A FISH SURVEY IN A MARLBOROUGH SOUNDS ESTUARY FROM 1971 TO 1978

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SUMMARY: Eight species and 175 individual fish were sampled from a small estuary in Tennyson Inlet, Marlborough Sounds from 1971 to 1978 by a 27.4 m set net of 12.4 cm stretched mesh size. During the sample period there was a consistent significant decline in both total number and total weight of fish per tide. Similar significant declines in both numbers and mean weight per fish occurred from the 1971-74 to 1975-78 periods for all species that had sufficient numbers to be tested for significance (dogfish, mullet, snapper, kahawai and warehou), but inadequate data for mullet and warehou prevented a test of weight decline for the 1975-78 period. Since these species range over a wide area of coastal habitats, it is conjectured that their declines reflect regional as well as local factors.

INTRODUCTION

Fish utilisation of the tidal flats of a small estuary in Marlborough Sounds was sampled by a set net over an eight year period from 1971-78. Fish numbers and weights were recorded per tide and summarised on a yearly and species basis. The study is continuing, but results are published now, because the significant declines in fish numbers and weights which we found may be indicative of a general trend and, as such, deserve immediate attention.

The sample area is the tidal estuary of a small river mouth which enters Duncans Bay, an arm of Te Mako Bay, Tennyson Inlet, Marlborough Sounds (41° 8'S, 173° 46'E). The estuary is 7 hectares in size and roughly rectangular in shape. The catchment is pasture and holiday-home subdivision on the lower slopes, and native beech-podocarp forests on the upper slopes. The forests are grazed and browsed by possum *(Trichosurus vulpecula),* goats *(Capra hircus),* deer *(Cervus elephas)* and pigs *(Sus scrota).* There is sheet and sometimes gully erosion during heavy rainstorms. Except for the farm and subdivision, the entire catchment is part of Marlborough Sounds Maritime Park and is in the centre of the least disturbed part of the Park.

The substrate of the estuary is a matrix of alluvial gravel and small stones with a covering, in places, of silt or, rarely, sand. The substrate below the net is firm with small stones and a silt covering for the eastern half of the net length and soft silt in a tidal stream bed for the remainder. Eel grass *(Zostera)* is common in places, though some substrates are uncolonised by plants. The common shellfish are the cockle "tuangi" *(Chione stutchbery!)* and the pipi *(Pap hies (Amphidesma) australe);* the angled wedge shell *(Tellina (Angulus) gaimard!)* is less common. The mud flat crab *(Helice crassa)* is common.

METHODS

The net is monofilament, 27.4 m long with a stretched mesh size of 12.4 cm. It was placed two-thirds of the distance from high tide to low tide, across a secondary channel of the river and secured with permanent low pegs. The net position was selected in 1971 in order to catch fish for eating on a regular basis. Other nets placed by us or other residents closer to low tide or in a deeper river channel were catching too many fish for our needs. The net was set and cleared in daytime only and, in winter especially, clearing was often done after two tidal cycles. Nearly half the first net-clearings (43 %) were done after the first tide, the remainder were done on the second tide. The net was first set and records taken in May 1971, and the present study includes all records until June 1978. All seasons were sampled.

After clearing, the fish were weighed. The spring scale was accurate to 150 grams, so smaller fish, such as mullet *(Aldrichetta torster!)* and immature fish were averaged by group measurements. For the first three years of the study, some of the weights were not taken, but a general size was noted so that later these sizes were converted to approximate weights based on subsequent size and weight records.

RESULTS

A total of 175 fish of eight different species were caught during the eight years of the present study. The numbers and weights per tide are listed in Table 1. Scientific names for the fish are as follows: dogfish *(Squalus acanthias),* yellow-eyed mullet *(Aldrichetta torsteri),* snapper *(Chrysophrys auratus),*

TABLE 1. *Number and weight of fish per tide for first net-clearings and for all net-clearings for years 1971 to 1978.*

			First net-clearings		All net-clearings	
Year	No. of tides	No. of fish caught	No. of fish / tide	Wt (kg) fish/tide	No. of fish / tide	Wt (kg) fish / tide
1971	37	73	3.3	6.0	1.9	3.4
1972	16	34	3.5	11.3	2.1	6.4
1973	10	12	1.2	2.3	1.2	2.0
1974	26	11	1.0	2.1	0.4	0.7
1975	53	16	0.5	0.5	0.3	0.3
1976	41	11	0.7	0.8	0.3	0.3
1977	47	13	0.3	0.3	0.3	0.3
1978	44	5	0.3	0.5	0.1	0.2

kahawai *(Arripis trutta),* warehou *(Seriolella brama),* barracouta *(Thyrsites atun),* spotty *(Pseudolabrus celidolus),* flounder *(Rhombosolea* sp.).

The data in Table 1 show that the number of fish caught per tide decreased over the years. In the last four years (1975-78), the net was set more often (35 times in 1971-74, 54 times in 1975-78) and left out longer (89 tides in 197-74, 185 tides in 1975-78). In the early 1970s the net was rarely left for many tides because sufficient fish for eating were caught in just a few tides. In recent years the net was left out for as long as a week with very little success. Because the number of tides sampled was different each year, it was necessary to calculate catch on a per tide basis in order to make the data comparable. Data from first net~clearings were treated separately in case there was any bias resulting from leaving the net out for subsequent tides. Using data from first net-clearings only, the number of fish caught per first tide showed a Spearman's Rank Correlation of 0.96 ($p < .01$) with the year of catch, indicating a statistically highly significant decline in fish numbers caught from 1971-78. Number of fish caught per first tide in the first four years (1971-74) compared with the last four years (1975-78) showed a X2 of 5.0 ($p < .025$) with the Median Test for Two Samples (Walker and Lev, 1953) indicating a significant decrease in numbers of fish per first tide between the two periods. Weight of fish per first tide had a Spearman's Rank Correlation of 0.93 ($p < .01$) with the year of catch and a X^2 of 5.0 ($p < 0.25$) for the Median Test, again showing a highly significant decline in catch weight with time. Data for all net-clearings in Table 1 show a greater decline in fish numbers and weight per tide than for first net-clearings only and the declines are also statistically significant.

The fish catch by species is listed and analysed in Table 2. The data are divided into two periods: A (1971-74) and B (1975-78). The Chi-square test was used to determine whether the difference in fish numbers between Periods A and B was sinificant. The non-parametric Runs Test (Walker and Lev, 1953) was used on the weight data to remove the possible bias of very large individuals and to allow inclusion of species with small samples. The results of these tests, marked by asterisks (*) in Table 2, showed that dogfish, mullet, kahawai and warehou had statistically significant declines in both fish numbers and weights between Period A and Period B both for first net-clearings and all net-clearings. Snapper showed a declining catch for first net-clearings and this decline was statistically significant for all net-clearings.

The pattern of statistically significant decreasing fish catches, both for the year to year comparisons for all species and for the 1971-74 and 1975-78 comparison for each species, is supported by three other general observations: (1) there were many fewer fish seen in the water surrounding the net when it was cleared in the last four years compared with the first four years; (2) there were no shags caught in the past six years compared with three pied shags caught in the first two years and an immature black-backed gull caught in 1973, an indirect index of the greater number of small fish available at that time; (3) there have been only a few cockle pits dug by snapper in the estuary in the past four years compared with fresh pits dug almost every sample period in the first four years and especially the first two years.

DISCUSSION

The major species of this study range over a wide area of coastal and ocean habitats (Sorensen, 1970) and are not solely resident in a single inlet like Te Mako Bay. Kahawai and barracouta usually

TABLE 2. *Fish species, numbers. numbers per tide for first net-clearings and all net-clearings for Period A* (1971-74) *and Period B* (1975-78) *and mean weights of fish for Period A and Period B.*

Fish	Total No. fish caught	Number of fish caught per tide				Mean weight (kg)	
		First net-clearing		All net-clearings			
		Period A 1971-74	Period B 1975-78	Period A 1971-74	Period B 1975-78	Period A 1971-74	Period B 1975-78
Dogfish *Squalis*	45	1.11	0 ***	0.47	0.016***	3.84	2.16***
Yellow-eyed mullet *Aldrichetta*	36	0.57	0.06 ***	0.28	0.059***		†
Snapper *Chrysophrys*	32	0.26	0.18	0.19	0.08 *	1.91	1.11*
Kahawai *Arripis*	29	0.28	0.11 *	0.20	0.06 ***	2.11	1.32**
Warehou *Seriolella*	21	0.40	0 ***	0.16	0 ***	0.863	X
Barracouta *Thyrsites*	8	0.09	0.04 X	0.045	0.022X	3.28	2.94X
Spotty *Pseudolabrus*	3	0.03	0 X	0.03	0 X		
Flounder *Rhombosolea*	1						

* $p < 0.05$ statistical difference between Periods A and B; ** $p < 0.01$; *** $p < 0.001$.
† sample weight not sufficiently accurate to test significance.
X sample size too small to test significance.

feed on the surface waters of the open ocean, snapper and warehou feed down to 300 feet (91.4 m) and dogfish to 600 feet (182.8 m) (Sorensen, 1970). It is, therefore, reasonable to assume that the declines in fish numbers and weights at Te Mako may reflect not only local factors, but also conditions over a wider coastal and ocean area. If this assumption is correct, then the significant decline in snapper numbers and weights shown in Table 2 may be the result of factors similar to those which influenced the snapper decline noted by Sullivan and Gilbert (1978) off the west coast of the North Island. These west coast snapper showed a 17 % a year summer catch/effort decline between 1974 and 1978. An examination of the age structure involved in this decline led Sullivan and Gilbert to conclude that if present fishing effort were not increased then the snapper population would continue to decline for a few years and then stabilise. If fishing effort increased then the snapper population would continue to decline and "a point might be reached where the fish population was so depleted that fishing was no longer economically viable" (Sullivan and Gilbert, 1978). The mean weight of Te Mako snapper declined 42% from 1.91 kg in 1971-74 to 1.11 kg in 1975-78. This rate is similar to that of 40% for the west coast snapper which declined from a mean weight of 1.46 kg in 1974 to 0.89 kg in 1978.

Commercial fishing by trawling and set lines has occurred frequently in Tennyson Inlet in the 1970s and has been especially common off Maud Island at the head of the Inlet (our observations and E. Twose, *pers. comm.,* 1978). In the past decade the New Zealand commercial catch rose from 36000 tonnes in 1967 to 44000 tonnes in 1971 to 53000 tonnes in 1977 (Marine Department, 1967, 1971; Campbell, 1979) an increase of 20% between 1971 and 1977. Known foreign catches were 3000 tonnes in 1967, 54000 tonnes in 1971 and 422600 tonnes reported for 1977 (Eggleston, 1978; E. J. Wright, *pers. comm.,* 29 June 1978; Anon, 1978; Campbell, 1979), an increase of 680% between 1971 and 1977. Total commercial catch has, thus, increased fourfold between 1971 and 1977.

Local environmental factors are probably not significant in the fish decline at Te Mako since the catchment is relatively undisturbed and was stable during the study period; there was no appreciable change in the courses of the streams entering and crossing the estuary or in the relative proportion of recent to former fresh sediments. The size of the *Zostera* area has remained fairly constant and shellfish numbers appear to have increased, perhaps due to declining predation by fish. Local.recreational

fishing has increased with an approximate doubling of the number of people and boats using the area from 1971 to 1978 as judged by an increase in the number of baches from 15 to 30 and by a near doubling of the number of cars parked near the launching ramp. Of the major species in our sample, only snapper are regularly caught by recreational fishermen, with an occasional kahawai taken for bait, which suggests that local fishing pressure on the spedes in our sample area has less than doubled. In the past few years some people have complained about poor catches and have decreased their fishing effort. From 1971 to 1974, three other residents occasionally set nets in the estuary. but since 1975 no other nets have been set, one resident stating that it was no longer worth the effort.

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