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A survey of kina populations (*Evechinus chloroticus*) in Dusky Sound and Chalky Inlet, southwestern New Zealand

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A SURVEY OF KINA POPULATIONS (*EVECHINUS CHLOROTICUS*) IN DUSKY SOUND AND CHALKY INLET, SOUTH WESTERN NEW ZEALAND.

P.E. McShane and J.R. Naylor

Abstract

A stratified random survey of kina (*Evechinus chloroticus*) populations was conducted in Dusky Sound and Chalky Inlet during November 1991. The survey revealed that kina were abundant with mean densities varying between 1.1 and 3.0 m^{-2} for four strata surveyed. Kina were recorded at all sites surveyed and were observed to be associated with stands of dense seaweed. Kina were also observed in dense aggregations down to 26 m depth. The mean size of kina varied significantly between strata as did the relative gonad yield. Few individuals smaller than 50 mm test diameter were recorded despite semi-destructive sampling. The gonad index (percent gonad weight to total weight) was highest for individuals around 100mm test diameter; such kina also had the highest frequency of high quality (yellow/orange gonad) roe. The gonad index for larger individuals was comparatively low. The bathymetry of the Sounds provides for an estimated subtidal fringe of 26m (to 9m depth). Thus the standing stock of kina to 9m was estimated to be 260, 2466, 805 and 130 tonnes for the Chalky Inlet, Anchor Group, Parrot/Pigeon and Indian Island strata respectively. For the area surveyed in Dusky Sound the standing stock of kina to 9m depth $\pm$ 95% confidence intervals was estimated at 3401 $\pm$ 808 tonnes.

1. INTRODUCTION

The unique character of the habitat and associated benthic communities within the fiords of Fiordland, southern New Zealand, has prompted numerous studies including surveys of the dominant biota (e.g. Grange 1985, Grange et al. 1981, Hurley 1964, McKnight 1968, McKnight and Estcourt 1978). However there is little published information on the coastal benthic communities, including those off the many small islands. Kina are sea urchins (*Evechinus chloroticus*) and are apparently dominant in the subtidal reef communities off Fiordland, southern New Zealand (McShane et al. unpub data, Street unpub.). The considerable value of sea urchin roe (the gonad) on Japanese markets has led to the development of sea urchin fisheries around the world especially in California (Tegner 1989), Washington (Kato and Schroeter 1985, Sloan 1986, Tegner 1989) and Japan (Mottet 1976). Although the observations of high densities of kina in Fiordland suggest a viable fishery, the sustainability of harvest of such a fishery is unknown. In contrast, there is a good understanding of the general biology of kina and its distribution in northern New Zealand (reviewed by Andrew 1988). The negative association of kina and kelps is well established (Andrew and Choat 1982, Choat and Schiel 1982, Schiel 1982, Schiel and Foster 1986, Andrew 1988) and is consistent with kelp-sea urchin interactions established for other species of echinoids (see Lawrence 1975, Harrold and Pearse 1987 for reviews).

The present study was initiated following a proposal to harvest 1000 tonnes of kina annually off Fiordland. Here we present information on the population structure of kina, including estimates of stock biomass, in Dusky Sound and Chalky Inlet off Fiordland. We concentrated our surveys around the offshore islands within Dusky Sound because of their potential to support a kina fishery. We present general morphometric information and assess the spatial variation in morphometry within the sounds. Observations on general habitat characteristics and other dominant biota are recorded as a prelude to more detailed studies of population biology and community disturbance following the commencement of any kina fishery in the region.

2. MATERIALS AND METHODS

A stratified random survey design was adopted with strata including the coastal fringe around Small Crafts Island (Chalky Inlet), Parrot and Indian Island and the general area around Anchor Island including the surrounding islands and the adjacent east coast (Dusky Sound, Figure 1). These strata were chosen as discrete areas within the region of interest. Sites were allocated randomly according to the relative area of the strata (Table 1). Although kina can occur at depths in excess of 40m (Street unpub.) we limited our survey to a maximum depth of 9m (the maximum practical depth from which kina could be extracted in a free dive fishery). We estimated the length of coastline in each stratum using a planimeter (NZMS map No. S 156).

The survey was conducted between 9 and 17 November 1991. At each site, two divers each haphazardly placed a 1m square quadrat on the reef surface. All kina within the quadrat were counted, observations of general habitat type (topography, dominant biota) were recorded and large epifauna counted where possible. Where possible, boulders were overturned and cracks and crevices searched for kina. By overturning the quadrat and repeating the above process at least 25 times, an area of at least 25 square metres was surveyed by each of two divers at each site. The quadrat was overturned laterally in a straight line perpendicular to the edge of the haphazardly-tossed quadrat. The direction of sampling was always away from the research vessel. In the usual case, where the quadrat was not aligned parallel to the shore, the direction of sampling proceeded from deep to shallow. Each site was therefore represented by two subsites each of around 25 m^2 in area. All kina in the sample area were sequentially collected until approximately 60 were gathered.

All kina collected were measured aboard the research vessel for widest test diameter to the nearest mm. At most sites a subsample of approximately 20 individuals was

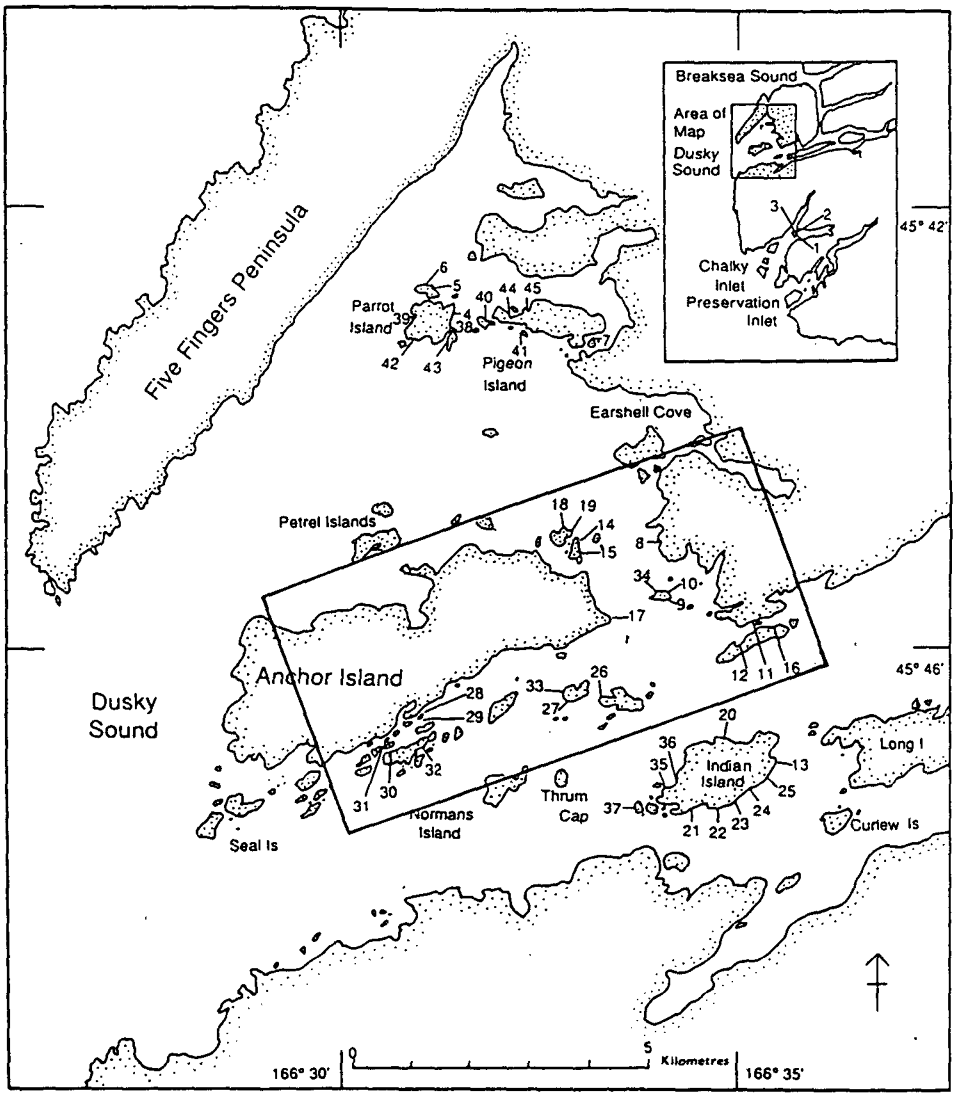

Figure 1. Stratified random site locality, Dusky Sound and Chalky Inlet, Fiordland. Sample strata include Small Crafts Island (Chalky Inlet); Parrot/Pigeon Islands; Indian Island; and the area indicated off Anchor Island and the adjacent east coast (Dusky Sound).

measured for total weight (to the nearest gm) with a beam balance. After weighing, each kina was dissected and the gonads removed and weighed to the nearest gm after removal of excess moisture and extraneous connective tissue. The volume of each gonad was also measured to the nearest ml by displacement of seawater in a 200 ml measuring cylinder. Gonad colour was noted with reference to a colour chart (Japanese sea urchin colour/volume chart). All measurements were taken within 1 h of collection.

For assessment of the variation in kina density between strata, a hierarchical analysis of variance was applied with individual diver records (subsites) nested within sites. (Underwood 1981).

3. RESULTS

3.1. General observations

The substratum in all strata was sometimes steeply inclined from the shore with little topographic relief, although at some sites boulders (small and large) were present (see Appendix). On steep relief reef there were often rocky "shelves" along which kina were aggregated. The substratum was mostly solid reef (granite) and there was no apparent difference in the underwater topography between strata. Thus the sites surveyed in Chalky Inlet were similar to those sites surveyed in Dusky Sound. The coastal waters were clear, although at some sites distant from the coast a freshwater surface layer of 1 to 2m was apparent. Seaweeds were particularly abundant at most sites. In shallow water (0 to 2m), stands of *Durvillea antarctica* were common, while in water down to 15 m, dense stands of the laminarian *Ecklonia radiata,* and the fucoids *Carpophyllum flexuosum, Sargassum sinclairii* and *Cystophora* spp. were observed. *Ulva lactuca* and *Codium* spp. were common at most sites as was *Caulerpa brownii* and the annual brown seaweed *Spatoglossum chapmanii*. Red seaweeds were abundant and diverse. Dominant epifauna included kina, the sea cucumber *Stichopus mollis* (densities up to 8 per square metre), limpets *Cellana* spp. and the snail *Turbo smaragdus* (densities up to 20 per square metre).

3.2. Kina density

A total of 4244 kina were counted within 2382 square metres from 45 sites in Chalky Inlet and Dusky Sound (Table 1). Kina were present at all sites (Fig. 2). The mean density of kina recorded from a site ranged from 0.1 to 5.5/m^2. Kina were observed on both rocky and sandy substratum (see Appendix) with dense aggregations (up to 28 per square metre) forming patches associated with low seaweed abundance. Such "barrens" did not usually occupy a large area (more than a few square metres) and were observed at most sites to be interspersed with patches of dense seaweeds.

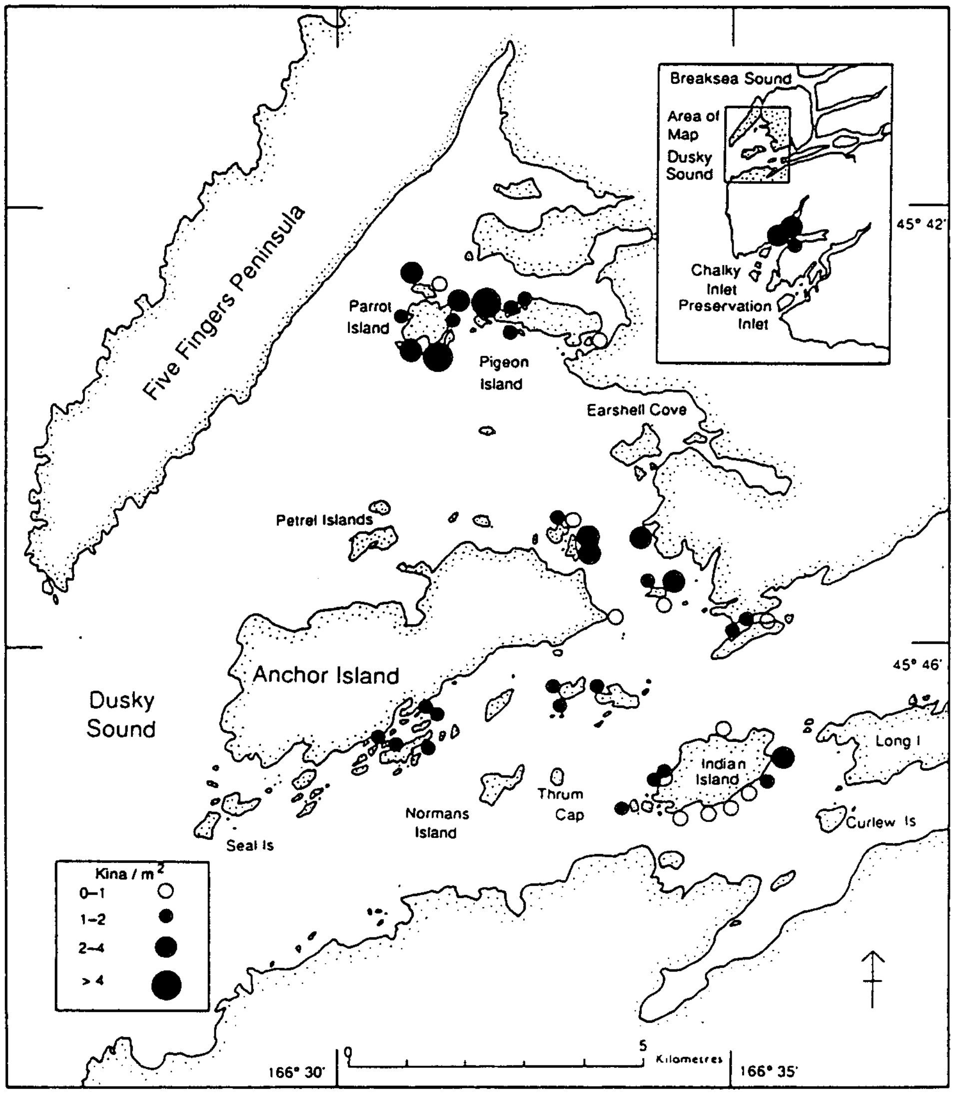

Figure 2. Density of kina within Dusky Sound and Chalky Inlet.

Analysis of variance revealed that the density of kina varied between strata ($F_{3,41} = 8.21$, $P < 0.001$); kina were most dense in Chalky Inlet and least dense off Indian Island. While densities varied from 1.1 to 3.0 m^{-2}, kina were abundant in all strata surveyed (Table 1). Samples were not taken at uniform depth; at a site each diver sampled at random from 1 to 9m. Nonetheless, within the depths sampled, we observed no obvious relationship between kina density and depth. Although quantitative data were not collected from deeper waters, kina were observed in aggregations at depths down to 26m (the maximum depth dived).

3.3. Size composition

The size composition of kina varied between strata (site nested within strata; ANOVA, $F_{3,38} = 106$, $P < 0.001$). Kina ranged in test diameter from 12 to 190 mm. Although the test diameters of kina from the Anchor group and Parrot/Pigeon Islands were similar, a mode of smaller individuals was present in size frequency distributions of kina from Chalky Inlet and Indian Island (Fig. 3, Table 1). A juvenile cohort of kina of test diameter around 50 mm was present off Chalky Inlet while a mode of kina around 90 mm in test diameter was apparent in kina sampled from Indian Island (Fig. 3). Small kina (< 50 mm test diameter) were almost always cryptic, typically inhabiting cracks and crevices in the substrata or the undersides of small boulders. In many cases we could not sample all habitat within a quadrat; for example the undersides of large boulders. Thus juvenile kina are probably underrepresented in our samples.

3.4. Gonad recovery

The volume (ml) of the gonad of kina (Y) was directly related to the weight of the gonad (g) (X) (least squares linear regression $Y = 0.95X - 0.18$; $N = 567$, $r^2 = 0.99$). Should this relationship be invariant seasonally then volume would be a more convenient measure of gonad size as it is relatively quick and can be performed in adverse conditions that can preclude accurate weighing.

Over all sites, the mean gonad index (percent of gonad wet weight to total weight) varied from 3.9 to 13.9 (Fig. 4). The mean gonad index varied significantly between strata (nested ANOVA $F_{3, 25} = 33$, $P < 0.001$) but the magnitude of the variation was not great (Table 1). The gonad index varied with the size (test diameter) of kina but not with the density of kina (Fig. 6, ANOVA slope = 0, $P = 0.76$). The gonad index varied independently of density for all strata (ANOVA, slope = 0, $P > 0.1$). A quadratic relationship of gonad index to test diameter adequately fitted the data for all strata except Indian Island (Fig. 5). Such a relationship accounted for more than twice the variation of gonad index with test diameter compared with linear models, however the scatter of residuals about the fitted curve is indicative of the high individual variation in gonad indices. The size

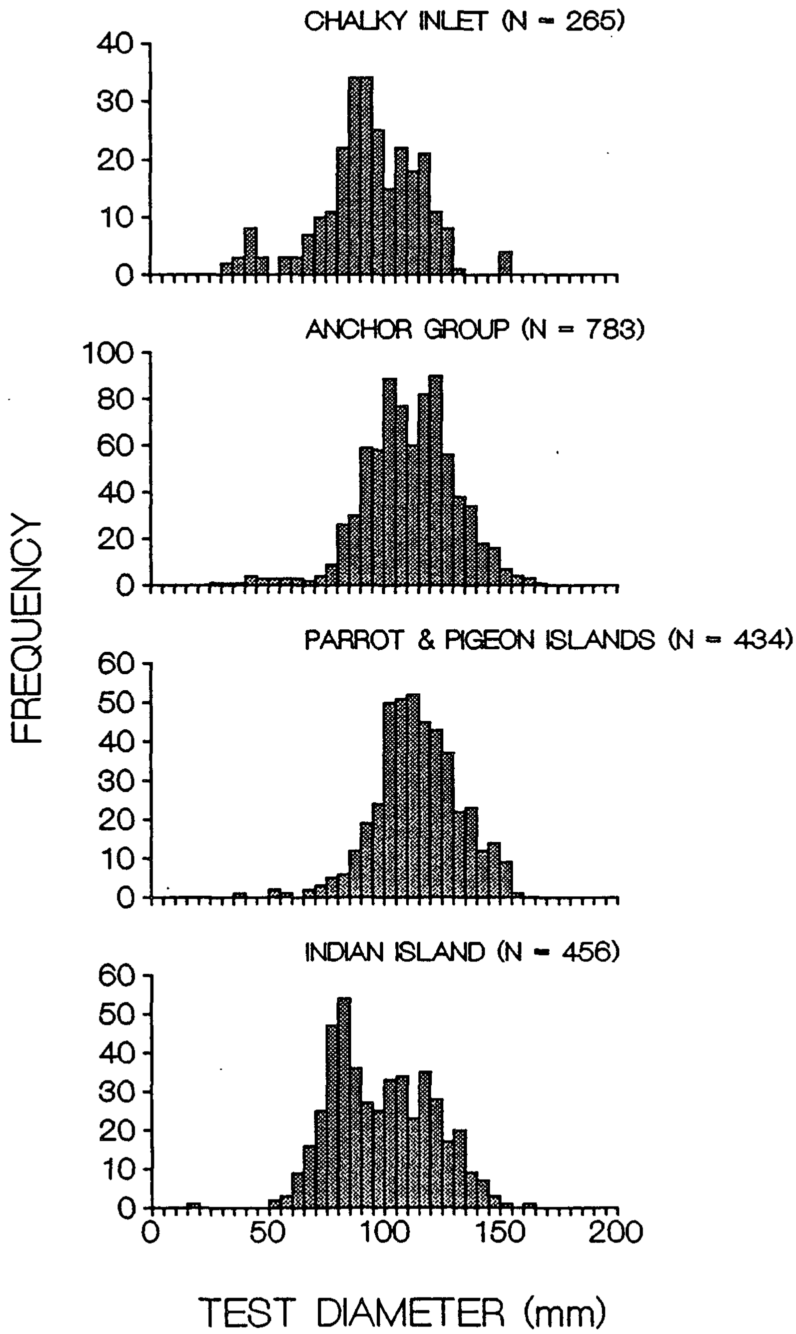

Figure 3. Size frequency of kina sampled from Chalky Inlet and Dusky Sound.

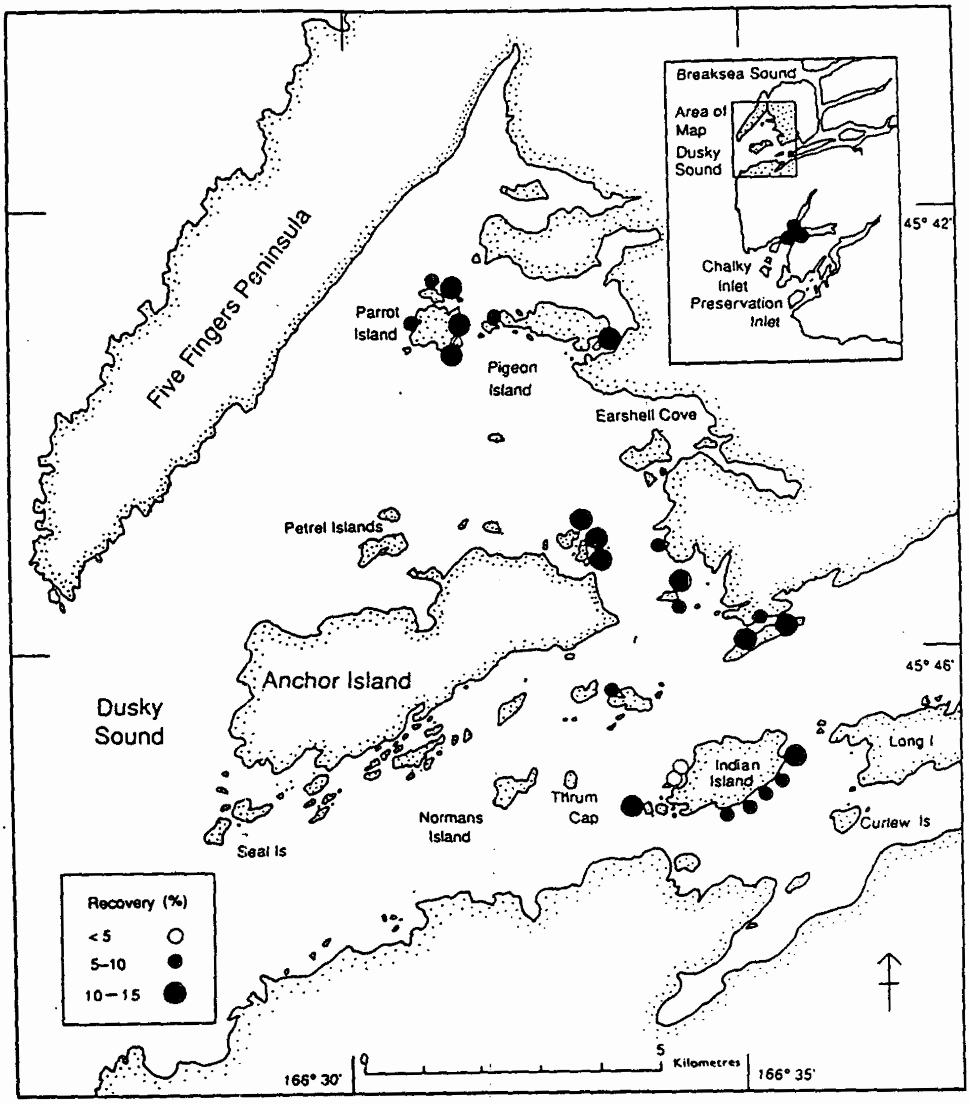

Figure 4. Variation in the gonad index (% recovery gonad/total weight) of kina sampled from within Chalky Inlet and Dusky Sound.

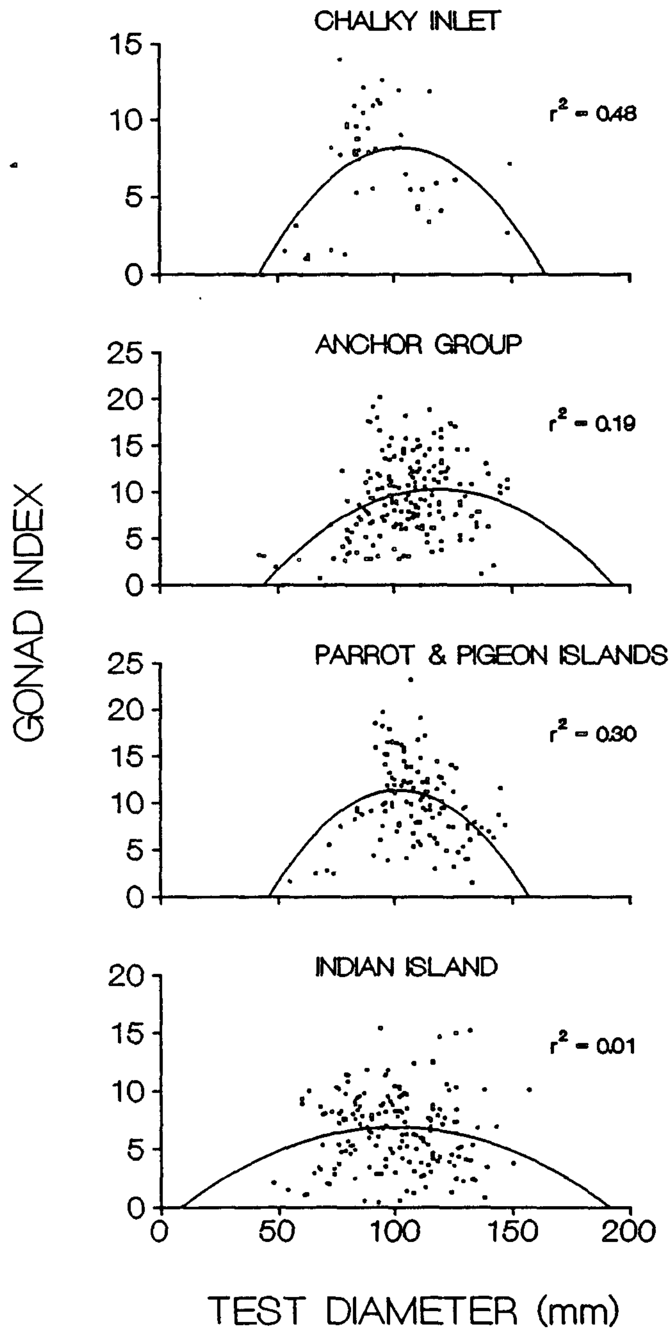

Figure 5. Variation in gonad index with the test diameter of kina sampled from Chalky Inlet and Dusky Sound.

at first maturity is around 50 mm test diameter, the relative size of the gonad reaches a maximum around 100 mm test diameter (around 120 mm for Anchor group) and that for individuals with test diameters greater than this, the relative size of the gonad decreases (Fig. 5). Gonad colour was observed to vary with the size of kina. Large individuals (test diameter > 120 mm) typically had dark brown gonads while individuals of around 100 mm test diameter or less usually had yellow to orange gonads. However, the relationship of gonad colour with size was observed to vary between sites.

TABLE 1. Summary data for a stratified random survey of kina (*Evechinus chloroticus*) populations in Dusky Sound and Chalky Inlet. Data are means (±S.E. for density; ±S.D. for length, gonad index; ±95% confidence limits for stock size)

Stratum	Sites	Surface area (m^2 x 1000)	Density (no/m^2)	Test Diameter (mm)	Gonad Index	Stock size (tonnes)
Chalky Inlet	3	250	3.0 (0.5)	89.6 (21.7)	6.0 (4.1)	260 (106)
Anchor group	20	3500	1.6 (0.2)	106.7 (20.0)	9.2 (4.4)	2466 (582)
Parrot/Pigeon Islands	12	700	2.3 (0.3)	110.1 (18.0)	9.8 (4.5)	805 (176)
Indian Island	10	300	1.1 (0.2)	94.1 (21.7)	6.5 (3.1)	130 (50)
TOTAL	45	4750				3661

3.5. Standing stock estimates

The relationship of total weight to test diameter followed a power function where:

Total weight (g) = 0.00055 Test diameter $(mm)^{2.9}$ (Fig. 7).

The mean length of kina in each stratum was used to estimate mean weight and the available stock of kina (to 9m depth) in each stratum (Table 1). In calculating available surface area to 9m depth, we assumed that the reef inclined at an angle of 20°. This was considered reasonable given that steep slopes, while present at some sites, were infrequent (Appendix). This generalisation provides for a 26 m coastal fringe and an estimate of available surface area in each stratum (Table 1). We further identified some shallow areas between the numerous islands in the study area of Dusky Sound from aerial photographs taken by us (an estimated 100,000 m^2) although this is an underestimate because conditions prevented us from

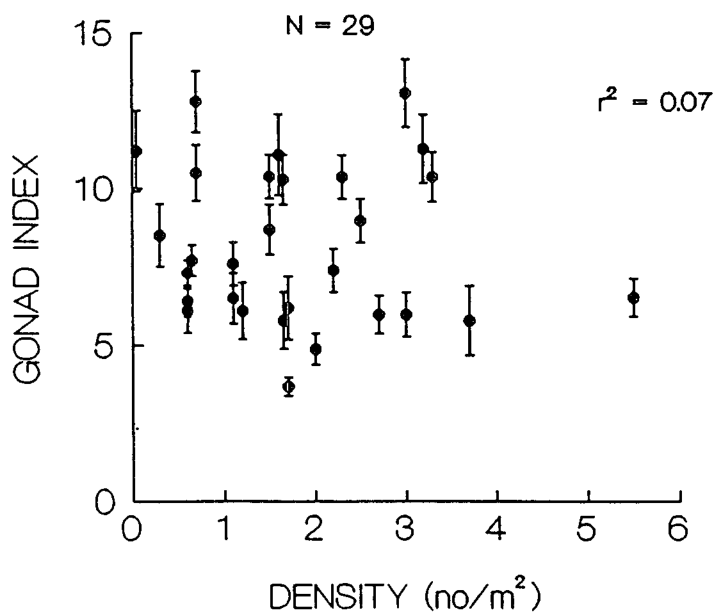

Figure 6. Variation in gonad index with the density of kina.

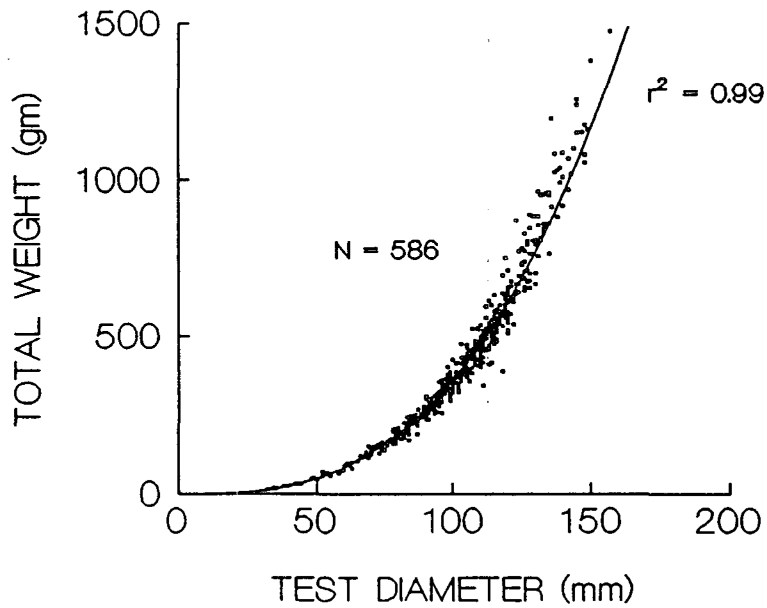

Figure 7. Relationship of total weight to test diameter for kina sampled from Chalky Inlet and Dusky Sound.

photographing most of the available coastal habitat. In all, some 85 Islands were identified off Anchor Island which together with the east coast (Fig. 1) provided an estimated available surface area of 3,500,000 m^2 in the Anchor group stratum (Table 1). Estimates of available surface area and standing stock of kina for the other strata are provided in Table 1. The total standing stock of kina (to 9m depth, $\pm$95% confidence intervals) in the area surveyed in Dusky Sound is estimated at 3401 $\pm$808 tonnes.

4. DISCUSSION

4.1. General findings

There is an abundant kina resource in Dusky Sound. Kina were ubiquitous throughout the survey area. Our estimate of standing stock is conservative for the following reasons. First, our estimates did not take into account the complexity of the coastline that would provide for a much greater surface area than that included in our estimation. This is particularly relevant given the abundance of small islands for which accurate estimates of available subtidal habitat are elusive and our observations that the reef surface was seldom flat and even. Second, our survey area was restricted to depths of 9m or less, yet kina were obviously distributed in dense aggregations to depths much greater than this. Third, our survey area encompassed only a small part of Dusky Sound; a minimum of an additional 2.2 sq km of coastal habitat is estimated to 9m depth in the area of Dusky Sound not included in our survey. Thus the total standing stock of kina in Dusky Sound is substantially greater than our estimate.

Several additional points of interest emerge from our survey. The density of kina recorded in Dusky Sound and Chalky Inlet compares with similar estimates from northern New Zealand (Choat and Schiel 1982, Schiel 1982, Choat and Andrew 1986). These studies revealed densities of up to 40 m^{-2}. Off Kaikoura in Southern New Zealand (Dix 1970a) reported densities of kina up to 50 m^{-2}. Our findings are remarkable in that high densities of kina persisted over a relatively large area rather than a few dense patches interspersed with regions of low abundance (Choat and Schiel 1982). Schiel (1982) and Choat and Schiel (1982) note that kina are rare below 12m depth in northern New Zealand. Andrew (1988), reviewing the distribution of kina, pointed to the infrequent yet documented occurrence of kina in deeper waters. The high water clarity of Dusky Sound permitted a visual assessment of kina in waters deeper than those surveyed in detail by us. We frequently observed high densities of kina (patches of 20 m^{-2}) at least down to 26m in Dusky Sound.

Dense patches of kina were frequently interspersed with dense stands of seaweed - a finding in contrast to the well documented inverse relationship of kelp and kina density (reviewed by Andrew 1988). Those seaweeds preferred as food by kina, including *Ecklonia radiata, Sargassum sinclairii* and *Landsburgia quercifolia* (Andrew and Choat 1982, Schiel 1982, Andrew 1986) were commonly associated with kina populations, a finding in contrast to that found off northern New Zealand (Andrew and Choat 1982, 1985, Choat and Schiel 1982). The dense stands of *Ulva lactuca* observed by us at most sites in the present study were evidently being consumed by kina (pellets of *Ulva* were conspicuous in the tests of dissected individuals).

Food is a critical factor influencing gonad yield in sea urchins (Lawrence 1975). In sea urchins, the gonad functions as a nutrient store (Giese 1966) and the relative size of the gonad is a commonly used index of nutritional state (Harrold and Reed 1985). Gonad colour, a factor important in the salability of roe is also dependent on the quantity and quality of food eaten by sea urchins (Mottet 1976, Tegner 1989). The weight of the gonad of kina can increase rapidly with feeding (Andrew 1986, 1988). Conversely, dense aggregations of sea urchins can be maintained with little food by individuals utilising nutrient reserves stored in the gonad (Giese 1967). The studies summarised above, together with our observations of dense seaweed in kina-dominated communities, explain the comparatively high gonad yields we recorded despite the high density of kina. While we expected the gonads to be comparatively large because of high gametogenic activity in spring prior to spawning in summer (Dix 1970b, Walker 1982), the negative relationship between density and gonad yield previously found for kina (Andrew 1986, Choat and Andrew 1986) and other species of sea urchin (Harrold and Pearse 1987, Tegner 1989) was not apparent. The lack of a such a relationship is further evidence of the abundance of food in the Dusky Sound and Chalky Inlet region.

4.2. Fisheries development

Kina are abundant in Dusky Sound, yet there is an accumulated stock of larger, older (see Dix 1972) individuals. The comparatively low yield of gonads from larger kina may be due to senility (Dix 1969). The relative yield of roe could be expected to increase with fishing concomitant with the removal of these large, non productive individuals as has been demonstrated in other sea urchin fisheries (Mottet 1976, Kato and Schroeter 1985, Sloan 1986). Even so, our gonad recovery measurements revealed good yields and the high quality roe demanded by export markets (see Hartstone 1984) was frequent in our samples. Harvests of kina from shallow waters could be maintained in the short term by migration from deeper waters and relatively high growth rates are predicted with the abundant seaweed resource in the region (see Dix 1972).

Compared with the literature on the biology and ecology of sea urchins, there is a paucity of information on their fisheries biology (Conand and Sloan 1989). There has been scant attention to the stock assessment of sea urchin fisheries even though such fisheries can have considerable commercial value and, in the case of at least one Japanese fishery, suffer stock decline (Kawamura 1973). Thus, there is a lack of detailed case histories that can be used as a guide to develop a kina fishery in Fiordland. For example; there is no information on the proportion of the standing stock that can be sustainably harvested in a sea urchin fishery. This is not surprising given the usual difficulty of deriving such estimates for fisheries operating on large spatial scales with a class of animals that has highly variable growth, mortality and recruitment (e.g. see Andrew 1988, Ebert and Russell 1988). Thus, while our survey provides an estimate of the biomass of the standing stock of kina in areas of Dusky Sound, we can only speculate on an annual sustainable harvest.

Overall, there is little regulation of fishing in other sea-urchin fisheries of the world (Conand and Sloan 1989). For instance, there are no annual catch quotas applied to any major sea urchin fishery (Japan, North America). A rotational harvest scheme, with populations periodically closed to fishing, has been successfully applied to sea urchin fisheries in Japan and Washington (Mottet 1976, Kato and Schroeter 1985, Sloan 1986, Tegner 1989). Such a strategy promotes recruitment, maximises yield per recruit (Mottet 1976) and provides for a regular population assessment in closed areas prior to the reintroduction of fishing. This is important when considering the harvest of sedentary species such as kina, where catch rates can be maintained against declining biomass by the serial depletion of substocks.

Restricting fishing activity to discrete areas (substocks) would overcome many of the problems associated with serial depletion. For relatively small areas, fishermen could be restricted to individual substocks; catch data would therefore be more useful in assessing the relative state of the stocks. Furthermore, such stock reduction accompanying fishing would permit more accurate estimates of the biomass of kina in a particular area. Robust assessments of substocks of kina would be possible with the influence of spatial variability in growth, mortality and recruitment lessened. More importantly though, in the case of Fiordland, such focussed fishing would permit the detailed evaluation of a harvest strategy in a discrete area without endangering the entire stock. Surveys similar to that described here could be conducted in other areas of Fiordland, such as the greater Chalky and Preservation Inlets which are known to support dense kina populations (Street unpub.). Such areas, together with the coastal areas of Dusky Sound, could be included in a rotational fishing strategy (see Tegner 1989).

4.3. Kina fishing ,community ecology and further research

The main predators of kina include rock lobsters and benthic reef fishes (Andrew 1988, Andrew and MacDiarmid 1991). The removal of large numbers of lobsters from the Fiordland region prompts the hypothesis of predator release (*sensu* Breen and Mann 1976) which may explain the high abundance of kina in some areas. Yet despite a burgeoning literature on this subject (reviewed by Andrew and MacDiarmid 1991) the principal mechanisms regulating sea urchin abundance remain obscure (Schiebling and Hamm 1991). The lack of knowledge of regulatory processes in sea urchin-dominated communities can be attributed to a failure to conduct the necessary experiments on the appropriate scale (time and space). The proposal to harvest 1000 tonnes of kina from Dusky Sound provides an opportunity to examine the effects of a focussed disturbance on the inhabitant kina-dominated communities. The sustainability of this harvest will be more accurately guaged by the results of initial fishing and of sequential population surveys which will provide the necessary information on growth, mortality and recruitment.

The permanent closure of some representative habitat to fishing could be a prerequisite to the development of a fishery so that a proper assessment of the effects of fishing can be conducted. We suggest that Indian, Parrot and Pigeon islands and their associated offshore islands could serve as permanent controls against which fishing induced changes in the wider Dusky Sound region can be assessed against natural changes in the community (Underwood 1991). Such islands are ideally suited to ecological study. First, as far as we can tell from our initial studies, the structure of the subtidal benthic communities off these islands is representative of the coastal communities of Dusky Sound. Second, the bathymetry of the sounds is such that the deep water (> 100 m) which separates adjacent islands creates a migratory barrier for many of the epifaunal species. This, and the comparatively small subtidal surface area off many of the islands in the sounds, permits detailed and accurate censuses, together with appropriate experimental manipulations of the biota of interest while also satisfying the requirement for reasonable replication.

For example, the rock lobster populations of several adjacent islands could be manipulated to allow for several density treatments and an examination of the effect of lobster predation on kina populations (Andrew and MacDiarmid 1991). The anecdotal claim that kina outcompete paua (*Haliotis iris*) could be adequately tested following an appropriately scaled experiment comparing dense (non-fished) with sparse (fished) populations of kina. The interaction of kina populations and kelp communities is better explored with large rather than small-scale experiments (Choat and Andrew 1986). Evidence from the present study that paradigms of sea urchin-kelp interaction do not necessarily apply to southern New Zealand warrants further detailed study. This and other studies would enhance our understanding of ecological processes which maintain the complex subtidal communities off southern New Zealand.

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Appendix Summary data : assessment of kina populations Chalky and Dusky Sound, November 1991. Data are means (S.E.), (S.D. for test diameter).

Site	Stratum	Sample area (m2)	Density (no/m2)	Test Diameter (mm)	Gonad Index	Topography
1	Chalky	35	1.7	76.4 (21.0)	6.2 (1.0)	rock cobbles gravel
2	"	50	3.7	99.9 (21.3)	5.8 (1.1)	sand cobbles rock
3	"	63	3.0	93.0 (15.9)	6.0 (0.7)	solid reef bldr rock
4	Parrot	50	3.0	110.9 (17.3)	13.1 (1.1)	solid reef
5	"	50	1.6	111.0 (21.9)	11.1 (1.3)	solid reef
6	"	50	2.5	120.8 (15.5)	9.0 (0.7)	solid reef steep slp
7	"	50	0.1	no sample	11.2 (1.3)	rubble congl sand
8	Anchor	50	2.2	99.3 (13.7)	7.4 (0.7)	solid reef
9	"	50	0.3	no sample	8.5 (0.9)	solid reef
10	"	50	3.2	107.5 (14.5)	11.2 (1.1)	solid reef
11	"	59	1.6	94.1 (16.0)	5.8 (0.9)	solid reef steep slp
12	"	67	1.5	114.2 (12.4)	11.6 (0.8)	solid reef
13	Indian	71	2.7	79.3 (16.3)	10.6 (0.6)	solid reef
14	Anchor	50	2.3	113.0 (17.1)	10.4 (0.7)	solid reef
15	"	50	3.3	108.1 (17.2)	10.4 (0.8)	solid reef
16	"	50	0.7	104.9 (14.5)	12.8 (1.0)	solid reef
17	"	50	0.8	111.2 (25.3)	no sample	solid reef
18	"	50	1.1	117.6 (22.3)	no sample	solid reef steep slp
19	"	50	0.7	114.7 (14.7)	10.5 (0.9)	solid reef steep slp
20	Indian	50	0.1	no sample	no sample	solid reef,rocks
21	"	51	0.6	85.5 (13.8)	6.4 (0.5)	solid reef
22	"	50	0.6	97.7 (14.2)	6.1 (0.7)	solid reef, f/w layer
23	"	60	0.6	116.1 (11.9)	7.3 (0.4)	solid reef
24	"	53	0.6	101.8 (17.2)	7.7 (0.5)	solid reef
25	"	55	1.1	80.7 (17.9)	6.5 (0.8)	solid reef
26	Anchor	51	1.2	94.3 (21.1)	6.1 (0.9)	solid reef
27	"	53	2.0	120.7 (15.8)	no sample	solid reef steep slp
28	"	59	2.2	105.0 (19.9)	"	solid reef steep slp
29	"	51	1.7	112.6 (17.1)	"	solid reef
30	"	50	1.5	99.4 (27.5)	"	solid reef
31	"	55	1.5	91.0 (15.1)	"	solid reef/rubble
32	"	54	1.4	112.6 (19.6)	"	solid reef
33	"	54	1.1	120.1 (20.6)	"	solid reef
34	"	55	1.6	120.0 (11.9)	"	solid reef
35	Indian	55	2.0	105.5 (18.9)	4.9 (0.5)	solid reef,bldrs
36	"	50	1.7	102.9 (19.5)	3.7 (0.3)	solid reef
37	"	55	1.6	114.4 (23.1)	10.3 (0.8)	solid reef
38	Parrot	50	1.5	120.2 (12.8)	10.4 (0.7)	solid reef
39	"	50	1.1	110.2 (20.8)	7.6 (0.6)	solid reef,bldrs
40	"	50	5.5	108.4 (16.6)	6.5 (0.6)	solid reef,bldrs
41	"	58	1.9	116.7 (14.5)	no sample	solid reef,largebldrs
42	"	51	2.5	109.9 (16.9)	"	solid reef,largebldrs
43	"	58	4.4	96.9 (17.6)	"	solid reef
44	"	59	1.5	108.9 (13.6)	"	solid reef
45	"	50	1.4	105.1 (15.0)	"	solid reef/cobbles