Assessment of fish populations in the Avon-Heathcote Estuary: 2006

Seining amongst the kite-surfers during the fish survey.

NIWA Client Report: CHC2007-015
March 2007

NIWA Project: CCC07502

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Prepared for

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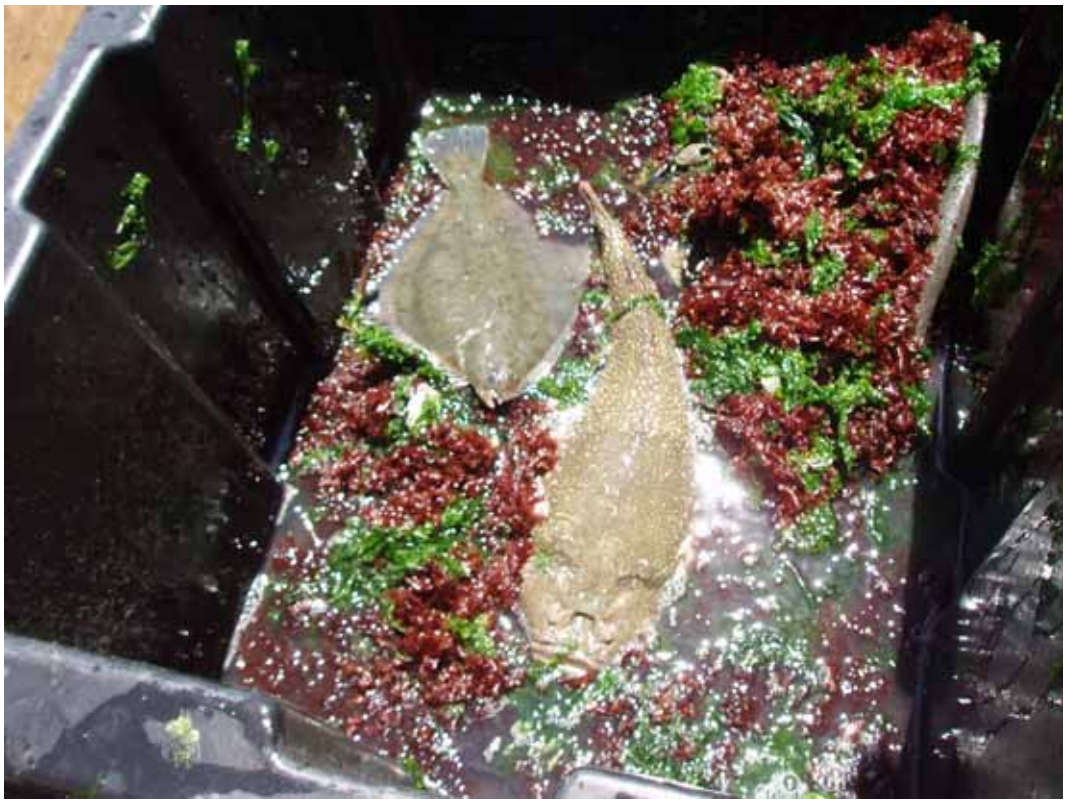
Towing the trawl net in the main channel at low tide during the fish survey



A large spotted stargazer and sand flounder amongst the seaweed in one trawl catch

Contents

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Executive Summary

This is the second of six planned annual surveys of the Avon-Heathcote estuary commissioned by the Christchurch City Council to monitor changes in fish species diversity and abundance following the removal of wastewater discharges. Three surveys are being undertaken before removal, and three will be undertaken following completion of the scheme.

Results from this survey, undertaken in November 2006, suggest that fish species diversity is presently somewhat less than during the 1960s. However, the species apparently now absent were only present occasionally in the estuary in the 1960s, and many have since been the target of commercial fishers with consequent declines in abundance.

Abundance of most fish species in the 2006 survey was similar to that in 2005, which suggests that sampling intensity is sufficient to reliably assess changes over time. The only notable exception was that juvenile yellowbelly flounders were much less common in 2006 than 2005, but marked inter-annual variation in short-lived species like flatfish is not unusual, and is the reason three pre- and three post-wastewater removal surveys were planned and agreed. This survey has also confirmed the indication in 2005 that relative abundance of the two important flatfish species in the estuary appears to have changed since the 1960s. Sand flounder, especially adults, are noticeably fewer, whereas adult yellowbelly flounder are now both larger and more abundant than in 1965. Moderate numbers of juvenile sand flounder were once again present, particularly along the western muddy shore. As suggested last year, these changes in abundance may be related to increased commercial fishing pressure on sand flounders in Pegasus Bay, and/or increasing sea temperatures which could favour yellowbelly flounder, in addition to possible effects of wastewater discharges.

The sampling protocols developed for these surveys – one for adult fish (using trawling in the main channels at low tide) and the other for juvenile and small fish species (using beach seining around the margins at high tide) need to be repeated as closely as possible in future surveys. These will provide separate indices of fish abundance for juveniles (and smaller species) and adults, with possibly different trends for adults and juveniles of each species (as occurred for yellowbelly flounder in 2006). Changes in juvenile fish numbers could reflect recent events mostly within the estuary and may explain why numbers of larger fish have changed, whereas trawl surveys of larger fish will likely integrate data over more than one year, and will better describe what recreational fishers in the estuary are experiencing.

Future surveys should continue to be repeated in November as only small quantities of net-clogging sea lettuce were once again present (as anticipated) at this time of the year.

1. Background

NIWA was commissioned by the Christchurch City Council to undertake a series of six annual surveys in the Avon-Heathcote Estuary beginning November 2005, to assess changes in fish populations following the removal of wastewater discharges from the Estuary. This survey is the second of these surveys. Plans are to undertake three annual surveys prior to the removal of the discharges, followed by three once the scheme is completed, although the latter may not begin immediately or may be undertaken biannually if this seems appropriate for scientific reasons. This work was partly in response to claims that wastewater discharges from the Bromley ponds are relatively high in free ammonia, and that relatively few fish remain in the estuary. These surveys will indicate current population levels, and are expected to show improvements in fish abundance following removal of the wastewater from the Estuary.

The Avon-Heathcote Estuary is unique in the Canterbury area with its relatively large size (about 800 ha), historical use by a wide range of fish species, and its role as important habitat for many species of fish. It acts as a nursery area for many species, particularly the commercially important flounders, and provide an essential migration route for species such as freshwater eels, lamprey, common smelt, and brown trout, which spend different phases of their lifecycles in fresh water and the ocean.

In pre-European times, the Avon-Heathcote Estuary was among the most important and highly valued food-gathering sites for South Island Maori on the east coast. The estuary was rich with tuna (eels), karakara (lamprey), inanga (whitebait), and patiki (flounder) (Cromarty & Scott 1995).

Recreational fishers still catch some sand and yellowbelly flounders in the Estuary using drag nets, and whitebaiting is practised in the lower reaches of the Avon and Heathcote Rivers, mostly above the extent of saltwater influence. While no reliable data are available on numbers of fishers or size of catch for any of these fisheries, anecdotal evidence suggests catches are much smaller than previously.

2. Historical information on changes in fish populations in the Estuary

The largest and most systematic survey of fish populations in the estuary was undertaken 40 years ago in 1965-66 (Webb 1967, Webb 1972, Webb 1973a, Webb 1973b, Webb 1973c, Webb 1973d). Webb recorded 28 fish species compared with the 37 species recorded from all surveys (Table 1), and presented extensive biological

Table 1 : Species and relative abundance of fish recorded during surveys of the Avon-Heathcote Estuary. Relative abundance between species is indicated by one of three categories: +++ = common, ++ = frequent, + = rare. For the recent surveys, ♦ = juveniles only. (N.B. relative abundance cannot be compared between reports as sampling effort in different habitats may be unequal).

Species	Webb 1972, Webb 1973d	Knox and Kilner 1973	Eldon and Kelly 1992	Nairn 1998	James 2006, James 2007
Barracouta (*Thyrsites atun*)	+	+			
Bully – Common (*Gobiomorphus cotidianus*)	+++	+	++	+++	+
Bully – Giant (*Gobiomorphus gobiodes*)	+	+	+		+
Bully – Redfin (*Gobiomorphus huttoni*)	+	++			
Brown trout (*Salmo trutta*)	++	+	+	+	
Chinook salmon (*Oncorhynchus tshawytscha*)				+	+ ♦
Clingfish (*Trachelochismus pinnulatus*)	+	+			+
Eel – Shortfin (*Anguilla australis*)	++	+	++		+
Eel – Longfin (*Anguilla dieffenbachi*)	+	+	+		
Elephant fish (*Callorhinchus milii*)		+			
Flounder – Black (*Rhombosolea retiaria*)		+	+		
Flounder – Sand (*Rhombosolea plebeia*)	+++	+++	+	+++	++
Flounder – Yellowbelly (*Rhombosolea leporina*)	+++	+++	++	+++	++
Globefish (*Contusus richei*)	+++	++			+ ♦
Inanga or whitebait (*Galaxias maculatus*)	+++	+	+	+	
Kahawai (*Arripis trutta*)	+++	++			+ ♦
Moki (*Latridopsis ciliaris*)	+	+			
Pipefish (*Leptonotus* sp.?)		+			
Piper or garfish (*Hyporhamphus ihi*)	+	+			
Red cod (*Pseudophycis bachus*)	++	++			
Red gurnard (*Chelidonichthys kumu*)	+	+			
Rig (*Mustelus lenticulatus*)	+	+			
Rockfish (*Acanthoclinus fuscus*?)	+	+			
Seahorse (*Hippocampus abdominalis*)	+	+			+
Smelt – Common (*Retropinna retropinna*)			+		+++
Smelt – Stokell's (*Stokellia anisodon*)	+	+			
Sole – Common (*Peltorhamphus novaezeelandiae*)	+++	+		+	+
Sole – Speckled (*Peltorhamphus latus*)					+
Sprat – Slender (*Sprattus antipodum*)					+
Sprat – Stout (*Sprattus muelleri*)					+
Stargazer – Estuary (*Leptoscopus macropygus*)				+	+
Stargazer – Slender (*Crapatulus angusticeps*)	+	+			+
Stargazer – Spotted (*Genyagnus monopterygius*)	+	+			+
Spotty (*Pseudolabrus celidotus*)	+++	++		+	+
Thornfish (*Bovichtus variegatus*)	+	+			
Triplefins (Family Tripterygiidae)	++	+++	+	++	+
Yelloweye mullet (*Aldrichetta forsteri*)	+++	+++	++	++	+++

information on the main species present. Webb used two methods to sample the fish resources: a small otter trawl and a beach seine (see Table 2 for specifications). We attempted to replicate this gear as much as was practicable for this series of surveys so that major changes in fish abundance over the last 40 years could be better interpreted.

The major difference between the surveys was the much smaller mesh of the beach seine used in the current surveys in order to sample small fish.

(Nairn 1998) attempted to repeat this survey in 1996-97 using a beam trawl, but was unable to do so because of the large amount of sea-lettuce present at the time. Beach seining in the channels and dip-netting around the margins were substituted, but only qualitative comparisons could be made with Webb's earlier survey. In spite of recording only 11 fish species (39% of the total recorded in 1965-66), (Nairn 1998) concluded fish species diversity had not declined because sampling was more restricted.

3. Sampling methods and data analysis

3.1. Sampling gear and methodologies

Identical trawl and beach seine sampling gear was employed in November 2006 to that used in the first annual survey in November 2005, so that changes in fish abundance between these and future surveys can be determined. As noted above, sampling gear used was also as similar as possible to that used in the 1965 survey.

3.1.1. Trawling

The specifications of the small research otter trawl (Model: Florida Flyer) used are in Table 2. A backup net was purchased this year with both nets owned by the Christchurch City Council and stored at NIWA Christchurch. Operation of the trawl net was as described in the 2005 survey (James 2006).

A total of 18 trawls were completed (3 more than in 2005), of which 5 were in the Avon channel, 5 in the Heathcote channel, and 8 in the main channel (Fig 1). Based on the results of experiments undertaken in 2005 to determine the optimum time for trawling in relation to tide state (see James 2006), we trawled over a maximum period of about 2.5 hours around low tide in order to maximise catches. One improvement over the 2006 survey was that the harbourmaster had issued us with a permit to exceed

5 knots if necessary, and we sometimes did so when moving between sites to maximise the limited fishing time available around low tide.

Table 2: Specifications of the fishing gear used in the present surveys compared with the 1965 survey (Webb 1972). *Assumed effective width for 20 m long seine net.

	Trawling		Seining	
	1965 survey	Present surveys	1965 survey	Present surveys
Headrope length (m)	7.31	7.3	-	-
Net length (m)	-	-	20.1	11
Codend length (m)	1.21	5.5	0	4
Net depth (m)	1.21	0.8	1.5	2.3
Effective fishing width (m)	4.2	6.0	15*	9
Mesh (stretched) (mm)	50.8	50	63.5	9
Otter board area (m^2)	0.76	0.56	-	-
Towing ropes (m)	26	20 & 30	55	20
Distance covered per tow/haul (m)		137-541	55	80-100
Area covered per haul ($m^{2)}$		822-3246	~ 825	720-900
Boat length (m)	3.65	5	-	-
Outboard motor horsepower	3.5	90	-	-

3.1.2. Beach seining

The beach seine used was a new one recently constructed for the Christchurch City Council and identical to that used in 2005 (Table 2).

As in 2005, a total of 12 beach seine hauls were made at similar locations to last year (Fig. 2). Beach seining was undertaken over a period of about 2.5 hours either side of high tide when the shallow mud flats were mostly inundated and access from the shore was relatively easy. Sampling procedures were similar to those employed in November 2005.

3.2. Fish processing

As previously catches were processed as soon as possible after each tow/haul to ensure fish could be returned alive to the water where possible. Fish were quickly transferred to a large plastic bin containing seawater and thereafter identified, measured, and returned to the water. Small numbers of fish which were difficult to identify in the field were retained and examined later in the laboratory. In addition this year, a limited number of individuals of the most common species – yelloweyed mullet, yellowbelly flounder, and sand flounder were kept and stomach removed for

later diet analysis. It is hoped this will be funded by and incorporated into the proposed NIWA programme to examine restoration of estuaries.

3.3. Data analysis

Data from the 2006 survey have been added to the MS-ACCESS database established for the 2005 survey. The database will be made available to the Christchurch City Council for archiving.

As before, fish abundance (number of each species captured per 1000 m^2) was estimated for both trawling and seining, and these data are beginning to provide the baseline against which to assess any future changes in abundance. Once again, where seine hauls contained very large numbers of smelt and juvenile yelloweye mullet, subsamples were measured. Total numbers and abundance estimates of these species were then calculated by multiplying up subsampled numbers.

4. Results and discussion

4.1. Fish species diversity

Sixteen fish taxa were recorded during the 2006 survey (Table 3) compared with seventeen the previous year, and nineteen for both surveys combined.

This compares with 28 species recorded in the more intensive year-round survey in 1965 (Webb 1972), eleven species in the limited 1988 survey (Nairn 1998), and 37 taxa recorded in total over the last 40 years from all sources. Although the present surveys are single annual snapshots with no seasonal component and thus will miss some species which only occur seasonally, it does appear that fish species diversity has diminished over the last forty years. Species recorded as present in the 1960s but have not during recent surveys are predominantly commercial marine species which are now harvested more heavily, and whose populations have declined as a result (barracouta, elephant fish, kahawai adults, moki, red cod, red gurnard, and rig), and smaller rocky shore or riverine species whose habitats are not being sampled by the current fishing gear (redfin bully, longfin eel, inanga, rockfish, thornfish).

Of interest this year was the capture of over 200 small (2 cm) globefish, and three small Chinook salmon in one beach seine haul at the mouth of the Estuary near Shag Rock. By contrast, no salmon and only one medium sized globefish were captured in the 2005 survey. Also of interest was the capture of twelve small kahawai, indicating spawning further south in the South Island than has previously been recorded.

Table 3: Fish taxa recorded from the Avon-Heathcote estuary during the fish survey of 13-22 November 2006, compared with the November 2005 survey.

Common name	Taxonomic name	MFish code	2005	2006
Chinook salmon	*Oncorhynchus tshawytscha*	SAM		y
Clingfish	*Trachelochismus pinnulatus*	CLI	y	
Common smelt	*Retropinna retropinna*	SME	y	y
Common sole	*Peltorhamphus novaezeelandiae*	ESO	y	y
Estuary stargazer	*Leptoscopus macropygus*	ESZ	y	y
Giant bully	*Gobiomorphus gobioides*	GBU	y	
Globefish	*Contusus richiei*	GLB	y	y
Kahawai	*Arripis trutta*	KAH	y	y
Sand flounder	*Rhombosolea plebeia*	SFL	y	y
Shortfin eel	*Anguilla australis*	SFE	y	y
Slender sprat	*Sprattus antipodum*	SPA	y	
Slender stargazer	*Crapatalus angusticeps*	SLZ	y	y
Speckled sole	*Peltorhamphus latus*	SPS		y
Spotted stargazer	*Genyagnus monopterygius*	SPZ	y	y
Spotty	*Notolabrus celidotus*	STY	y	y
Stout sprat	*Sprattus muelleri*	SPM	y	y
Triplefins	Family *Tripterygiidae*	TRP	y	y
Yellowbelly flounder	*Rhombosolea leporina*	YBF	y	y
Yelloweye mullet	*Aldrichetta forsteri*	YEM	y	y

Once again several “shrimps”, known properly as estuarine prawns *Palaemon affinis*, were recorded in the seine hauls on the eastern side of the Estuary, but numbers appear small compared with anecdotal reports of numbers several decades ago.

4.2. Fish catch, size and abundance

Total numbers of each species caught are presented for the 18 trawl tows and 12 seine hauls completed (Table 4). Although yelloweye mullet and common smelt taken by seine were once again numerically the most abundant (totalling several thousand), these were small individuals averaging about 7 cm in length (Table 4).

Of species likely to be of interest to recreational fishers, limited numbers of large yellowbelly flounder were caught, together with a few large shortfin eels, sand flounder, yelloweye mullet, and common sole. Notable for their absence one again were red cod, adult kahawai and barracouta (see Table 1 for a summary of species caught in earlier surveys).

Table 4: Number and mean length (cm) for all fish species caught in the Avon-Heathcote estuary, 13-22 November 2006, by fishing method. Results for the 2005 survey are shown in parentheses.

	Trawl		Seine	
Species	**N**	**L_{mean}**	**N**	**L_{mean}**
Chinook salmon			3 (0)	7.3 (-)
Clingfish	0 (2)	- (2.5)		
Common smelt			573 (1 611)	6.9 (6.8)
Common sole	6 (1)	27.8 (41.0)		
Estuary stargazer	1 (6)	16.0 (17.5)		
Giant bully	0 (2)	- (12.5)		
Globefish			207 (0)	2.0 (-)
Kahawai			12 (2)	6.1 (6.0)
Sand flounder	16 (23)	11.0 (10.4)	137 (130)	3.9 (4.3)
Shortfin eel	1 (4)	75.0 (75.5)	2 (0)	90.0 (-)
Slender sprat			(2)	(5.0)
Slender stargazer	1 (0)	26.0 (-)	1 (0)	15.0 (-)
Speckled sole			1 (0)	3.0 (-)
Spotted stargazer	9 (7)	19.8 (14.9)	4 (3)	7.8 (9.7)
Spotty	17 (18)	16.0 (13.4)	5 (2)	6.2 (6.0)
Stout sprat			101 (3)	7.1 (5.3)
Triplefins	0 (1)	- (7.0)	27 (28)	5.2 (5.2)
Yellowbelly flounder	34 (41)	34.1 (31.2)	29 (79)	11.8 (8.4)
Yelloweye mullet	37 (13)	19.4 (22.2)	2 307 (4 472)	7.3 (7.2)

As in 2005, the average size of yellowbelly flounder, sand flounder, and yelloweye mullet taken by trawl was much larger than that taken by seine (Table 5). This was to be expected given the much larger mesh size, greater towing speed, and the deeper channels fished by trawl. This shows quite clearly that, as intended, each method is sampling different sections of the population – trawling mostly larger adult fish, and seining mostly juvenile fish. Thus we are confident that the two indices of abundance which have been established will be important for monitoring changes in these two different segments of the populations in the future.

Whereas numbers of juvenile sand flounder captured, especially by seine, were very similar to those caught in 2005, numbers of juvenile yellowbelly flounder were markedly less. This was most apparent in seine catches (only 37% of 2005), but also in trawl catches (44%). Length frequency data (Table 6) indicate that this is because juveniles in the 10-30 cm size range were largely missing in 2006, suggesting poor recruitment of the 2005 year class.

Table 5: Mean lengths (cm) of the three most important species measured (sand flounder, yellowbelly flounder, yelloweye mullet), by fishing method and location.

		Sand flounder		Yellowbelly flounder		Yelloweye mullet	
Sampling method	**Area**	**N**	**L_{mean}**	**N**	**L_{mean}**	**N**	**L_{mean}**
Seine	East shore	8	4.8	6	5.5	743	7.2
	South shore	12	4.4	4	10.5	335	8.1
	West shore	117	3.7	19	14.1	596	7.0
Total, all seine sites		**137**	**3.9**	**29**	**11.8**	**1674**	**7.3**
Trawl	Avon channel	7	9.4	10	34.8	15	17.8
	Heathcote channel	5	14.2	12	35.2	11	20.3
	Main channel	4	9.8	12	32.5	11	20.8
Total, all trawl sites		**16**	**11.0**	**34**	**34.1**	**37**	**19.4**
Total, all sites		**153**	**4.6**	**63**	**23.9**	**1711**	**7.6**

Mean size of all three important species (yellowbelly flounder, sand flounder and yelloweye mullet) varied little by area within the estuary for both sampling methods (Table 5). The only exception was for juvenile yellowbelly flounder which were smallest on the eastern shore, and largest on the southern shore, a similar situation to that found in 2005. Unlike 2005, mean length of adult yellowbelly flounder in 2006 was similar at all three sites trawled. As in 2005, sand flounder captured in the channels by trawl were much smaller than yellowbelly flounder from the same areas (Tables 5, 6).

Numbers and mean size of yelloweye mullet in 2006 by sampling method and area (Table 5) were similar to that found in 2005.

Although numbers of both adult and juvenile yellowbelly flounder were found to be less than in 2005, they still appear to be larger and relatively more abundant than in 1965. Those taken in the channels are relatively larger now (71% > 320 mm - this report), 35% in 2005 (James 2006), 55% in 1996/97 (Nairn 1998), than in 1965 when only 6% were larger than this (Webb 1972). They are also now more common than sand flounder: in this survey only one adult sand flounder (> 20 cm) was caught by trawl (two in 2005), compared with 32 adult yellowbelly flounder (Table 6) (47 in 2005). This is similar to the situation in 1998 when Nairn captured eighty yellowbelly and only one sand flounder, but is in contrast to 1965 when sand flounder were markedly more abundant than yellowbelly flounder (Webb 1972).

Table 6: Length frequency distributions for all fish species caught in the Avon-Heathcote estuary, November 2006. Totals are the number of fish subsampled for length measurements, rather than total catches as in Table 4. Seine and trawl samples are denoted s, t, respectively.

Length (cm)	Chinook salmon	Common smelt	Common sole	Estuary stargazer	Globefish	Kahawai	Sand flounder (s)	Sand flounder (t)	Shortfin eel	Slender sprat	Slender stargazer	Speckled sole	Spotted stargazer	Spotty	Triplefin (s)	Yellowbelly flounder (s)	Yellowbelly flounder (t)	Yelloweye mullet (s)	Yelloweye mullet (t)
1							1												
2					207		42												
3							26					1			1				
4							29			1				2	8	1		8	
5		10				3	18			8					6	3		62	
6	1	166				6	11			20			2	4	9	6		689	
7		112				2	2			37			1	1	2	6		478	
8	2	39				1	2	4		21				1	1	4		118	
9		20	1				2	5		11			1			1		57	
10		7						3		2			1					67	
11		6					3	2		1			1			1		109	
12		3	1				1										1	55	
13																		13	
14		1												2			1	7	
15								1			1		1	1				2	
16				1										3		1		4	7
17													2					2	7
18													2					2	3
19														2		1			4
20														1					
21														4				1	8
22																			5
23														1					1
24																2			
25																			
26											1		1						
27																			
28			1																1
29																	2		1
30																	1		
31																	3		
32								1									2		
33			1														3		
34																	1		
35																1	4		
36																	3		
37																	5		
38																2			
39																	2		
40																	4		
41																			
42			1														1		
43			1														1		
…																			
49													1						
75									1										
85									1										
95									1										
Total	**3**	**364**	**6**	**1**	**207**	**12**	**137**	**16**	**3**	**101**	**2**	**1**	**13**	**22**	**27**	**29**	**34**	**1674**	**37**

Estimates of fish abundance (number of each species captured per 1000 m^2) are in Table 7, with comparable data from the 2005 survey in Table 8.

Table 7: Fish abundance (number per 1000 m2) for species caught in the Avon-Heathcote estuary by method and area during the 2006 survey.

	Seine				Trawl			
Common name	**East shore**	**South shore**	**West shore**	**Total**	**Avon channel**	**Heathcote channel**	**Main channel**	**Total**
Chinook salmon		1.0		0.2				
Common smelt	19.2	7.2	88.3	44.2				
Common sole						0.1	0.3	0.1
Estuary stargazer							0.1	
Globefish		67.6		16.0				
Kahawai	2.6			0.9				
Sand flounder	1.7	3.9	22.4	10.6	0.6	0.4	0.2	0.4
Shortfin eel			0.4	0.2			0.1	0.0
Slender sprat	0.9	29.4	1.3	7.8				
Slender stargazer		0.3		0.1		0.1		
Speckled sole		0.3		0.1				
Spotted stargazer			0.8	0.3	0.4	0.3		0.2
Spotty		1.6		0.4	0.3	0.3	0.5	0.4
Triplefin	1.1	4.6	1.5	2.1				
Yellowbelly flounder	1.3	1.3	3.6	2.2	0.8	0.9	0.6	0.8
Yelloweye mullet	220.3	124.8	171.3	178.0	1.3	0.8	0.6	0.8

4.3. Changes in fish diversity and abundance

A similar number of fish taxa were recorded in each of 2005 and 2006, totalling nineteen for both surveys. However, this is markedly less than the 28 species recorded in the more intensive year-round survey in 1965 (Webb 1972), and the 37 taxa recorded in total over the last 40 years from all sources. Although the present surveys are single annual snapshots with no seasonal component and thus will miss some species which only occur seasonally, it appears that fish species diversity has diminished somewhat over the last forty years. Those species which were recorded as present in the 1960s but have not been captured during recent surveys are predominantly commercial marine species which are now harvested more heavily and whose populations have declined as a result.

Table 8: Fish abundance (number per 1000 m^2) for species caught in the Avon-Heathcote estuary by method and area during the 2005 survey. (These estimates do not include data from the additional experimental trawls on 1 December 2005).

	Seine				Trawl			
Common name	**East shore**	**South shore**	**West shore**	**Total**	**Avon channel**	**Heathcote channel**	**Main channel**	**Total**
Clingfish	0	0	0	0	0	0	0.1	0.1
Common smelt	39.5	7.3	73.6	38.3	0	0	0	0
Common sole	0	0	0	0	0	0	0.1	0
Estuary stargazer	0	0	0	0	0.3	0.2	0.1	0.2
Giant bully	0	0	0	0	0.3	0	0	0.1
Kahawai	0	0.6	0	0.2	0	0	0	0
Sand flounder	8.5	6.1	27.8	13.4	2.1	0.5	0.2	0.7
Shortfin eel	0	0	0	0	0	0	0.3	0.1
Slender sprat	0	0.6	0	0.2	0	0	0	0
Spotted stargazer	0	0	1.0	0.3	0.7	0.2	0	0.2
Spotty	0	0.6	0	0.2	1.1	0.3	0.5	0.6
Sprat	0.9	0	0	0.3	0	0	0	0
Triplefins	1.5	6.7	0	2.9	0.1	0	0	0
Yellowbelly flounder	5.0	2.0	19.1	8.1	1.5	1.4	1.1	1.3
Yelloweye mullet	43.6	214.9	77.8	114.0	0	0.1	0.8	0.4

Fish abundance also changed little between the 2005 and 2006 surveys. Of the common species, sand flounder, yelloweye mullet and common smelt were all similarly abundant in both years; although yellowbelly flounder were less abundant in 2006, apparently because of poor recruitment of the 2005 year class – something that is not uncommon amongst short-lived species like flatfish. Notable amongst the less common species, was the increased abundance of sprat and globefish in 2006.

As has been noted previously, two other factors besides the effects of wastewater discharges could be influencing the abundance of fish species in the estuary. First, fish populations sometimes experience natural climate-induced fluctuations in abundance of different age groups. This results from variable recruitment between years which is often linked to changes in climatic conditions such as the El Nino-Southern Oscillation Index. Second, changes in commercial fishing effort and catch can influence abundance although these are likely to be incremental over longer time periods.

Compared with the 1965 survey, the abundance of the two important flatfish species in the 2005 and 2006 surveys has changed; sand flounder, especially adults, are

noticeably fewer than in 1965, although numbers are predicted to be higher during winter months; whereas yellowbelly flounder are now apparently both larger and more abundant than in 1965. These changes may be related to increased commercial fishing pressure on sand flounders in Pegasus Bay, increasing sea temperatures which could favour yellowbelly flounder, as well as possible effects of wastewater discharges. Commercial fishing has almost certainly contributed to the reduced abundance of valuable species such as red cod and kahawai.

5. Future Surveys

The two sampling methods deployed to sample different elements of the fish communities have proved successful – trawling in the main channels at low tide to sample larger fish, and seining at high tide around the margins to sample juveniles and smaller fish species. Thus two indices of abundance have been established – one for adult and one for juvenile fish. These both need to be continued for future surveys as they may indicate different trends amongst adults and juveniles of different species. Changes in juvenile fish numbers will reflect recent events mostly within the estuary and may explain why numbers of larger fish have changed, whereas data from trawl surveys of larger fish will likely integrate data over more than one year, and will better describe what recreational fishers in the estuary are experiencing.

Once again, only small quantities of sea lettuce were present in November so future surveys need to be repeated at this time. Continuation of sampling protocols used in 2006 should be continued for future surveys.

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7. References

Cromarty, P.; Scott, D.A. (eds). (1995). A directory of wetlands in New Zealand. Department of Conservation, Wellington. 395 p.

Eldon, G.A.; Kelly, G.R. (1992). Fisheries survey of the Avon River 1991-92. *Ministry of Agriculture and Fisheries, Freshwater Fisheries Report 137*. 33 p.

James, G.D. (2006). Assessment of fish populations in the Avon-Heathcote Estuary : 2005. *NIWA Client Report CHC2006-031*. 16 p.

Knox, G.A.; Kilner, A.R. (1973). The ecology of the Avon-Heathcote Estuary. Unpublished report to the Christchurch Drainage Board by the Estuarine Research Unit, Department of Zoology, University of Canterbury. 358 p.

Nairn, H.J. (1998). Fish fauna of the Avon-Heathcote Estuary, Christchurch. Unpublished MSc Thesis. University of Canterbury, 77 p.

Webb, B.F. (1967). A study of the biology of the fish population in the Avon-Heathcote Estuary, Christchurch. Unpublished MSc Thesis. Canterbury University, 304 p.

Webb, B.F. (1972). Fish populations of the Avon-Heathcote Estuary. 1. General ecology, distribution, and length frequency. *New Zealand Journal of Marine and Freshwater Research 6*: 570-601.

Webb, B.F. (1973a). Fish populations of the Avon-Heathcote Estuary. 2. Breeding and gonad maturity. *New Zealand Journal of Marine and Freshwater Research 7*: 44-66.

Webb, B.F. (1973b). Fish populations of the Avon-Heathcote Estuary. 3. Gut contents. *New Zealand Journal of Marine and Freshwater Research 7*: 223-234.

Webb, B.F. (1973c). Fish populations of the Avon-Heathcote Estuary. 4. Parasites. *New Zealand Journal of Marine and Freshwater Research 7*: 301-305.

Webb, B.F. (1973d). Fish populations of the Avon-Heathcote Estuary. 5. Records of less common species. *New Zealand Journal of Marine and Freshwater Research 7*: 307-321.

Figure 1: Trawl stations occupied during the fish survey of the Avon-Heathcote estuary, November 2006.

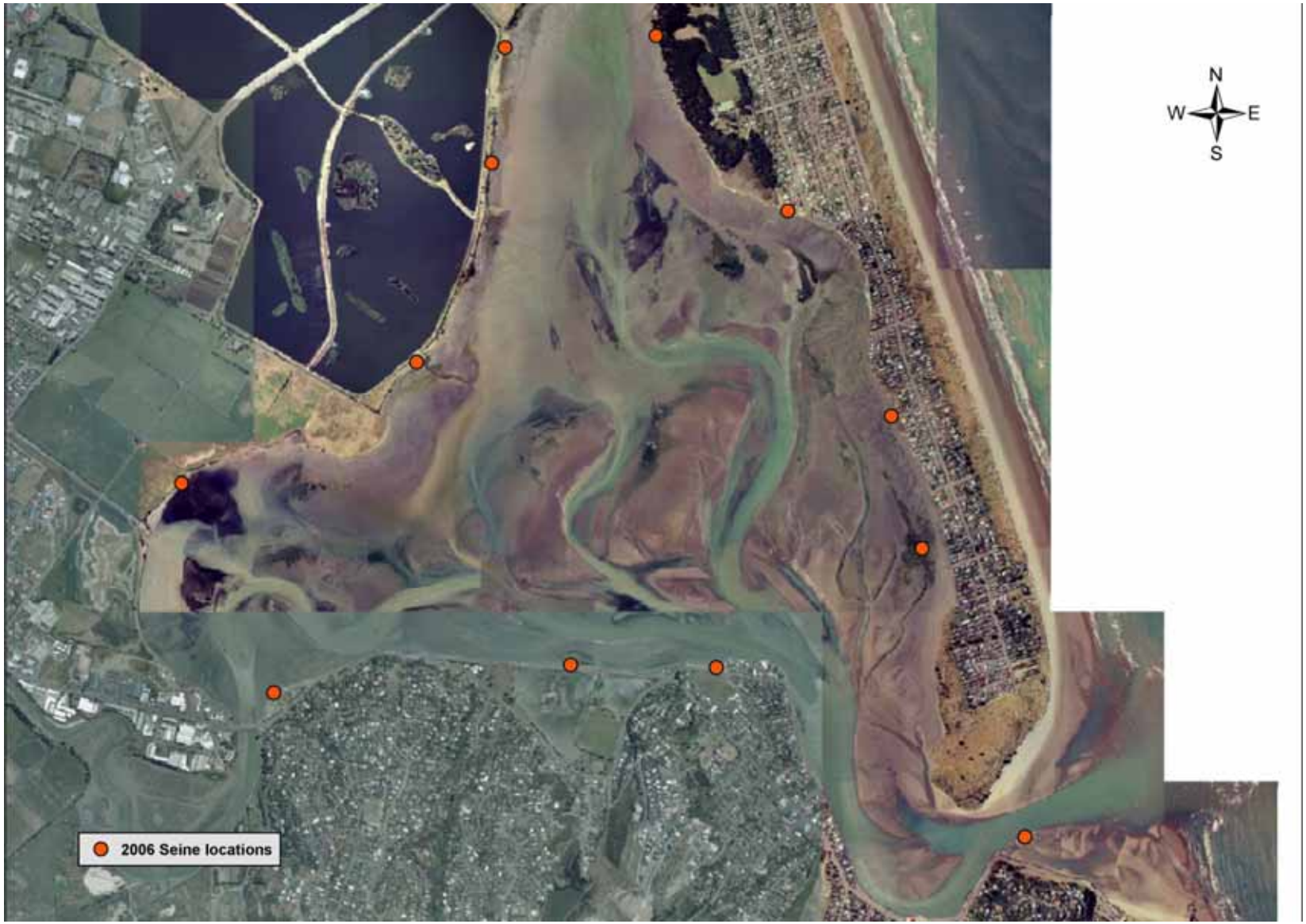

Figure 2: Seine stations occupied during the fish survey of the Avon-Heathcote estuary, November 2006.