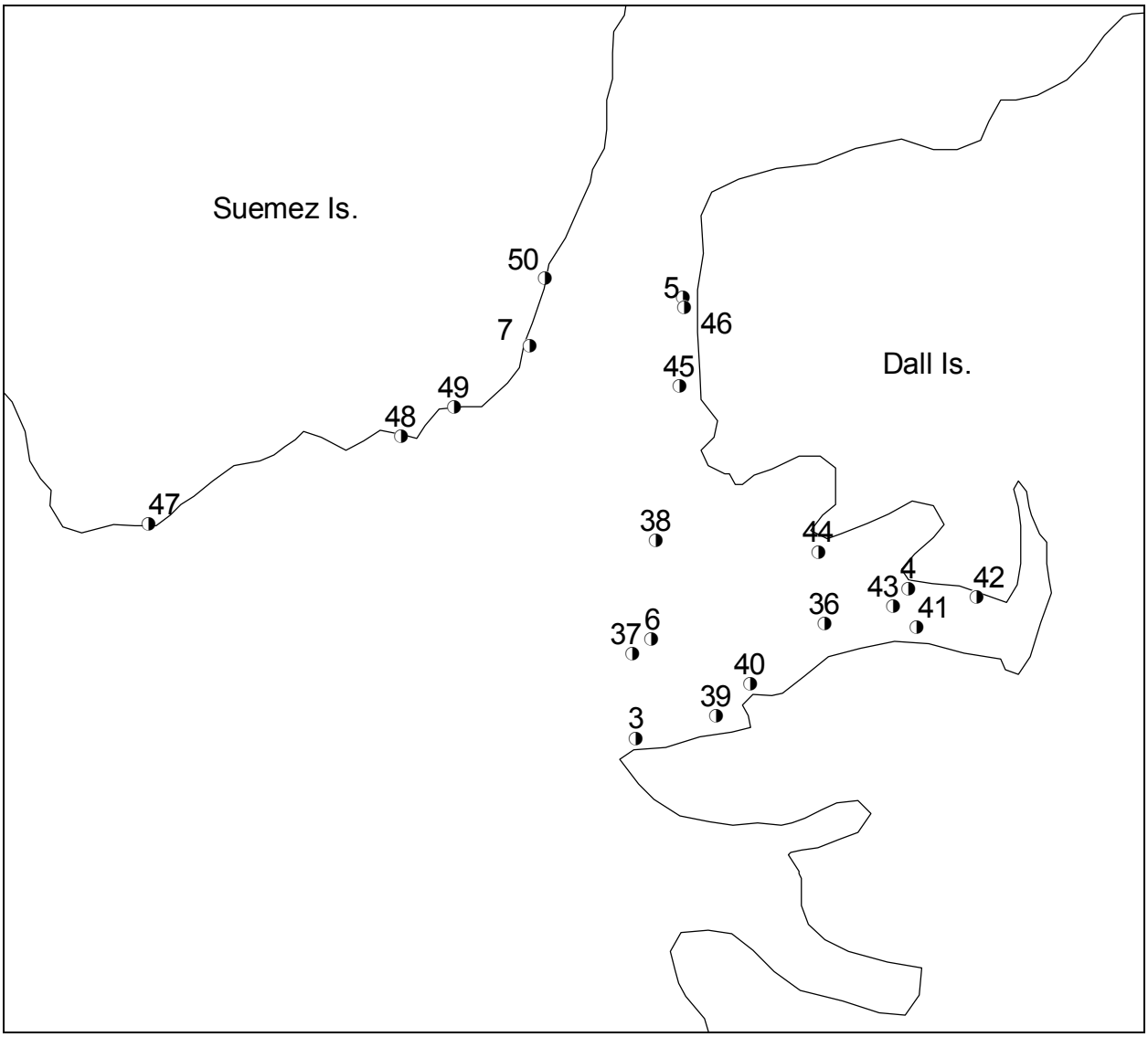

Figure 10. Map of transect pair locations in Statistical Area 104-30 control.

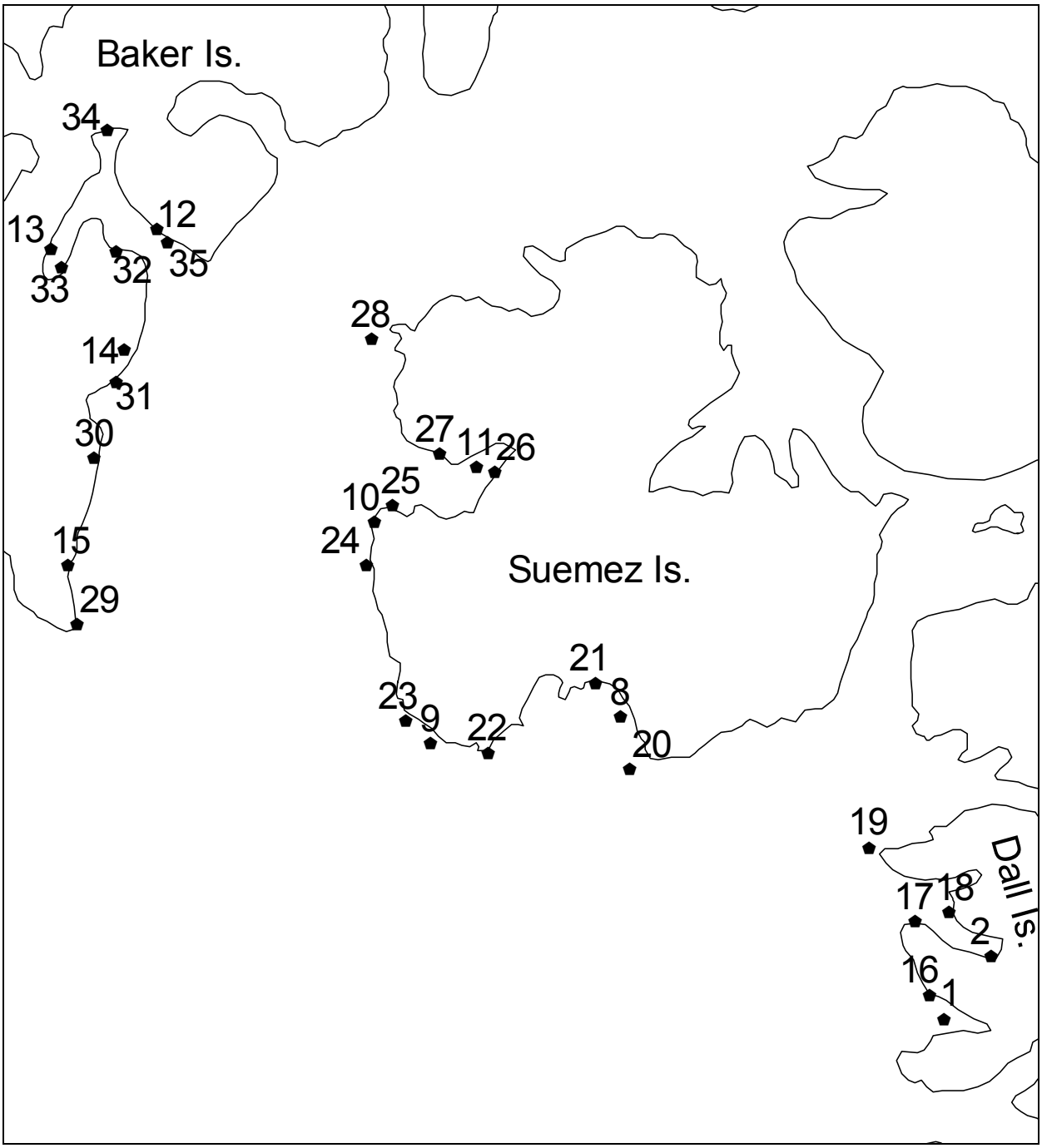

Figure 11. Map of transect pair locations in Statistical Area 104-30 experimental.

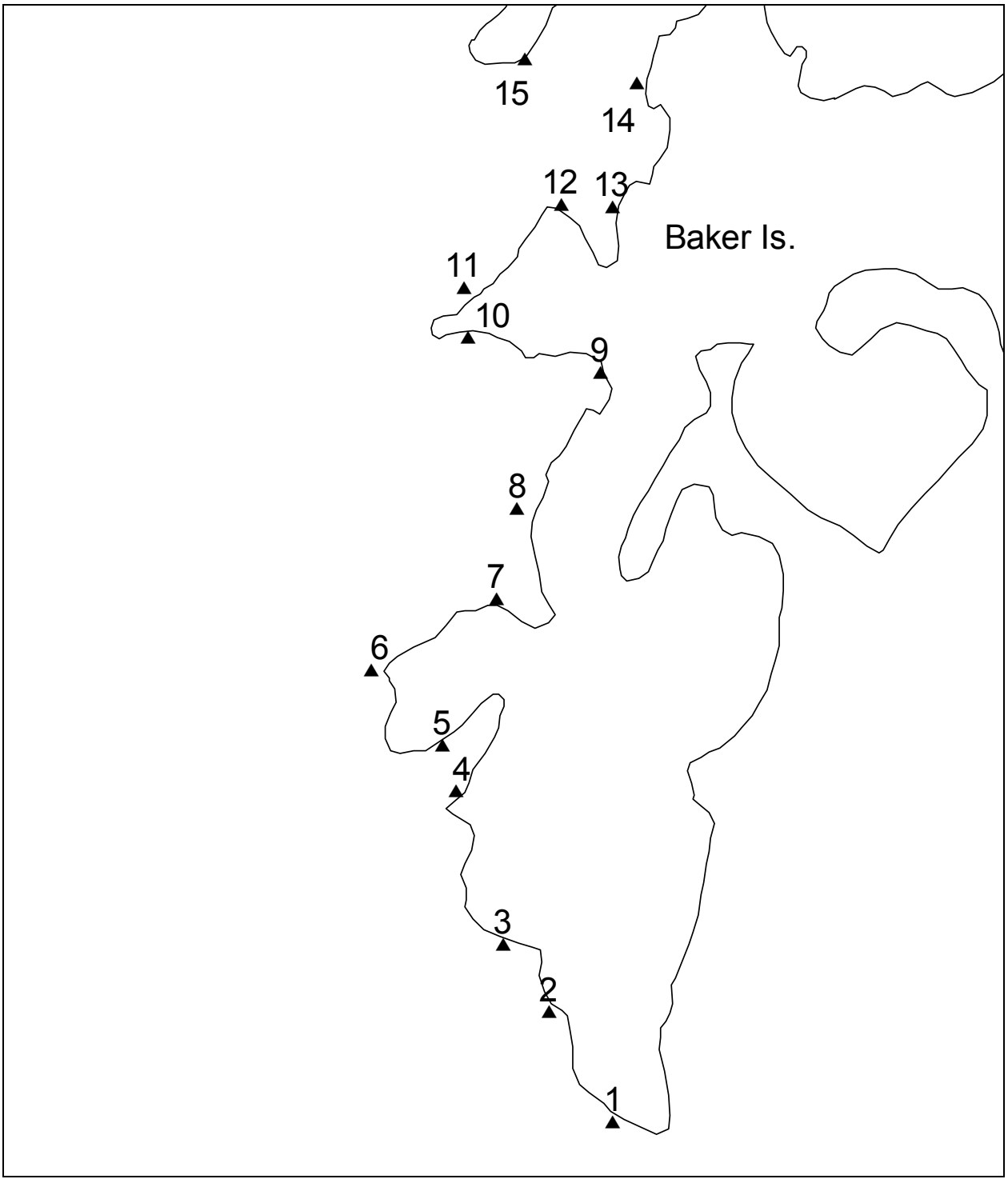

Figure 12. Map of transect pair locations in Statistical Area 104-35.

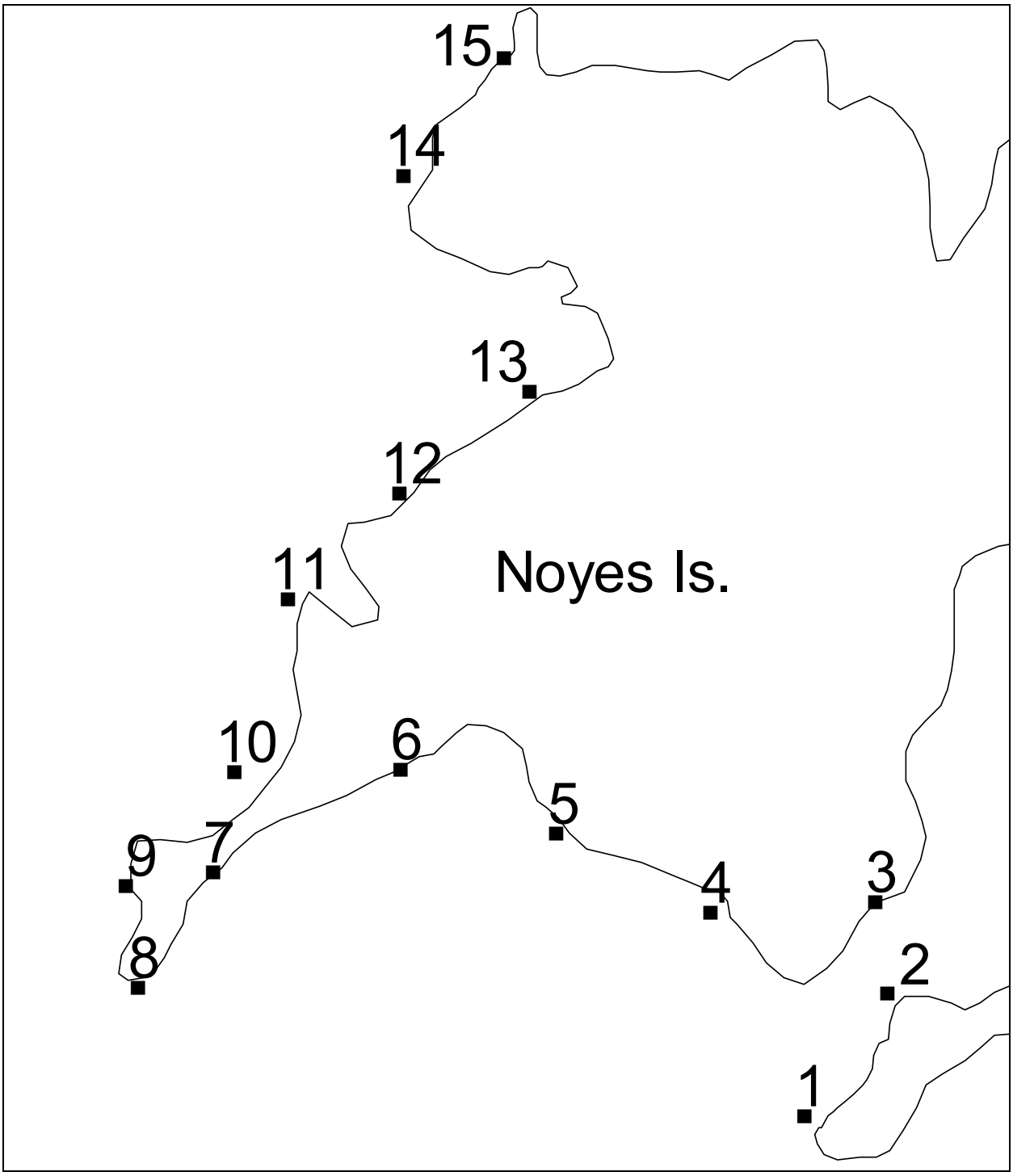

Figure 13. Map of transect pair locations in Statistical Area 104-40.

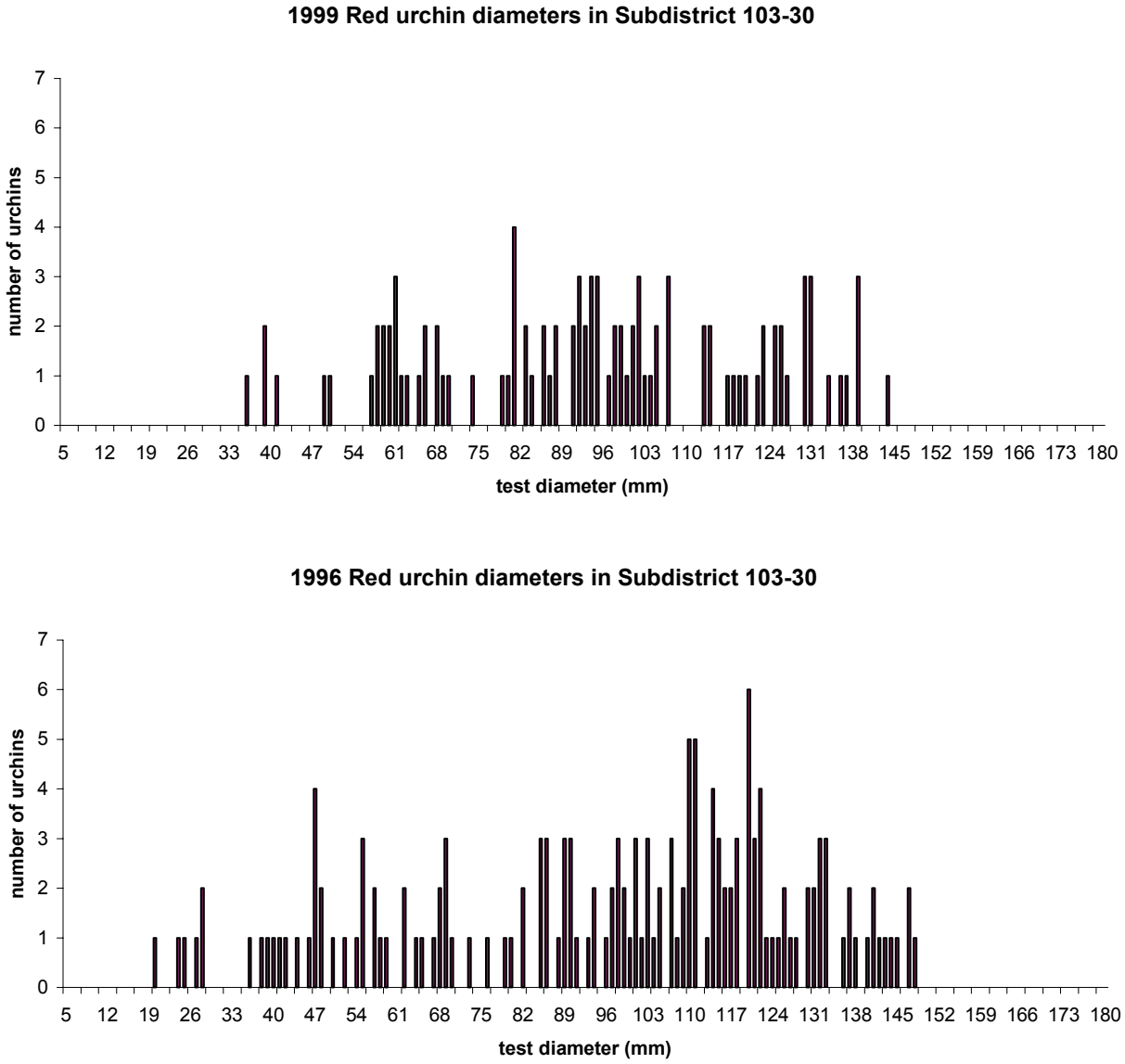

Figure 14. Red urchin size distributions in Subdistrict 103-30 in 1999 and 1996.

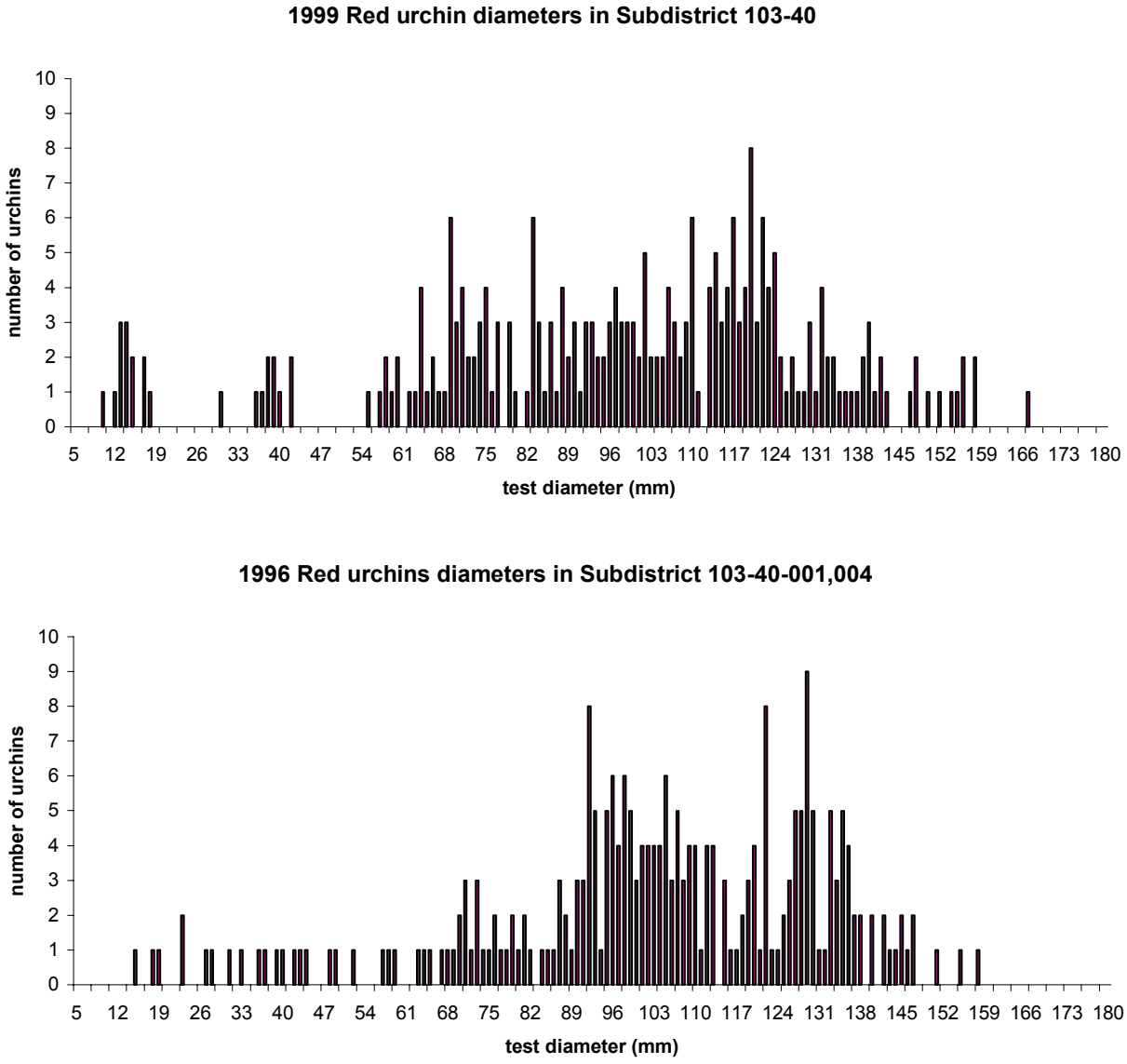

Figure 15. Red urchin size distributions in Subdistrict 103-40 in 1999 and 1996.

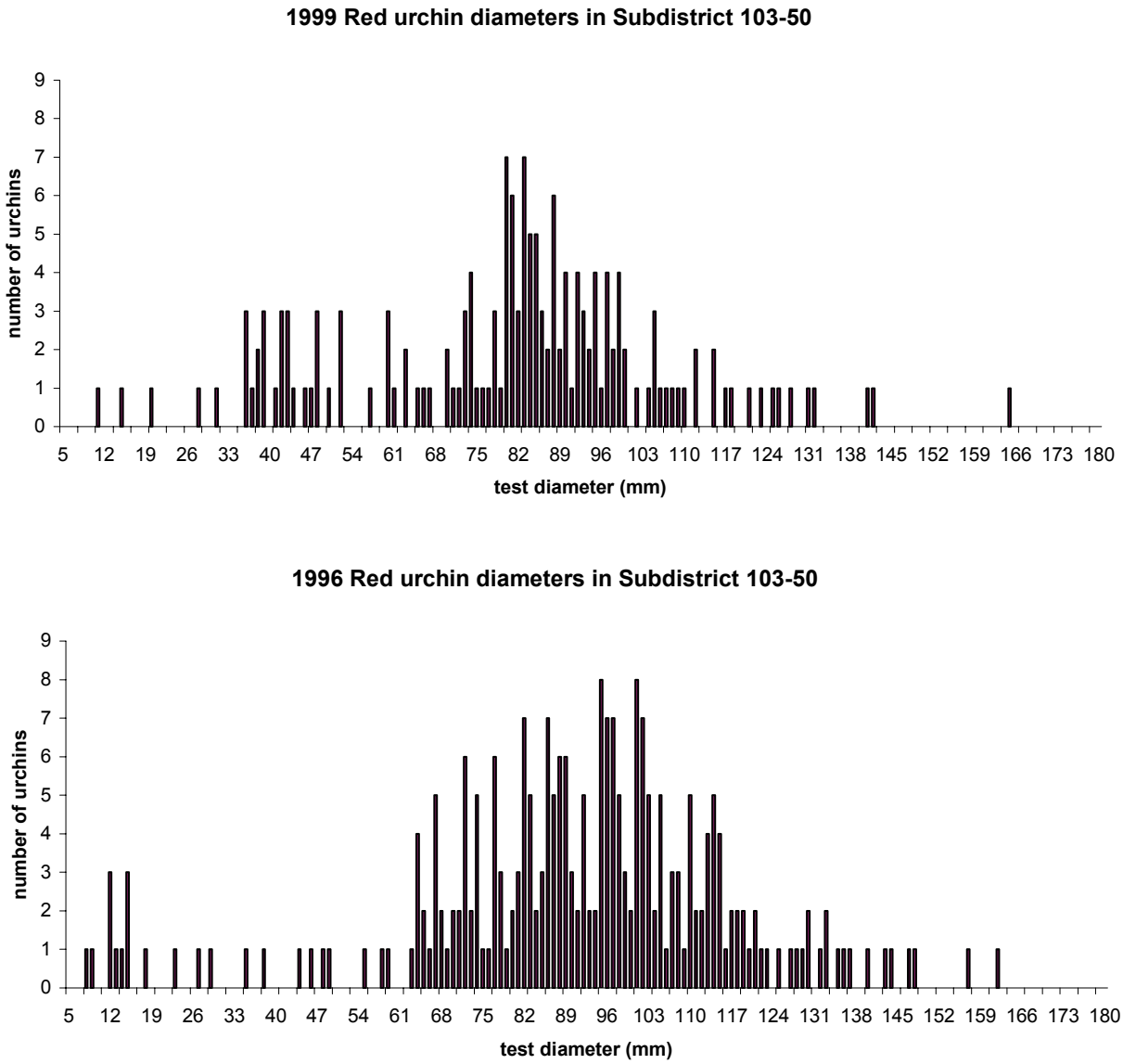

Figure 16. Red urchin size distributions in Subdistrict 103-50 in 1999 and 1996.

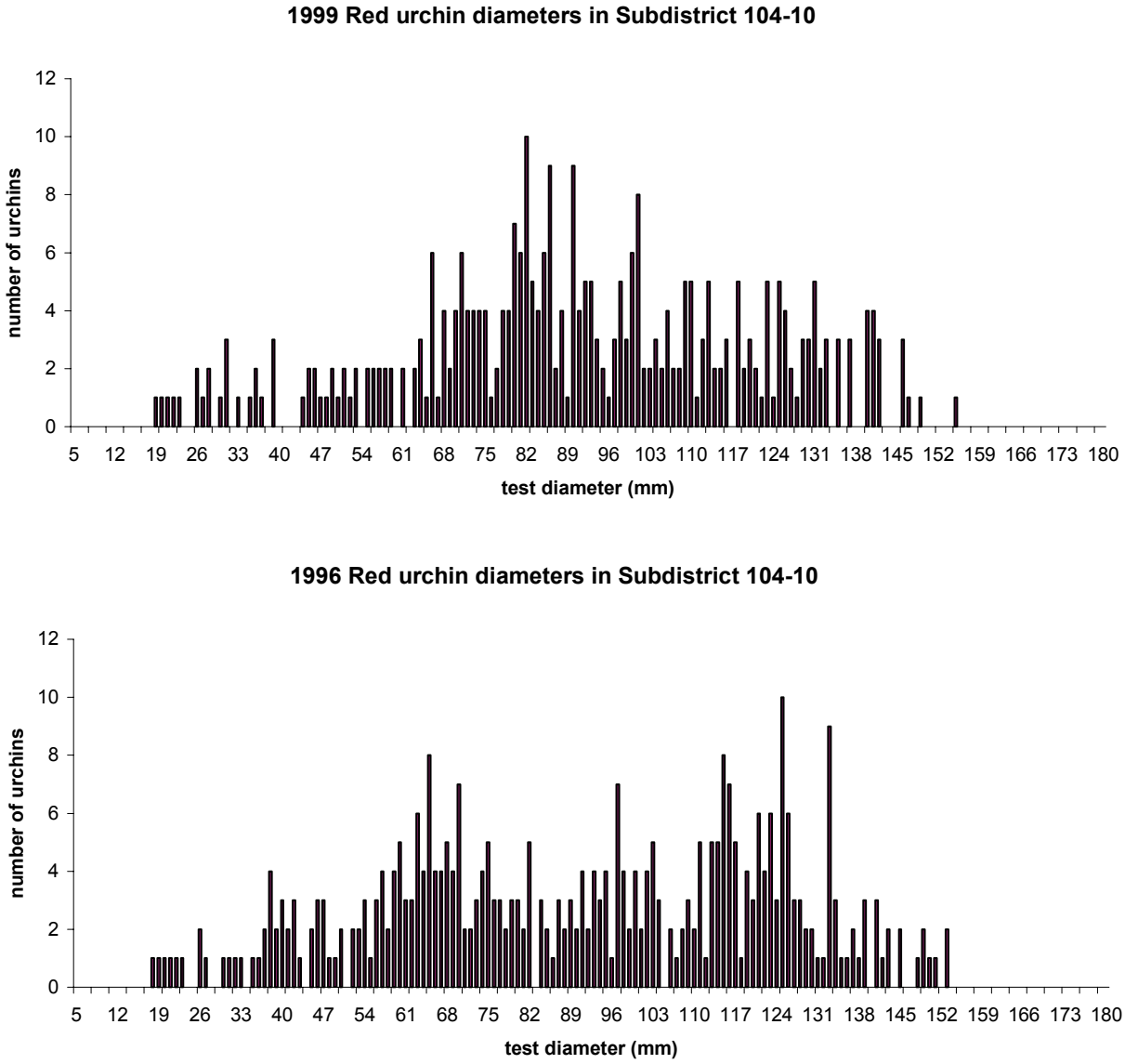

Figure 17. Red urchin size distributions in Subdistrict 104-10 in 1999 and 1996.

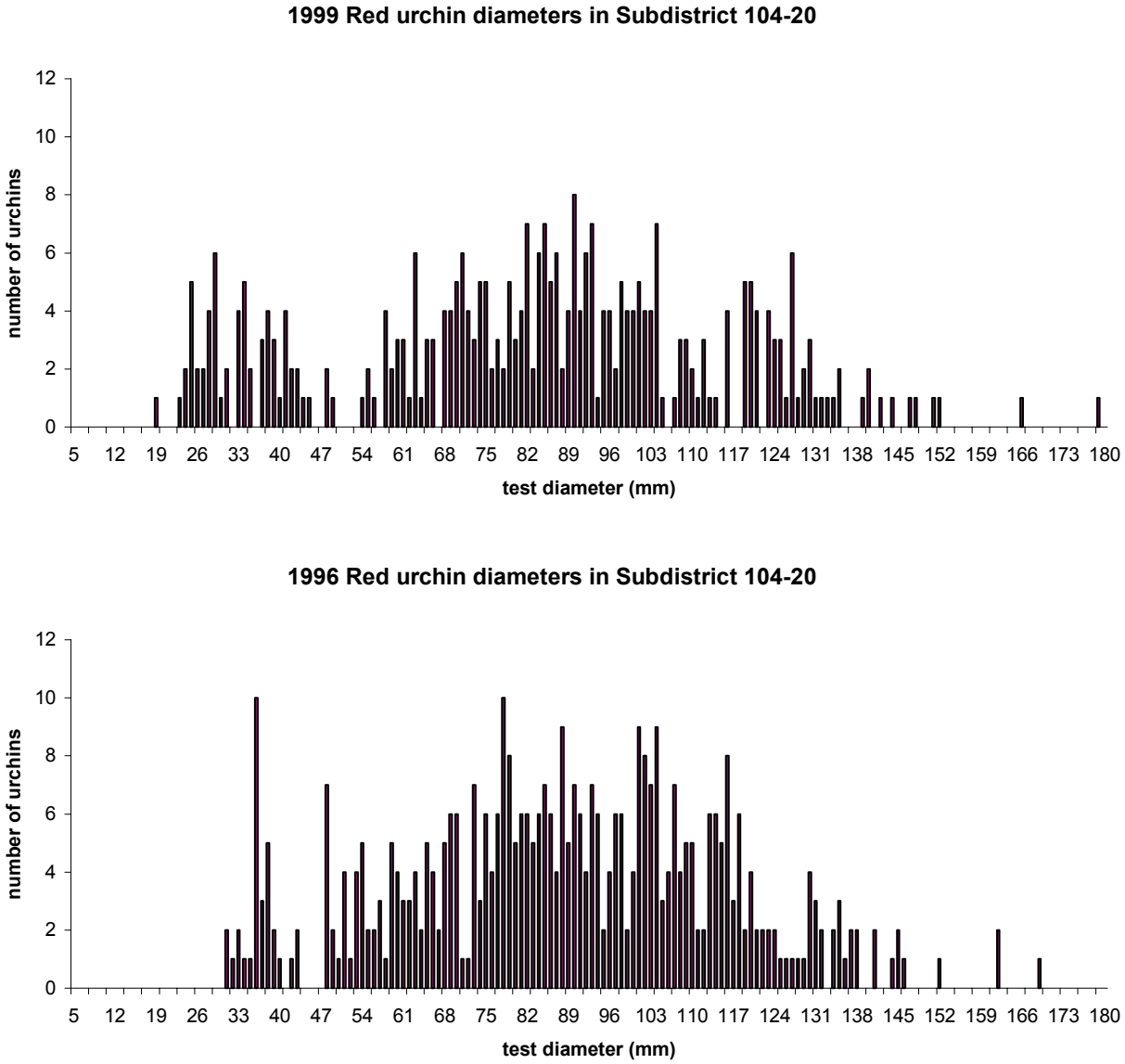

Figure 18. Red urchin size distributions in Subdistrict 104-20 in 1999 and 1996.

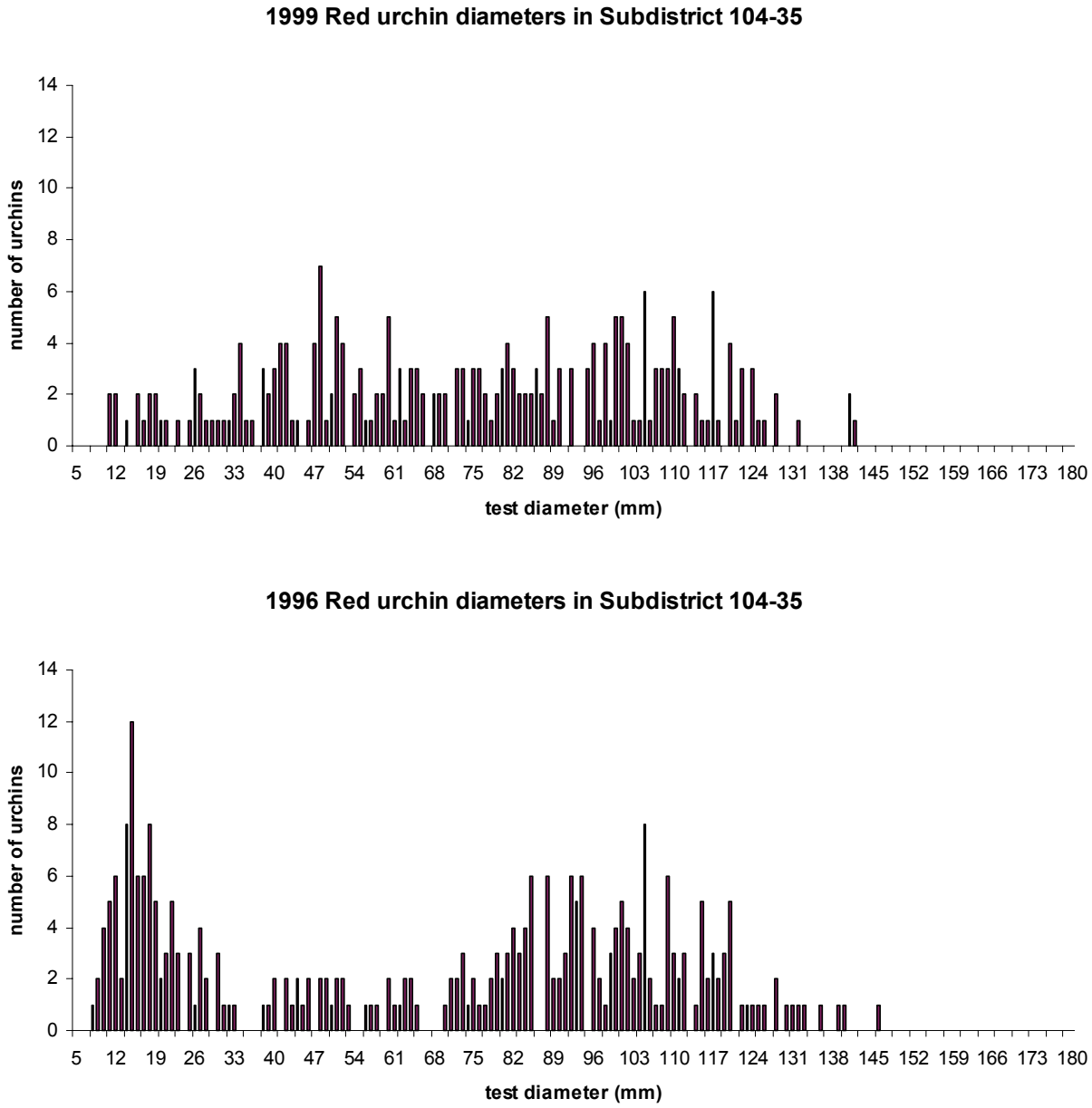

Figure 19. Red urchin size distributions in Subdistrict 104-35 in 1999 and 1996.

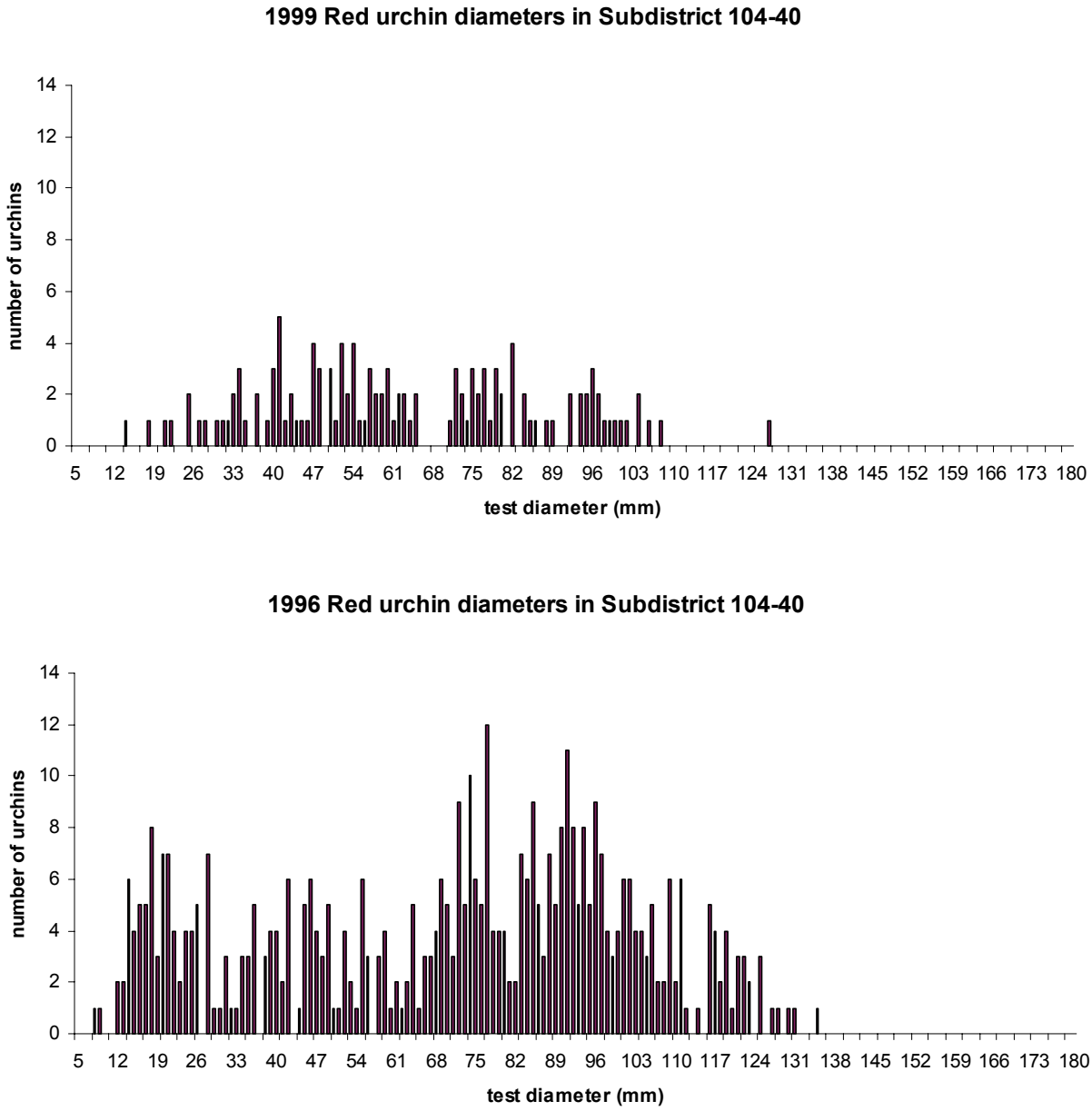

Figure 20. Red urchin size distributions in Subdistrict 104-40 in 1999 and 1996.

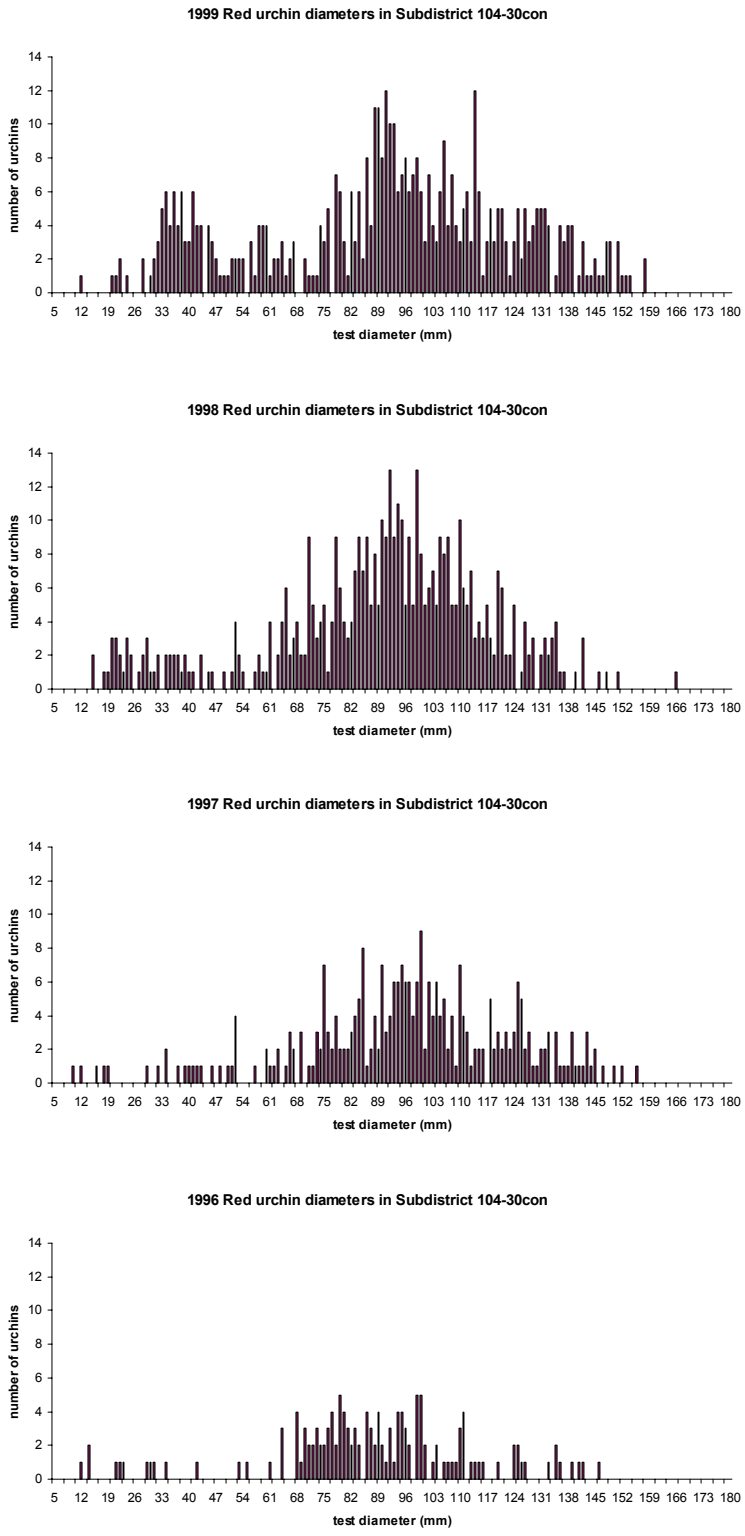

Figure 21. Red urchin size distributions in Subdistrict 104-30 control area during 1996 through 1999.

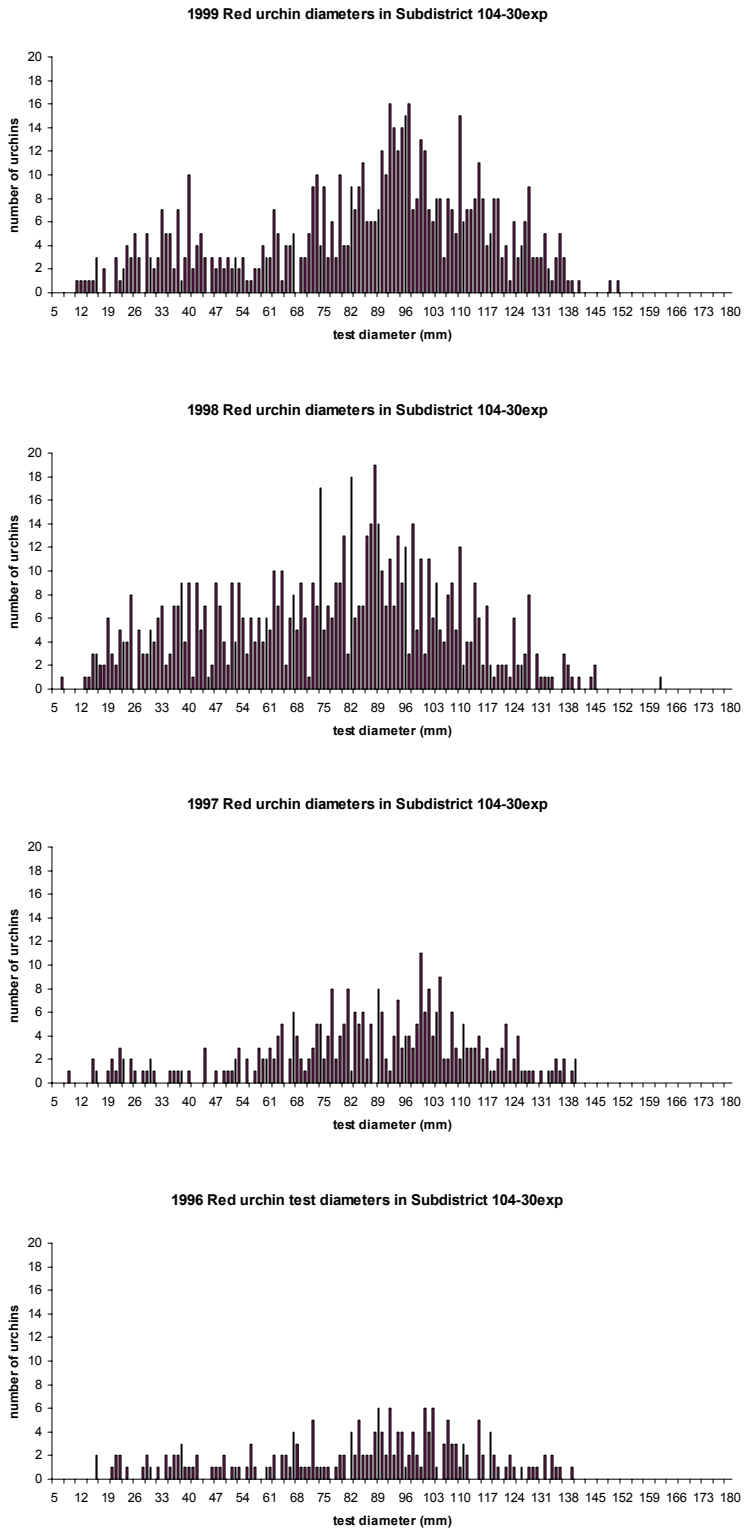

Figure 22. Red urchin size distributions in Subdistrict 104-30 experimental area during 1996 through 1999.

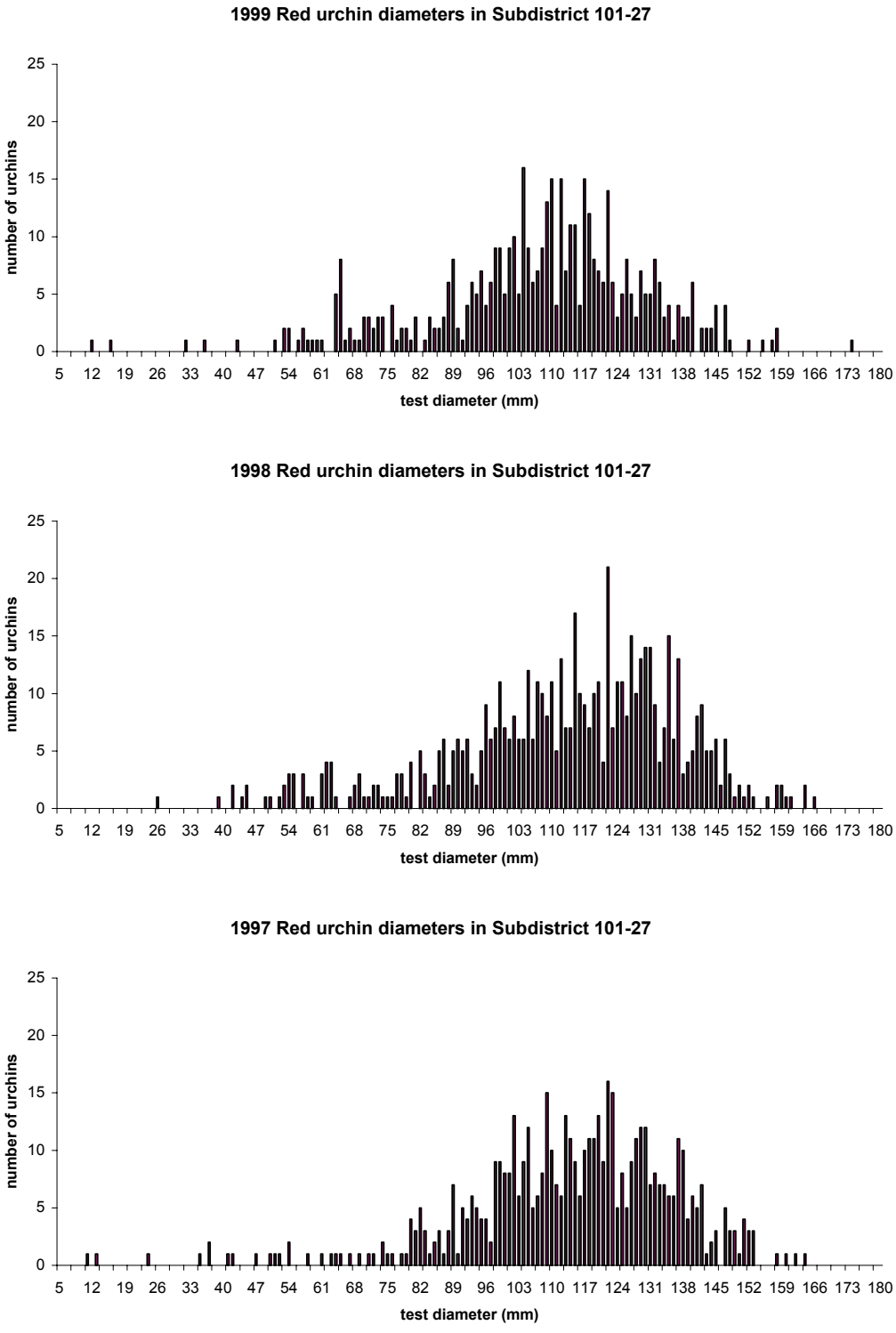

Figure 23. Red urchin size distributions in Subdistrict 101-27 control area during 1997 through 1999.

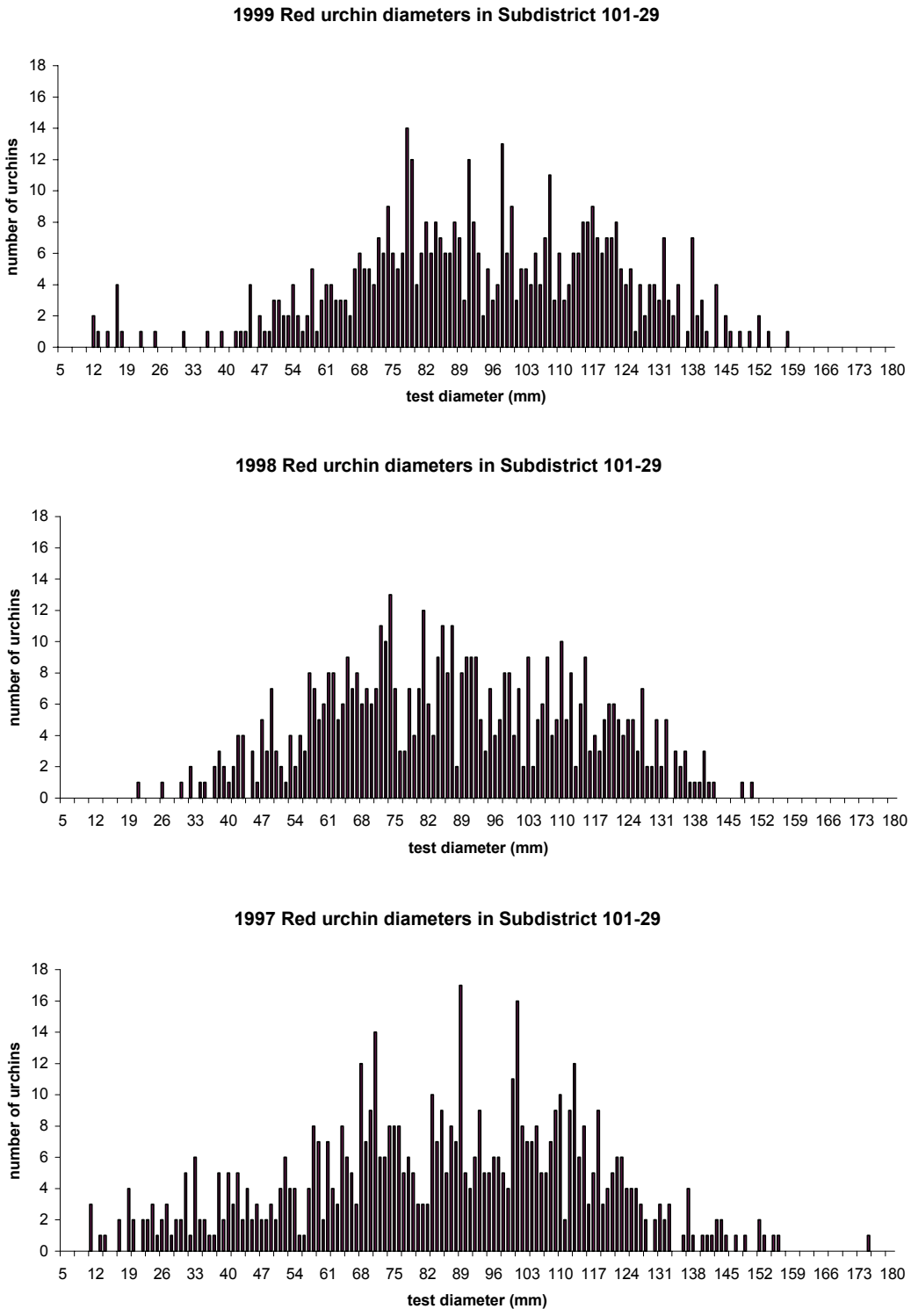

Figure 24. Red urchin size distributions in Subdistrict 101-29 experimental area during 1997 through 1999.

APPENDIX

Appendix 1. Latitude and longitudes of urchin transect pairs completed in Southeast Alaska, 1999.

Subdistrict 101-27

Transect number	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 number	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

-continued-

Subdistrict 103-30

Transect number	Latitude	Longitude
1	54.7289	-132.6838
2	54.8273	-132.7285
3	54.8897	-132.8102
4	54.9150	-132.7964
5	54.9338	-132.7539
6	54.9734	-132.9521
7	54.9668	-132.8365
8	54.9485	-132.9773
9	54.9317	-132.924
10	54.8963	-132.8727
11	54.8430	-132.8333
12	54.8057	-132.7788
13	54.7663	-132.7389
14	54.7399	-132.7547
15	54.6925	-132.7146

Subdistrict 103-40-001, 002, 004

Transect number	Latitude	Longitude
1	55.0200	-132.7917
2	55.0198	-132.8484
3	55.0539	-132.8493
4	55.0688	-132.9331
5	55.0657	-132.9166
6	55.0882	-132.9050
7	55.0868	-132.8206
8	55.0873	-132.8666
9	55.1537	-132.9061
10	55.1740	-132.9711
11	55.2335	-133.0386
13	55.2545	-133.0461
14	55.2678	-133.0695
15	55.2606	-133.0775
16	55.2306	-133.1100
17	55.1958	-133.0986
18	55.1542	-133.0892
19	55.1160	-133.0153
20	55.0764	-133.0151
21	55.0838	-133.0513
22	55.0483	-133.0517
23	55.0250	-133.0222
24	55.0219	-132.9641
25	54.9801	-132.9574
27	55.0422	-133.0608
28	55.0611	-133.0225
29	55.0967	-133.0922
30	55.0813	-132.9929
31	55.1422	-133.0617
32	55.1642	-133.0681
33	55.2081	-133.1289
34	55.2624	-133.1163
36	55.2730	-132.9843
38	55.2478	-132.9933
39	55.2376	-133.0823
40	55.1686	-132.9833
41	55.1374	-132.8917
42	55.0692	-132.8465
43	55.0913	-132.8921
44	55.0656	-132.9043
45	55.0453	-132.9253
46	55.0449	-132.8826
100	55.0316	-133.0020
101	55.0927	-133.0393

-continued-

Subdistrict 103-50

Transect number	Latitude	Longitude
1	55.2469	-133.1959
2	55.2818	-133.1372
3	55.2722	-133.1796
4	55.2900	-133.2423
5	55.2611	-133.2350
6	55.2942	-133.2703
7	55.2820	-133.3375
8	55.3329	-133.3118
9	55.3530	-133.3916
10	55.3289	-133.4352
11	55.3756	-133.5347
12	55.3666	-133.4906
13	55.4228	-133.4625
14	55.4186	-133.4889
15	55.4325	-133.5773
16	55.4207	-133.4132
17	55.4476	-133.6140
18	55.4320	-133.5577
19	55.4324	-133.4986
20	55.4550	-133.4197

Subdistrict 103-70

Transect number	Latitude	Longitude
1	55.5814	-133.7053
2	55.6081	-133.6250
3	55.6156	-133.5992
4	55.5942	-133.6064
5	55.6120	-133.6542
6	55.5556	-133.7028
7	55.5450	-133.6408
8	55.5545	-133.6222
9	55.5189	-133.5889
10	55.4825	-133.6314
11	55.4631	-133.6064
12	55.5008	-133.5411
13	55.5173	-133.5423
14	55.5189	-133.4845
15	55.5103	-133.4703

-continued-

Subdistrict 104-10

Transect number	Latitude	Longitude
1	54.6686	-132.6997
2	54.6684	-132.7334
3	54.6731	-132.7717
4	54.6820	-132.7576
5	54.6866	-132.7938
6	54.7082	-132.8113
7	54.6887	-132.8389
8	54.7007	-132.8507
9	54.7157	-132.8645
10	54.7262	-132.8702
11	54.7417	-132.8845
12	54.7484	-132.8252
13	54.7522	-132.8757
14	54.7788	-132.9101
15	54.7890	-132.9415

Subdistrict 104-20

Transect number	Latitude	Longitude
1	54.8243	-132.9508
2	54.8142	-132.9699
3	54.8299	-133.0037
4	54.8737	-133.0254
5	54.8906	-133.0341
6	54.9231	-133.0184
7	54.9283	-133.1224
8	54.9495	-133.0781
9	54.9695	-133.1571
10	55.0271	-133.1664
11	55.0533	-133.1858
12	55.1064	-133.2188
13	55.1173	-133.1758
14	55.1222	-133.1788
15	55.1271	-133.1585

Subdistrict 104-35

Transect number	Latitude	Longitude
1	55.2415	-133.6212
2	55.2599	-133.6398
3	55.2713	-133.6532
4	55.2967	-133.6671
5	55.3045	-133.6712
6	55.3170	-133.6920
7	55.3288	-133.6552
8	55.3438	-133.6492
9	55.3664	-133.6249
10	55.3724	-133.6635
11	55.3806	-133.6647
12	55.3945	-133.6364
13	55.3939	-133.6214
14	55.4145	-133.6142
15	55.4187	-133.6471

Subdistrict 104-40

Transect number	Latitude	Longitude
1	55.4230	-133.6656
2	55.4386	-133.6472
3	55.4500	-133.6500
4	55.4486	-133.6863
5	55.4586	-133.7204
6	55.4667	-133.7550
7	55.4537	-133.7966
8	55.4393	-133.8131
9	55.4520	-133.8158
10	55.4664	-133.7918
11	55.4880	-133.7800
12	55.5013	-133.7552
13	55.5141	-133.7266
14	55.5412	-133.7545
15	55.5560	-133.7320

-continued-

Subdistrict 104-30
Experimental

Transect number	Latitude	Longitude
1	55.1381	-133.2056
2	55.1544	-133.1838
8	55.2173	-133.3538
9	55.2103	-133.4416
10	55.2683	-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	-133.2124
17	55.1638	-133.2186
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

Subdistrict 104-30
Control

Transect number	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	55.2162	-133.2763
49	55.2193	-133.2664
50	55.2332	-133.2491

Appendix 2. Red sea urchin transect survey data collected in Southeast Alaska, 1999.

Subdistrict: 101-27

transect no	side a	side b	maximum depth (mllw, ft.)
1	45	29	50
2	144	90	49
4	7	11	50
5	16	13	50
6	48	56	50
9	54	63	50
10	149	112	50
12	82	92	50
13	21	9	50
14	26	49	50
15	0	2	50
16	0	6	50
17	10	2	50
18	78	130	50
19	12	10	50
20	81	71	50
21	12	50	50
22	6	1	50
23	14	57	50
24	153	204	54

Subdistrict: 101-29

transect no	side a	side b	maximum depth (mllw, ft.)
1	57	63	50
2	39	29	50
3	114	92	50
4	112	184	31
5	21	58	50
6	117	188	50
7	42	56	50
8	457	476	49
9	318	330	50
10	244	449	50
11	35	71	50
12	331	137	50
13	132	29	50
14	100	119	50
15	193	183	50
16	137	164	50
17	152	302	50
18	0	0	50
19	34	73	50
20	353	210	50

-continued-

Subdistrict: 103-30

transect no	side a	side b	maximum depth (mllw, ft.)
1	6	5	40
2	6	0	50
3	1	6	40
4	0	0	40
5	0	0	43
6	10	31	50
7	90	65	50
8	0	0	40
9	0	0	40
10	0	0	40
11	0	0	40
12	0	0	40
13	65	2	40
14	0	0	40
15	2	0	40

Subdistrict: 103-40

transect no	side a	side b	maximum depth (mllw, ft.)
1	0	0	0
2	20	31	33
3	0	0	33
4	0	0	33
5	0	0	33
6	0	0	33
7	0	0	33
8	0	0	33
9	0	0	50
10	0	0	50
11	0	0	50
13	4	0	50
14	0	0	50
15	38	29	50
16	0	0	50
17	0	0	50
18	0	0	33
19	2	12	33
20	5	0	33
21	0	7	33
22	0	0	0
23	0	0	0
24	20	19	33
25	0	0	0
27	0	0	0
28	12	19	33
29	0	0	0
30	7	15	33
31	0	0	33
32	1	1	50
33	0	0	50
34	101	0	50
36	0	0	50
38	0	0	51
39	68	75	50
40	18	13	50
41	0	0	50
42	0	0	33
43	0	0	33
44	0	0	15
45	12	4	33
46	0	0	33
100	5	1	33
101	0	0	0

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Subdistrict: 103-50

transect no	side a	side b	maximum depth (mllw, ft.)
1	43	16	40
2	0	0	33
3	60	13	40
4	0	0	33
5	0	0	40
6	1	0	40
7	0	0	33
8	3	0	40
9	347	292	40
10	229	219	40
11	0	0	40
12	205	156	40
13	0	0	40
14	0	0	18
15	0	0	40
16	0	0	33
17	0	0	40
18	0	0	33
19	0	0	40
20	0	0	33

Subdistrict: 103-70

transect no	side a	side b	maximum depth (mllw, ft.)
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	1	0	33
8	0	0	33
9	0	0	33
10	0	0	33
11	0	0	33
12	0	0	33
13	0	0	33
14	0	0	33
15	0	0	33

Subdistrict: 104-10

transect no	side a	side b	maximum depth (mllw, ft.)
1	74	14	55
2	325	278	56
3	42	61	55
4	158	73	55
5	2	1	56
6	112	82	40
7	0	0	56
8	158	115	40
9	35	39	56
10	15	0	40
11	12	14	56
12	0	0	0
13	74	46	56
14	142	217	56
15	139	147	40

Subdistrict: 104-20

transect no	side a	side b	maximum depth (mllw, ft.)
1	0	0	33
2	1463	1296	56
3	144	88	40
4	54	90	40
5	288	341	40
6	0	0	0
7	433	393	54
8	31	20	40
9	500	739	44
10	66	65	33
11	0	0	0
12	302	202	40
13	65	78	40
14	7	5	40
15	2	3	40

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Appendix 2. (page 4 of 5)

Subdistrict: 104-30 control

transect no	side a	side b	maximum depth (mllw, ft.)
3	679	692	40
4	0	0	33
5	191	380	40
6	244	128	50
7	204	223	33
36	97	75	33
37	326	228	44
38	270	250	33
39	108	69	40
40	13	48	40
41	0	0	33
42	0	0	33
43	0	0	33
44	51	60	40
45	247	244	40
46	517	493	43
47	116	198	60
48	25	0	42
49	138	142	40
50	336	446	51

Subdistrict: 104-30 experimental

transect no	side a	side b	maximum depth (mllw, ft.)
1	774	727	37
2	0	0	40
8	351	550	40
9	32	33	40
10	0	0	40
11	189	187	40
12	41	41	33
13	0	0	0
14	264	170	14
15	69	139	40
16	110	143	40
17	257	245	40
18	277	211	40
19	170	193	55
20	261	346	40
21	0	0	0
22	2	37	40
23	81	105	40
24	408	488	40
25	138	96	33
26	0	0	0
27	176	77	40
28	651	862	40
29	316	250	40
30	446	342	40
31	87	70	40
32	0	0	0
33	0	0	0
34	0	0	0
35	24	52	33

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Subdistrict: 104-35

transect no	side a	side b	maximum depth (mllw, ft.)
1	6	0	47
2	42	160	51
3	220	125	50
4	304	271	40
5	312	345	40
6	0	0	0
7	542	412	39
8	85	86	43
9	117	122	40
10	162	97	52
11	0	0	40
12	0	0	40
13	0	0	40
14	0	0	40
15	6	0	40

Subdistrict: 104-40

transect no	side a	side b	maximum depth (mllw, ft.)
1	70	78	40
2	0	1	40
3	0	0	40
4	55	46	40
5	0	0	40
6	8	0	40
7	245	281	54
8	51	32	40
9	0	0	40
10	0	0	40
11	0	0	40
12	0	0	40
13	0	0	40
14	0	0	59
15	0	1	40

Appendix 3. Red sea urchin test diameters in millimeters by subdistrict and transect, collected in Southeast Alaska, 1999. First row are transect numbers.

Subdistrict 101-27

1	2	4	5	6	9	10	12	13	14	18	19	20	21	22	23	24
89	93	99	118	115	145	102	133	139	123	68	64	88	66	116	95	133
88	73	110	126	104	130	129	104	139	115	16	123	104	117	144	88	121
118	98	132	110	120	119	106	110	121	127	72	83	122	140	108	109	113
120	121	132	109	112	129	102	115	142	119	119	147	107	140	94	114	115
105	94	120	95	112	126	112	122	71	131	65	87	100	70	114	102	114
78	102	70	76	117	117	118	104	145	140	97	92	91	115	117	88	89
117	117	88	69	101	124	109	95	147	107	64	128	118	120	108	114	98
117	109	114	65	109	98	126	117	152	135	65	129	108	140	135	92	112
118	119	138	57	105	132	133	119	157	107	59	118	108	127	135	96	96
108	128	140	67	101	123	120	134	174	122	89	84	127	114	118	99	93
104	131	144	87	95	86	120	95	143	107	92	122	112	122	101	89	97
122	109	110	121	111	123	116	117	158	107	67	122	125	137	73	89	118
105	122	90	100	143	128	103	100	155	125	65	132	94	126	129	84	123
109	111	89	107	110	125	104	94	139	138	125	133	92	65	102	81	105
114	113	145	106	104	118	97	104	145	107	53	57	99	130	124	90	104
79	99	158	101	81	129	43	127	148	108	110	79	109	112	117	109	101
96	98	129	108	98	133	113	97	71	113	72	74	122	74	132	110	112
89	102	110	142	110	134	136	105		133	110	119	101	122	131	99	102
74	86	122	105	94	127	114	64		115	76	105	110	132	118	103	113
112	104	138	115	101	122		117		132	112	140	104	101	106	85	115
119	105	54	99	103	126				122	70	147	87	113	126	119	137
124	36	135	64	60					109	84	102	89	102	132	98	126
106	120	32	64	114					115	117	98	118	65	112	104	112
99	99	56	58	96					106	98	108	109	65	134	103	131
114	115	76	54	102					115	65	80	114	118	93	95	78
61	101	109	53	123					100	112	129	110	116	77	100	122
105	104	125	12	104					93	51	81	111	130	104	108	126
106	110	113	109	71					117	111	103	95	116	85	99	131
112		130	97	137					117		121	112	73	88	110	121
93		147							112		97	117	98	76	104	110
														137	93	
															130	

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Subdistrict 101-29

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20
120	146	81	108	88	100	82	66	96	98	133	100	71	68	83	124	54	138	117
125	78	125	152	123	78	73	91	101	91	100	79	120	123	117	116	51	143	111
138	138	115	108	83	81	78	72	115	100	113	62	76	127	99	70	57	154	91
99	122	74	89	132	103	72	77	108	74	102	50	74	79	121	134	64	140	107
133	130	81	109	119	67	84	59	100	84	143	85	105	132	120	117	50	112	96
104	121	87	124	125	79	75	94	135	91	107	98	88	80	31	117	54	141	118
112	122	45	122	137	97	87	106	116	92	130	70	110	68	138	120	47	107	110
104	132	114	108	139	67	84	58	108	83	84	65	91	90	132	122	47	65	135
77	128	120	121	118	61	74	79	119	98	103	58	98	82	121	113	44	114	64
73	140	93	98	79	69	75	83	91	107	117	79	88	82	105	87	17	13	120
73	152	84	76	127	56	12	91	81	89	129	58	105	91	115	108	17	89	135
116	117	92	95	116	74	67	84	117	88	121	87	71	70	122	80	18	61	100
132	139	64	66	97	69	88	75	124	111	115	58	72	79	109	111	22	78	125
118	158	113	108	134	91	25	92	103	97	103	99	79	78	105	108	74	80	93
108	110	49	71	115	95	89	54	98	98	97	82	78	123	120	63	72	130	78
88	122	107	116	119	90	143	52	99	90	106	45	74	12	117	117	71	132	116
	143	78	118	131	55	150	75	107	93	145	60	72	15	87	103	78	148	80
	124	82	118	94	42	123	78	98	82	126	68	86	76	92	121	72	132	113
	138	67	99		84	100	127	119	95	108	72	98	93		106	83	145	87
	133	62	102		51	69	58	81	105	91	55	119	86		122	86		68
	131	115	118		45	85	52	108	101	105	81	129	138		98	48		63
	104	51	125		77	78	17	127	91	113	61	98	74		122	60		83
	98	75	138		69	89	17	106	85		77	86	89		116	88		67
	129	84	93		36	78	50	114	114		113	96	135		123	82		78
	110	79	116		79	102	39	101	93		73	121	129		88	77		79
		75	140		45	85	79	92	91		86	70	100		110	85		100
		62	104		69	76	54	102	89		112	60			99	78		128
		68	115		107	98	82	110	95		53	73			92	131		65
		74	114			109			112		85	62			114	92		102
		68	130			119			86		53	43			118	70		
		85	115			95			92		61	63			77	57		
						73					76							

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Appendix 3. (page 3 of 8)

Subdistrict 103-30

1	2	7	13
50	99	136	117
36	125	98	134
49	123	130	94
39	102	123	95
62	113	126	95
57	131	137	126
92	120	107	58
39	92	107	114
60	81	139	139
61	91	88	80
63	101	130	81
60	131	103	102
61	86	99	131
61	81	144	91
59	105	107	
65	101	127	
66	83	114	
59	119	98	
69	81	139	
105	41	97	
58	95	102	
100	84	125	
70	86	130	
68	92	94	
66	87	122	
79		93	
93		113	
104		88	
94		118	
74		83	
68			

Subdistrict 103-40

2	13	19	20	24	28	30	39	40	100
103	38	105	99	98	89	130	120	120	134
66	36	100	95	75	84	132	17	124	90
88	37	122	55	74	72	123	15	120	122
108	60	186	15	93	74	154	117	115	87
110	42	96	125	102	73	167	71	40	86
97	38	130	83	58	65	124	83	122	92
113	42	96	110	104	64	119	132	99	122
94	39	117	88	102	71	111	18	119	93
109	39	120	103	107	69	129	96	109	100
97		120	105	92	64	140	95	113	114
90		130	156	76	58	141	59	86	98
75		101	116	10	62	143	93	75	132
69		83	88	108	69	158	137	100	128
118		116	135	138	69	155	82	127	139
127		139	119	106	72	152	118	124	97
124		126	125	124	83	107	94	110	99
79		116	140	113	64	117	121	117	
102		148	136	92	57	158	13	122	
77		79	115	109	70	148	89	63	
30		142	131	69	77	114	17	114	
71		102	119	122	68	110	83	113	
79		133	134	123	74	133	86	107	
67			77	73	64	156	13	97	
70			116	85	60	150	12	106	
14			106	106	80	147	121	120	
84			101	132	71	115	14	110	
117			83	75	69	140	120	120	
114			70	98	102	123	14	104	
110			114		66		13	90	
84							91	121	
							142	118	
								88	
								117	
								123	

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Subdistrict 103-50

1	3	9	10	12
81	95	95	48	43
71	115	74	42	61
92	105	84	48	92
98	80	79	52	115
165	83	89	42	60
117	98	85	50	94
85	88	95	46	99
80	78	80	57	94
74	84	81	43	105
106	86	77	48	97
86	82	80	11	97
126	87	93	47	95
109	104	88	99	96
88	88	82	81	31
123	100	90	142	97
89	112	83	131	39
91	83	70	74	36
121	60	65	63	39
81	85	80	63	42
108	107	83	102	39
125	88	81	28	38
105	84	78	90	36
78	100	90	84	44
73	97	87	52	37
80	70	85	74	20
73	84	92	110	36
80	81	86	112	41
90	88	67	132	43
93	118	72	66	15
141	99	83	60	38
92	93	75	85	
99	73	76	83	
128		52		
		82		
		83		

Subdistrict 104-10

1	2	3	6	8	9	10	11	13	14	15
66	59	82	93	82	109	70	126	110	33	92
37	73	123	119	75	113	80	110	131	94	97
77	108	82	88	90	93	99	86	22	100	116
64	133	85	101	85	101	93	113	30	89	112
101	142	83	84	118	83	79	109	31	86	101
118	135	68	101	113	48	56	123	35	76	71
77	140	57	120	106	64	86	95	103	106	100
78	72	74	111	71	131	85	92	99	103	65
100	140	70	101	131	81	93	90	66	19	100
135	80	72	98	69	121	88	45	112	79	112
82	73	110	137	107	100	69	124	88	68	86
90	130	55	86	84	101	57	125	141	75	122
104	140	51	129	109	86	105	125	39	91	120
116	140	78	130	113	98	86	135	131	72	97
91	141	63	102	68	78	83	133	68	109	129
119	127	82	132	80	113	81	125	46	86	105
118	52	79	114	73	36	59	90	26	92	84
130	90	128	121	73	47	66	91	94	90	75
126	126	80	82	20	31	31	123	93	58	108
133	87	56	99	123	46	53	51	28	70	92
109	127	71	97	149	44	67	49	45	81	85
110	142	28	74	146	64	90		53	100	123
36	81	55	66	147	50	88		146	82	90
120	83	71	115	98	87	85		74	81	63
106	137	71	125	146	58	70		116	95	80
71	82	118	132	72	74	141		125	96	91
107		126	61	142	78	39		115	90	85
75		82	94	131	61	27		118	98	82
66		66	104	155	79	26		129	83	
49			110	104	80	39			86	
			101	114	23	106			92	
				137	84	80			102	
				141		81			21	
									98	

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Subdistrict 104-20

2	3	4	5	7	8	9	10	12	13	15
116	27	63	37	77	103	78	98	35	66	82
121	84	29	63	90	111	71	55	86	63	108
75	39	55	80	48	82	86	119	96	63	140
79	29	37	74	79	91	107	130	90	70	124
82	34	54	68	87	152	126	179	109	71	129
82	77	79	72	70	99	119	124	83	101	104
127	96	66	98	93	102	84	110	97	97	133
121	109	74	62	100	90	72	58	102	104	139
121	101	68	72	95	100	33	104	105	140	135
71	87	33	60	77	99	76	58	82	74	151
91	94	65	74	66	116	90	112	80	93	119
82	25	70	61	92	85	87	102	48	63	123
70	109	60	99	104	95	80	114	42	104	123
124	25	64	72	103	104	113	116	43	85	142
130	28	71	58	84	129	75	120	93	90	128
135	28	84	59	92	85	123	119	92	104	127
74	38	82	75	41	120	119	127	102	98	112
86	31	86	93	19	93	61	56	121	69	98
147	103	69	60	25	127	29	120	43	85	166
91	92	69	42	24	103	27	58	34	91	125
120	95	68	73	29	132	26	75	78	65	
90	28	70	59	31	130	29	108	37	87	
127	87	81	39	33	108	86	89	88	95	
116	34	73	41	28	148	76	84	41	96	
144	26	79	44	29	125	69	87	34	92	
101	89	81	45	35	99	75	71	38	81	
125	90	81	49	24	101	96	71	33	73	
131	25	83	63	34	65	110	120	38	89	
127	25	85	61	40	89	100		93	98	
134	85	90	68	38		112		101	100	
123	23		85	41		84		39		
88				79		92				
				30		93				

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Subdistrict 104-30 Control

3	5	6	36	37	38	39	40	44	45	46	47	48	49	50
90	43	70	146	70	130	108	118	78	96	122	118	131	43	36
61	45	58	28	76	149	95	98	111	88	138	113	154	143	35
56	39	112	128	98	107	95	99	98	88	114	86	127	43	38
51	28	47	142	88	115	120	90	95	66	129	120	137	91	38
54	36	60	110	12	98	114	99	96	96	152	92	129	131	42
57	24	75	148	84	106	91	123	75	108	125	133	145	101	34
53	42	52	132	94	93	90	127	86	105	131	114	127	86	34
33	36	73	139	59	101	130	78	116	92	131	117	124	122	33
51	38	64	153	79	94	97	115	79	95	124	58	142	112	41
56	40	72	138	89	105	102	104	83	119	132	104	121	148	38
106	42	59	128	60	113	102	96	158	115	112	97	133	106	32
46	45	82	117	82	119	111	90	120	67	132	100	133	102	33
92	36	63	99	91	89	114	122	109	84	111	87	132	139	60
80	40	53	34	78	107	106	99	93	93	126	107	111	138	36
88	39	86	112	86	105	99	106	93	93	141	127	128	114	34
80	31	67	114	100	95	99	80	90	59	136	108	46	59	34
85	60	99	151	91	103	87	121	74	97	120	91	34	106	37
82	39	65	129	83	89	111	106	84	142	147	115	124	93	35
89	45	76	129	100	103	97	92	78	104	114	96	119	52	38
76	37	74	136	89	88	91	88	91	99	127	91	158	86	30
102	41	96	97	94	107	95	78	66	79	125	105	114	62	22
88	48	67	114	108	91	98	91	92	102	103	101	145	49	35
93	20	108	144	82	87	115	88	76	93	136	115	91	137	32
89	45	63		96	92	94	118	89	75	130	114	21	94	32
88	50	62		85	88	74	112	102	110	125	105	102	94	41
89	46	82		78	92	121	84	96	130	126	120	125	83	31
88	40	58		92	108	90	74	89	114	118	105	149	109	41
78	41	42		64	71	133	98	84	151	110	58	22	149	37
89	47	92		86	118	97	121		108	138	112	100	114	43
54	37	113		109	93				100	84	109		125	36
56		92		98					151		121			33
79		82		79					106					41
		79		81					117					33
		103		87					89					38
									106					
									139					
									95					
									64					
									139					
									135					
									137					
									136					
									35					
									100					
									130					
									148					
									131					
									90					
									132					
									91					
									86					
									76					
									93					
									90					

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Subdistrict 104-30 Experimental

1	8	9	11	12	14	15	16	17	18	19	20	22	23	24	27	28	29	30	31	35
72	118	36	116	104	72	91	49	93	86	25	39	92	24	99	126	126	118	118	52	73
112	93	33	100	135	102	90	149	95	105	132	115	75	29	83	115	100	93	116	23	70
74	128	77	97	135	97	58	137	95	124	116	16	95	37	121	111	94	114	128	41	95
128	73	96	99	110	110	87	125	73	113	112	86	76	33	37	112	86	99	117	27	82
101	96	83	125	128	95	93	102	92	104	73	97	85	18	37	127	94	136	107	15	115
94	124	87	102	110	101	127	48	85	108	37	112	90	29	51	92	72	53	115	57	73
104	108	93	66	130	115	77	128	115	24	91	113	96	43	77	104	34	75	124	70	62
73	111	37	85	131	34	87	115	11	103	27	89	92	21	60	110	33	57	139	82	88
96	134	102	98	108	98	108	136	95	100	25	67	110	26	77	111	112	58	131	72	85
118	120	40	65	128	99	97	129	100	97	48	104	80	18	60	100	91	54	128	35	72
90	100	91	61	94	93	90	151	96	101	39	73	95	16	89	66	114	39	117	69	85
100	91	30	111	120	101	92	104	89	105	107	126	99	26	40	71	96	99	126	46	79
90	82	88	59	117	113	92	129	84	103	79	94	40	75	46	84	100	83	117	122	41
50	84	22	94	107	109	96	101	81	93	124	92	97	85	38	72	123	105	104	138	74
60	103	30	69	106	92	93	136	76	108	80	85	114	90	40	71	101	44	97	40	37
83	133	35	119	107	95	84	114	99	100	87	90	75	50	32	114	109	95	113	52	61
111	97	85	120	112	97	115	127	110	99	95	79	31	103	49	111	122	103	81	43	67
42	92	26	107	121	85	92	100	84	78	33	90	40	91	33	110	141	71	46	75	62
71	116	35	115	110	109	75	137	80	95	30	121	74	35	42	125	119	102	63	73	62
82	102	96	105	29	93	105	124	113	102	31	53	75	92	90	114	103	122	72	98	79
95	93	94	116	93	13	82	135	14	108	24	76	96	37	87	119	94	91	61	63	67
34	100	25	84	94	88	92	110	110	116	35	79	85	93	40	129	100	86	82	47	64
72	79	97	116	101	97	94	137	101	118	26	90	84	91	79	128	136	120	63	51	54
44	101	34	75	88	92	94	113	127	110	27	29	97	82	80	107	98	82	59	63	56
78	130	84	114	75	96	92	97	79	104	96	83	82	73	69	105	89	105	52	40	67
106	136	40	89	98	12	97	110	95	107	79	100	90	65	84	132	101	101	36	110	43
48	127	34	65	109	95	83	96	132	119	114	87	92	32	77	109	98	107	32	110	62
71	88	33	62	120	92	89	119	70	119	81	85	62	127	86	115	115	90	21	47	50
83	112	79	43	120	93	89	130	106	131	29	88		23	120	110		124	21	101	42
132	96	97	81	119	108		128	72	105	24	116		26	94	119		91	62	98	43
122			66					96			93			44			91	16	120	67
78			55					133			77			40					73	33
74											97			66					59	54
59											86			63					113	
42											96			65					132	

-continued-

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Subdistrict 104-35

2	3	4	5	7	8	9	10
19	101	111	55	117	66	81	17
80	19	26	102	109	51	112	82
105	76	42	96	111	89	55	100
117	75	39	65	110	60	87	80
69	105	35	55	101	95	38	65
65	47	38	49	120	85	132	50
52	16	40	60	126	61	117	41
78	88	40	77	102	98	72	112
100	96	114	27	101	101	98	30
82	62	103	86	124	60	81	63
73	110	82	48	122	76	122	104
110	11	96	48	108	26	105	41
73	26	121	54	85	33	34	29
116	11	41	95	125	92	117	18
48	27	115	42	105	105	95	18
68	36	107	122	117	72	21	34
90	25	80	75	141	77	42	54
97	107	34	60	102	68	81	52
62	98	42	52	117	59	76	34
84	44	20	72	109	100	86	39
124	100	41	83	120	110	120	47
88	88	75	51	102	59	47	51
86	12	16	73	108	90	142	48
66	23	106	92	118	48	114	40
28	101	32	58	88	70	141	48
57	12	33	90	124	98	64	47
74	14	38	92	128	100	50	48
84	108	70	60	120	88	79	51
111	87	69		128	110	43	52
64	58	81		96	79		64
	46			99	31		62
	107			105			56
	83			109			51

Subdistrict 104-40

1	4	7	8
32	79	34	60
88	94	27	37
75	89	101	47
82	82	31	96
47	46	48	41
75	42	62	84
92	79	58	47
77	96	52	86
94	92	104	60
96	76	40	34
95	98	127	77
80	106	72	61
79	59	59	48
73	82	57	41
72	85	50	41
80	74	108	82
54	78	41	54
21	97	33	44
34	97	28	39
47	72	54	45
48	53	25	50
84	71	33	57
43	75	54	40
58	63	30	41
73	99	25	50
65	95	57	22
63	55	52	53
60	64	62	52
77	100	65	40
52	76	56	102
	18	35	43
	14		51
			104
			37

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