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A summary of commercial catch data and biological information for kina (*Evechinus chloroticus*)

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EXECUTIVE SUMMARY

A summary of commercial catch and biological information is presented for New Zealand's kina (*Evechinus chloroticus*) fishery. Catches have generally been less than the competitive quota for each management area (QMA). Results from an experimental fishery in Dusky Sound suggest sustainable harvests in that area, small in relation to the FMA, are at least 130 t. However, size composition data from Dusky Sound indicate an accumulation of large individuals with relatively few pre-recruits. Variation in a range of biological parameters occurs over small distances. Such variation should be taken into account when defining boundaries for managing kina stocks.

1. INTRODUCTION

1.1 Overview
This paper refers to commercial catch data and to unpublished results and analyses of biological studies of kina. It updates an earlier assessment which described the fisheries biology of kina (McShane *et al.* 1994).

1.2 Description of the fishery
Kina inhabit shallow waters (generally less than 10 m) off New Zealand. Kina are caught by diving, shorepicking, or bottom trawl or dredging all around New Zealand, including the Chatham Islands. Most are caught by diving, but there is a substantial dredge fishery in Tory Channel (QMA 7). Kina are harvested for their roe (the gonad of the animal) and are sold mainly on the domestic market. An experimental fishery in Dusky Sound (QMA 5) was established in an attempt to develop export markets, to estimate representative sustainable yields, and to assess the effects of kina fishing on the plants and animals which co-occur with kina. Poor product quality frustrated the development of export markets and the fishery harvested only 130 t of the permitted 1000 t per annum. Dusky Sound and surrounding coastal waters (Chalky and Preservation Inlets, Breaksea Sound) remain closed to kina fishing.

Kina roe varies considerably in quality. Export markets demand a small, fine-textured, yellow or orange roe. Such roes are usually found in small to medium sized individuals (70–100 mm diameter), but roe quality varies seasonally, from place to place, and is generally poor after spawning.

The existing commercial fishery is divided into eight QMAs, some of which are managed under a competitive quota system. The Chatham Islands (QMA 4) and QMAs 1 and 9 have no annual catch limit. Permit holders do not have individual catch entitlements, but collectively can catch no more than the annual competitive quota.

Kina are accessible to divers or shore pickers and current estimates of the size of the recreational fishery are small. Kina have been used historically by Maori for food. Current fishing levels by Maori have not been quantified.

1.3 Literature review

Surveys of kina on Ariel Reef, an offshore reef near Gisborne (QMA 2) which had received high fishing effort, were reported by McShane (1993). The survey showed that kina were present, but not in large numbers. No large patches were observed and the general habitat was dominated by *Ecklonia radiata*, an observation consistent with a low abundance of kina (Andrew 1988).

Results from research surveys of kina in Arapawa Island, D'Urville Island, and Dusky Sound were presented by McShane *et al.* (1994). In Dusky Sound, where most of the research was done, no significant variation in the density of kina or seaweed was due to fishing. McShane *et al.* (1994) described the failure of the Dusky Sound experimental fishery and noted the occurrence of a bitter taste in the roe of harvested individuals. The general biology of kina was summarised by McShane *et al.* (1994c).

McShane & Bradbury (1995) described the management of the Washington State sea urchin fishery (U.S.A.) and compared it with management options for the New Zealand kina fishery. McShane *et al.* (1996) described the reproductive biology of kina. They showed that the volume of roe varied with size (diameter), and that this relationship varied among locations. The relative roe yield decreased for large individuals (over 120 mm), but there was no significant variation in the viability of gametes among kina of different sizes.

2. REVIEW OF THE FISHERY

2.1 Catch and landings data

Recent reported landings and competitive quotas are shown in Table 1.

Table 1: Reported landings (t) of kina by Fishstock from 1983–84 to 1994–95 and actual competitive quotas (t) from 1986–87 to 1994–95. – no data or no quota

Fishstock	SUR 1		SUR 2		SUR 3		SUR 4		SUR 5	
	Landings	Quota	Landings	Quota	Landings	Quota	Landings	Quota	Landings	Quota
1983–84*	81.42	–	180.27	–	12.64	–	3.98	–	2.60	–
1984–85*	64.46	–	83.81	–	2.42	–	7.44	–	6.17	–
1985–86*	71.95	–	139.11	–	6.24	–	52.73	–	0.22	–
1986–87*	52.05	–	142.64	–	0.60	–	28.35	–	6.09	–
1987–88*	22.08	–	154.10	–	0.00	–	76.50	–	4.01	–
1988–89*	13.36	–	49.72	200.00	0.25	100.00	124.89	–	0.00	200.00
1989–90†	10.17	–	309.16	200.00	5.19	100.00	195.30	–	13.37	200.00
1990–91†	69.16	–	88.75	200.00	21.31	100.00	35.92	–	121.47	200.00
1991–92†	78.72	–	36.65	200.00	15.62	100.00	192.59	–	227.88	200.00
1992–93†	89.59	–	170.36	200.00	9.92	100.00	21.84	–	377.03	200.00
1993–94†	150.71	–	182.92	200.00	8.12	100.00	55.31	–	200‡	200.00
1994–95†	151.93	–	157.70	200.00	6.68	100.00	99.24	–	200‡	200.00

*FSU data

† LFRR data excludes experimental harvest Dusky Sound (133 t in 1992–93)

‡ estimates only as notification of closure was given when processors reported a total of 190 tonnes. It is likely that catches exceeded 200 tonnes in these years.

Table 1 (cont):

Fishstock	SUR 7		SUR 8		SUR 9	
	Landings	Quota	Landings	Quota	Landings	Quota
1983–84*	55.07	–	0.00	–	0.25	–
1984–85*	99.63	–	0.00	–	0.94	–
1985–86*	85.59	–	0.00	–	2.02	–
1986–87*	52.63	–	0.00	–	0.00	–
1987–88*	174.85	–	0.01	–	0.05	–
1988–89*	5.30	150.00	0.00	50.00	0.00	–
1989–90†	48.18	150.00	0.00	50.00	0.00	–
1990–91†	58.66	150.00	0.01	50.00	0.00	–
1991–92†	113.56	150.00	0.21	50.00	0.00	–
1992–93†	209.48	150.00	0.00	50.00	0.00	–
1993–94†	93.03	150.00	2.37	50.00	0.85	–
1994–95†	155.28	150.00	88.97	50.00	0.00	–

Catches have generally been less than the competitive quota for each QMA except QMA 5. In QMA 5 in recent years (since 1992) the competitive quota has been reached early in the fishing year (about December).

3. RESEARCH

3.1 Resource surveys

3.1.1 Dusky Sound

About 3500 t of kina were estimated to be within free dive range in Dusky Sound (McShane *et al.* 1993). A harvest of 130 t caused no measurable change in the density of kina in Dusky Sound.

3.1.2 Other areas of QMA 5 and QMA 7

Surveys of Chalky Inlet provided a biomass estimate of 130 t. Other than the crude estimates above, there are no reliable estimates of biomass for kina elsewhere in QMA 5. Semi-quantitative surveys of Stewart Island indicate less abundant stocks than those in Dusky Sound and Chalky Inlet. Observations suggest dense stocks off the Fiordland coast, but few kina off the south coast of the South Island.

Transect surveys of kina were conducted in 1993 off D'Urville and Rangitoto Islands and Arapawa Island (QMA 7). Kina were abundant in all areas surveyed. The mean densities of kina were similar (about 1 m^{-2}) but the mean size differed greatly between the two areas surveyed (76 mm for D'Urville and Rangitoto; 49 mm for Arapawa). Kina from Arapawa were, on average, one-third the weight of those from D'Urville and Rangitoto.

Estimates of available biomass were 2500 t for D'Urville/Rangitoto and 500 t for Arapawa.

3.2 Biology

The biological information relevant to an assessment of kina stocks is summarised below.

3.2.1 Distribution

Kina are sea urchins and are common on subtidal reefs of New Zealand, including the Chatham Islands. To the north, kina are found at the Three Kings Islands but not the Kermadec Islands. To the south, kina occur at the Snares Islands, but are absent from the Auckland Islands and Campbell Island. Kina can form very dense aggregations (up to 50 m^{-2}) but vary in abundance from place to place. They are mostly found in shallow water (less than 10 m) but some can be found as deep as 25 m.

In Southland (QMA 5), where there is keen interest in expanding the existing fishery, kina are abundant off the Fiordland coast, particularly, the embayments of Preservation and Chalky Inlets and Dusky Sound. Kina are scarce in the fiords, probably because of a poor tolerance to the fresh water prevalent in that habitat. Dense beds of kina can be found off Stewart Island, particularly the east coast. However, compared with Fiordland, stocks are not abundant. Kina are generally not abundant off the Otago coast.

3.2.2 Feeding

Kina feed on drift seaweed which they trap with their spines. Alternatively, they can graze on intact plants and, by their feeding activities, prevent the colonisation of juvenile plants on subtidal reefs. Such heavy grazing can result in the characteristic "barren" grounds associated with dense beds of kina. Off Fiordland, possibly because of the productivity of the seaweed, kina do not appear to form extensive barren areas (McShane *et al.* 1993). Kina prefer kelps (particularly *Ecklonia radiata*) to other seaweeds, but will consume a range of weeds including sea lettuce (*Ulva lactuca*). The diet of kina may influence the colour of the roe which is important when considering its potential market value.

3.2.3 Reproduction

Male and female kina exist in equal numbers. It is not generally possible to identify the sex of mature specimens *in situ*. The size at first maturity varies considerably among areas (between 40 and 90 mm diameter). For mature kina, the weight of the roe increases with diameter to produce a maximum of about 80 million eggs in females. Large kina (over120 mm in diameter) usually produce proportionally less roe. In spawning, eggs and sperm are shed into the water column. Spawning usually occurs annually. Although the timing of spawning can vary over small distances, it usually occurs in the summer or early autumn.

After fertilisation, a planktonic larva exists for about 10 weeks, during which time it may settle and change to a reef-dwelling existence.

3.2.4 Early life/recruitment

Soon after settlement, the tiny kina will hide in cracks and crevices in the reef surface. Divers can find individuals as small as 3 mm in diameter, but they are generally too hard to see until they reach about 15 mm diameter (about 9 months of age). Small kina can be eaten by crabs and fish and are not usually seen during the day on open reef habitat, preferring to shelter under boulders or in cracks.

Estimates of settlement and observations of small young of the year kina suggest that recruitment (kina added to the fishable stock each year) is highly variable. In Dusky

Sound fewer than 50% of individuals are below 50 mm diameter. Low rates of recruitment were consistent with nil results from settlement collectors deployed in Dusky Sound. However, recent observations suggested a strong pulse of pre-recruits in neighbouring Chalky and Preservation Inlets. There is likely to be strong interannual variation in recruitment as well as spatial variation among populations.

3.2.5 Growth and survival

Kina, like other sea urchins, grow slowly at first. Growth rates increase after the first year and then growth slows once individuals reach reproductive maturity (in their third or fourth year). Kina continue to grow as long as they live (to a maximum age of about 30 years). Survival of small kina is probably low in relation to large individuals. For unfished populations, about 75% of kina larger than 50 mm diameter survive each year. The main predators of large kina are starfish, particularly the seven armed *Astrostole scabra*. Other predators include octopus and rock lobster.

4. STOCK ASSESSMENT

The Maximum Constant Yield (MCY) for kina in Dusky Sound was estimated to be 255 t (Annala 1995). It is likely, given the immeasurable impact of a 130 t harvest of kina in Dusky Sound in relation to the large area of available kina habitat in QMA 5, that sustainable harvests are greater than the present 200 t competitive quota. Similarly, the biomass estimates from only two areas of QMA 7 would suggest sustainable harvests greater than the present 150 t competitive quota. However, other than the result for Dusky Sound, there is no other information with which to reliably evaluate potential sustainable harvests.

5. IMPLICATIONS FOR MANAGEMENT

5.1 Other sea urchin fisheries

There is concern over the long-term viability of all of the world's major sea urchin fisheries because most have few catch restrictions and little information is available to assess potential sustainable harvests. More often than not, management has been ad hoc with regulations being introduced as emergency measures to avoid collapse of the stock rather than being part of a strategic plan aimed at conservation. There is little that New Zealand can glean from the management of other sea urchin fisheries, other than avoiding the same mistakes.

California has the world's largest single sea urchin fishery currently producing about 20 000 t (green weight) p.a. This fishery can be characterised by rapid development (from 1971) and little regulation. The main management tools have been size limits and limited entry (introduced in 1987). There is evidence of declining CPUE (40% since 1989) and serial depletion, prompting concern that present harvest rates are too high. A detailed analysis of the existing information, including information on growth and survival, suggested that rotational harvests of populations be considered as a viable management option (Botsford *et al.* 1993).

Like all North American sea urchin fisheries, the Oregon fishery is comparatively recent (1986), with catches peaking at 4000 t in 1990. The fishery has since declined despite limited entry, size limits, and a minimum depth of harvest.

Washington State provides the most innovative strategy for managing its sea urchin fishery: rotational closure. Even so, concerns over the long-term viability of the fishery have prompted further measures such as emergency closures, limited entry, size limits, fleet reduction, reduced fishing seasons, and limits on the numbers of divers per boat. Annual surveys are conducted to provide information on the status of individual areas, but lack precision and do not provide sufficient information to set sustainable harvest levels.

The Alaskan and Maine sea urchin fisheries provide contrasts of regulation. Alaska is conservatively managed with catch quotas based indirectly on a surplus production model (MSY occurs at half the estimated virgin biomass level). These, admittedly conservative, measures result in low (3% of the available stock) but probably sustainable catches of about 30 t annually. Alaska plans to derive more robust estimates of productivity in association with the adaptive management of their sea urchin fisheries. Maine has no regulations. There is nothing by way of resource assessment or even of catch/effort information. There are no size limits for the Maine sea urchin fishery.

The Mexican sea urchin fishery has several forms of regulation including size limits, closures, and catch quotas. However, little adherence to these regulations mean that the fishery is considered to be on the verge of collapse.

Management of the sea urchin fishery in Canada is by way of limited entry, size limits, closed seasons, and quotas. There are different management regimes for the northern and southern fisheries (off British Columbia). For the southern fishery, there are 26 management areas managed by quotas based on educated guesses of sustainable harvests.

The main management tool used by the Japanese for their sea urchin fisheries is restocking with cultured juveniles. Despite this enhancement, the Japanese production of sea urchins is in decline.

5.2 QMA 5

The spatial variation in the biology of kina, and their disaggregate stock structure, suggests a finer scale of management than that presently employed. Examples of fine scale spatial management exist for the Washington and Canadian fisheries in which small areas (10's of kilometers) are opened for fishing on a periodic basis. It is difficult to see if such a strategy is effective. Areas considered for spatial management would be necessarily small as kina may vary in recruitment, growth, survival, and roe quality/ quantity over distances as small as several hundred metres.

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