

THE IMPACT OF SURF-ZONE FISH COMMUNITIES ON FAUNAL ASSEMBLAGES ASSOCIATED WITH SANDY BEACHES

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INTRODUCTION

Studies on fish assemblages associated with surf-exposed beaches are scarce. The most notable (Pearse et al 1942; Gunter 1945, 1948; Carlisle et al 1960; McFarland 1963; and Schaefer 1967) in common with other studies on nearshore fish assemblages, have concentrated on "community structure". Cailliet, et al (1978) pointed out that few attempts have been made to stress the functional relationships between fish assemblages and their food sources. Based on the estimation of assimilation and importation of organic carbon to a surf beach at Mustang Island, Texas, McFarland (1963) related productivity of plankton to fish biomass.

The present paper synthesizes data from studies of "community structure" of the surf-fish assemblage at King's Beach, Algoa Bay with information on the feeding habits of the assemblage (Lasiak 1982). The impact of the surf-fish assemblage on other biotic components of the beach/surf ecosystem is discussed in terms of energy flow and transformation, as a result of predation.

METHODS

The surf-zone fish assemblage at King's Beach was sampled monthly between September 1978 and October 1980, by means of seine netting. Details of the procedure are given in Lasiak (1982). Based on the monthly catch statistics, biomass and energy equivalents the standing crop of each species was estimated in terms of

$\text{kJ m}^{-3} \text{ y}^{-1}$. The feeding habits of each species were studied by means of wet and dry gravimetric analyses of stomach contents. The frequency of occurrence of prey items was also noted.

Attempts were made to obtain laboratory estimates of food consumption rates. However, the dynamic nature of the fish assemblage meant that considerable resources were required to obtain sufficient animals for experimentation at regular intervals. Experimental studies therefore had to be abandoned. This "dynamicism" also affected the success of 24h studies in providing data on the quantity of food consumed by each species on a daily basis. To overcome this problem the minimum estimates of daily food intake rates are based on the maximum feeding intensities (stomach contents are expressed as a percentage of the total body mass on both a dry and wet mass basis) observed during the course of the study. The annual food intake is given by:

$$\text{Total intake} = 365 \times M \times F \left(\frac{P_1 + P_2 + P_3 + \dots + P_n}{100} \right)$$

where: M is the mean biomass of each trophic group.

F is the maximum feeding intensity

($P_1 \dots P_n$) is the average percentage contribution of each prey item to the overall diet of that trophic group.

Using calorific values from Joubert and Hanekom (1980) the contribution of each was expressed in $\text{kJ m}^{-3} \text{ y}^{-1}$.

RESULTS AND DISCUSSION

Infaunal beach organisms made only a small contribution (12% dry mass) to the food base utilized by the fish. Motile organisms, in the form of mysids, prawns and other fish, constituted the primary food source (58,6% dry mass) (Fig. 1). An additional food source was the epi- fauna and flora associated with the nearby harbour wall and scattered offshore reefs. This accounted for 15,5% of the food consumed.

The 59 species of fish recorded were divided into six trophic groups based on their feeding habits. The majority of species consumed a wide variety of prey items. Opportunism was prevalent which suggests that many species are capable of utilizing "superabundant" prey items when they are available. The King's Beach ichthyofauna was dominated either by planktivores or benthic feeders. McFarland (1963) found that the most abundant species at Mustang Island were planktivorous.

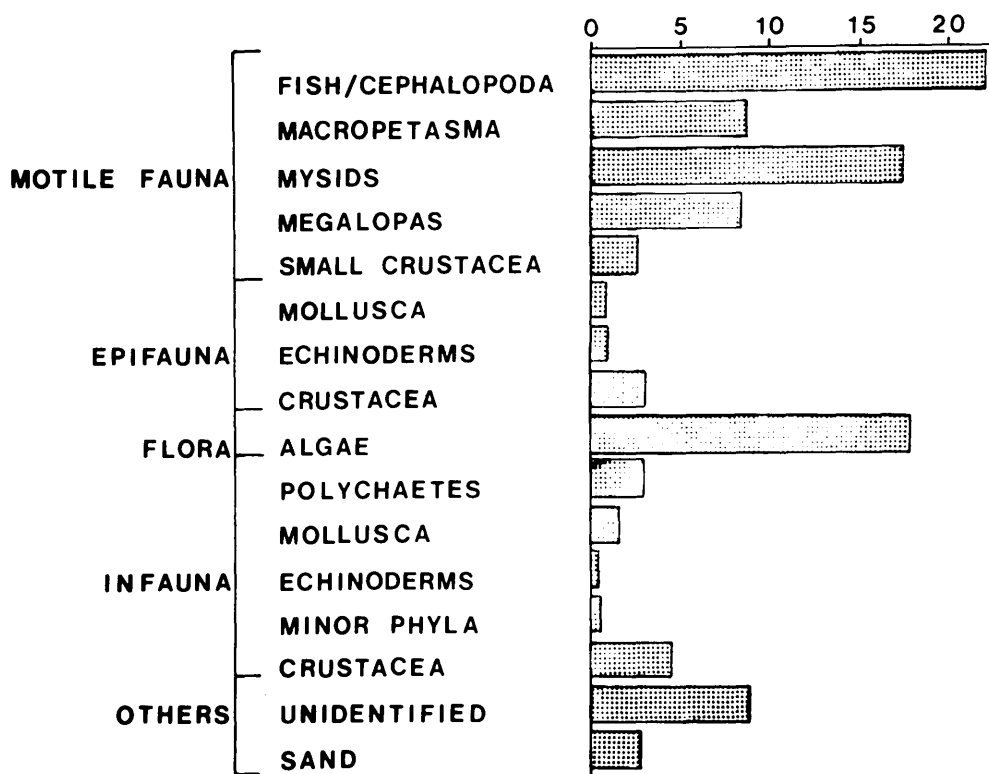


FIGURE 1 Total trophic spectra for King's Beach. Values are the total percent by mass (wet) of each prey category for all fish species.

Food consumption estimates.

The major representatives of each trophic group plus details of their observed feeding intensities are given in Table 1. The maximum feeding intensities observed amongst benthic feeders, detritivores, herbivores, omnivores, piscivores and planktivores were 3,06%; 4,65%; 5,32%; 7,17%; 8,45%; and 10,86% respectively. Use of these values as an indication of the minimum daily intake rate is subject to criticism. However, Pandian (1967) obtained a maximum daily consumption rate equivalent to 5% of total body mass in Megalops cyprinoides under experimental conditions. Being of a similar order of magnitude the use of maximum feeding intensities as an estimate of minimum daily intake may be justified.

Comparison of standing crop and food intake estimates.

Figure 2, based on Odum's (1975) energy circuit language, represents the estimated energy flow from the major prey items to each trophic group. Only food items contributing to more than 1% of the food base are indicated.

Beach macrofaunal production has been estimated at $106,58 \text{ kJ m}^{-2} \text{ y}^{-1}$ at King's Beach (McLachlan 1977). Preliminary estimate of sublittoral macrofaunal production for King's Beach is approximately $61,25 \text{ kJ m}^{-2} \text{ y}^{-1}$ (A. Cockroft, personal communication). Feeding habit studies indicated that benthic feeders consume a minimum of $69,78 \text{ kJ m}^{-2} \text{ y}^{-1}$. Thus the loss of macrofaunal production by fish predation amounts to 83,2% of the total production.

It has been estimated that the P/B ratio for the mysid, Mesopodopsis slabberi, is unlikely to exceed eight, based on this ratio and the standing crop estimate (T. Wooldridge, personal communication) predation by surf-zone fish removes at least 3,32 times the M. slabberi production annually. Similarly the P/B ratio for the swimming prawn Macropetasma africana is

unlikely to exceed four (A. Cockroft, personal communication). On this basis it would appear that the surf-fish assemblage consumes 96,2% of the available production.

McFarland (1963) concluded that the recruitment of plankton from net productivity and from importation was at least several orders of magnitude in excess of the food requirements of the surf-fish at Mustang Island, Texas. He also pointed out that beach fauna would make only a small contribution to the food base, since they probably represented less than 5 - 10% of fish biomass.

Differences in the efficiency of sampling methods used to estimate both fish and plankton stocks may account for the anomalies between estimates of consumption and annual production of prey items at King's Beach. However, the patchy occurrence and immigration of motile organisms are likely to be the major factors involved. Estimates of both food consumption rates and standing crop will be influenced by the patchy distribution of both predators and prey. Considerable fluctuations were noted in the contribution of five major prey items to the total food base utilized by surf-fish throughout the year (Table 2).

The large variation (0 - 96%) in the contribution made by the mysid M. slabberi may be attributed to the presence or absence of large shoals in the sampling area. On occasion the biomass of M. slabberi just outside the surf reached $1,9 \text{ g.m}^{-3}$ whereas the mean value used in estimating annual production was only $0,135 \text{ m}^{-3}$ (T. Wooldridge, personal communication). Differences in the proportional representation of the trophic groups also affects the contribution of various prey items to the food base. This variation reflects the dynamic nature of the surf-fish assemblage. The two prominent trophic

TABLE: 1

Number of stomachs examined, frequency of occurrence of empty stomachs and feeding intensity of the dominant species from each of the trophic groups represented at Kings Beach.

TROPHIC GROUP	SPECIES	N	% empty stomachs	FEEDING INTENSITY		
				min.	max.	mean
BENTHIC FEEDERS	<i>Lithognathus lithognathus</i>	88	31,8	0,005	3,06	0,40
	<i>Lithognathus mormyrus</i>	118	32,2	0,003	2,37	0,38
	<i>Umbrina capensis</i>	99	23,2	0,003	2,47	0,34
DETRITIVORES	<i>Liza richardsoni</i> > 20 g	273	63,4	0,004	7,01	1,09
HERBIVORES	<i>Sarpa salpa</i> > 5 g	361	8,9	0,004	4,65	1,45
OMNIVORES	<i>Diplodus sargus</i> > 10 g	358	15,6	0,003	7,17	0,83
	<i>Rhabdosargus holubi</i>	65	38,5	0,01	2,61	0,43
PISCIVORES	<i>Argyrosomus hololepidotus</i>	147	27,9	0,01	5,39	0,67
	<i>Pomatomus saltatrix</i>	89	36,0	0,02	8,45	0,87
PLANKTIVORES	<i>Diplodus sargus</i> < 10 g	184	9,8			
	<i>Liza richardsoni</i> < 20 g	89	33,7			
	<i>Lithognathus mormyrus</i> < 10 g	217	7,8			
	<i>Monodactylus falciformis</i>	299	28,4	0,005	5,21	0,31
	<i>Pomadasys olivaceum</i>	729	24,0	0,01	10,86	1,66
	<i>Rhabdosargus globiceps</i> < 10 g	150	29,3			
	<i>Sarpa salpa</i> < 5 g	113	6,2			
	<i>Trachurus capensis</i> < 10 g	119	41,2			

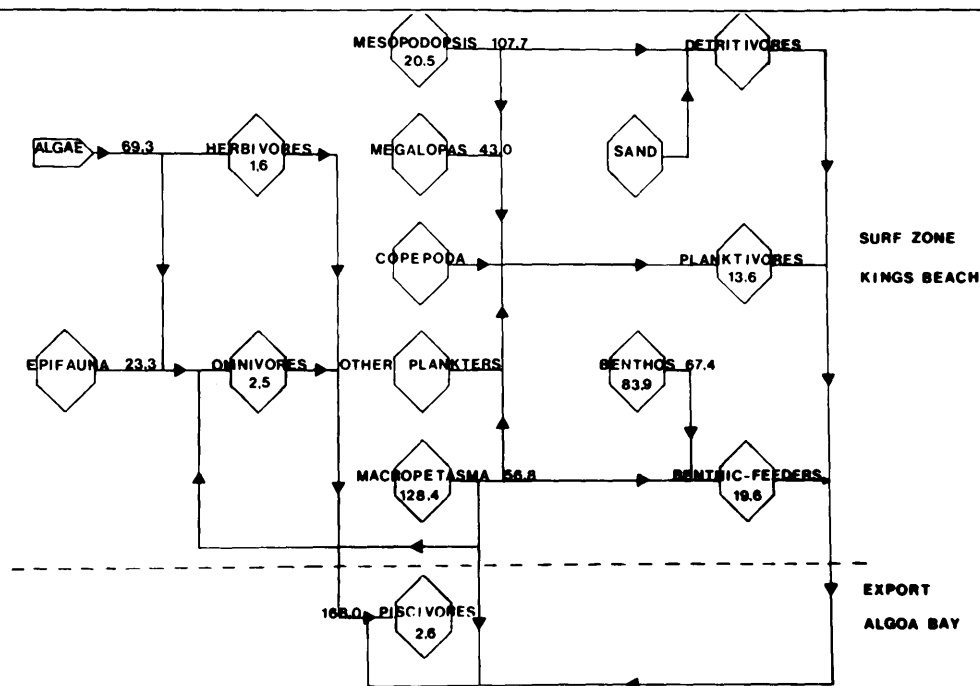


FIGURE 2 Energy circuit diagram illustrating fish predation on major food categories. Values in kJ/m³/yr.

TABLE 2

Variability in the percentage contribution of five major prey items to the diet of the fish assemblage.

Prey Item	\bar{x}	% Contribution		
		s.d.	min.	max.
<u>Mesopodopsis slabberi</u>	9,6	21,8	0,0	96,1
<u>Macropetasma africana</u>	12,5	18,4	0,0	59,0
Algae	21,9	42,7	0,0	92,7
Beach macrofauna	3,4	5,4	0,0	24,2
Fish	21,8	20,2	0,0	65,7

groups, benthic feeders and planktivores, showed the greatest variability (Table 3).

TABLE 3

Variability in the proportional representation of the five major trophic groups within the fish assemblage.

Trophic Group	\bar{x}	s.d.	Biomass
			Coeff. of Var.
	(g)	(g)	(g)
Piscivores	2811,7	2507,7	522,9
Benthic feeders	18640,0	28812,1	5650,5
Planktivores	7551,1	7881,5	1545,7
Omnivores	1752,7	2177,5	427,1
Herbivores	2601,8	6516,9	1278,1

The impact of surf-zone fish on other biota. The fate of energy and matter gained from prey items ingested needs to be examined in order to assess the impact of predators. Depending on the residence time, diel activity patterns and digestion rates of the predator, material lost in faeces and excreted as nitrogenous wastes may be lost or retained in the sandy beach/surf zone system. McLachlan et al (1981) suggest that as a result of turbulence and the absence of sedimentation of organic matter, all macrofauna faeces and pseudofaeces are immediately returned to the detritus pool in the surf zone. This will also apply to fish remaining in the environment for a sufficient period of time for digestion and evacuation of wastes to take place.

A species such as the herbivore Sarpa salpa, which moves into the surf zone at night for shelter (Lasiak, 1982), may contribute directly to the detritus pool by bringing in material from outside the system (ie. reefs where they feed).

Winberg (1956) considers the energy content of waste products to have an average value equivalent to 20% of that of the food consumed. Consequently the fish assemblage may have a significant effect on the recycling of energy and material within the beach/surf ecosystem. Energy going into reproduction and growth may eventually be lost. This is a result of high larval mortality, the stochastic processes

determining the distribution of surviving off-spring and migration patterns. Energy put into activity, digestion and metabolism will be lost to the system as heat.

The relationship of the surf-zone fish assemblage to other biotic components within the beach/surf ecosystem clearly revolves around their role as energy transformers. The instability of the surf-fish "community structure" suggests that a great deal of energy and material gained by predation within the surf-zone will be ultimately exported. The residence time of individual fish has a significant effect on macrofaunal and planktonic production.

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