ISSN 7110-2001

NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT NO. 62

THE EFFECTS OF THE HUNTLY POWER STATION ON THE DISTRIBUTION OF RESIDENT FISH AND SHRIMPS

by

I.A. Kusabs
J.A.T. Boubee
B.L. Chisnall

Report to: Electricorp Production (Northern Thermal Group)

Confidential to client

Waikato Fisheries Consultants
MAF Fisheries
c/ Box 445
HAMILTON

Servicing freshwater fisheries and aquaculture

March
1990

NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORTS

This report is one of a series initiated in January 1989, and issued by the Freshwater Fisheries Centre, MAF Fisheries. The series was established to ensure that reports prepared for clients, tribunal hearings, internal use, etc., are collected together and available to future users. They are for limited circulation, and some may be confidential.

ISBN 0-477-08400-1

MAF

MAF Fisheries is the fisheries business group of the New Zealand Ministry of Agriculture and Fisheries. The name MAF Fisheries was formalised on 1 November 1989 and replaces MAFFish, which was established on 1 April 1987. It combines the functions of the former Fisheries Research and Fisheries Management Divisions, and the fisheries functions of the former Economics Division of MAF.

Enquiries to: The Librarian
Freshwater Fisheries Centre
PO Box 8324
Riccarton, Christchurch
New Zealand

SUMMARY

The distributions of resident fish and freshwater shrimps in the Waikato River near the Huntly thermal power station was studied by setting fyke nets along the river margins from January 1984 to November 1985. Coarse fish such as catfish, goldfish and mosquitofish were found to be more common in areas affected by the thermal plume discharge than in areas at ambient. Shrimps also appeared to be more numerous in the plume. Catches of eels were strongly influenced by factors such as habitat, water level and possibly lunar phase and it was not possible to separate thermal effects from these dominating factors.

CONTENTS

FIGURES

Page

TABLES

1. INTRODUCTION

The lower Waikato River contains a rich assemblage of fish species, with eel, mullet and whitebait species supporting commercially important fisheries. The effect of thermal discharge on the small migratory species has been described by Stancliff et al. (1988a, 1988b, 1989). Apart from eels (Chisnall 1987), little has been published on other species that live in and around the thermal plume. This report summarises the result of work undertaken from January 1984 to November 1985 to determine the impact of Huntly power station on resident fish and shrimps.

1.1 Study Area

The Waikato River at Huntly is approximately 8m above seas level and 80km from the sea. The Huntly thermal power station is located on the true left bank of the Waikato River below the confluence of the Waahi Stream (Fig. 1).

Over the sampling period (1984-1985), the station was being commissioned and never generated at full capacity. Although the temperature of the cooling water discharge varied with station generation, season and river flow, the resulting thermal plume remained distinct for at least 2km downstream of the station.

2. METHODS

2.1 January 1984 to April 1985 Sampling

2.1.1 Sampling Regime

Monthly sampling trips were made to the Waikato River near the Huntly power station from January 1984 to April 1985. Up to 6 unbaited single wing fyke nets, with the largest hoop 0.6m in diameter and with 25mm stretch mesh were used to sample shortfinned eels (Anguilla australis), longfinned eels (Anguilla dieffenbachii), catfish (Ictalurus nebulosus), and goldfish (Carassius auratus). Other smaller species were also caught in the nets but as the mesh used did not retain them effectively, counts were discarded. The fyke nets were set overnight with the leader toward the shore. Sampling sites were located in river margins and backwaters in both ambient and plume water (Fig. 1).

2.2 December 1984 to November 1985 Sampling

A comprehensive study on the biology of juvenile eels in backwaters of the lower Waikato River from December 1984 to November 1985 was carried out by Chisnall (1987). As a bycatch of this sampling program, a number of other species including; inanga (Galaxias maculatus), mosquitofish (Gambusia affinis), common bully (Gobiomorphus cotidianus), and freshwater shrimp (Paratya curvirostris), were captured. As these species were effectively retained by the fine meshed sampling gear used, the catches are presented here.

2.2.1 Sampling Regime

Sampling followed a fortnightly regime from 11/12/84 to 21/5/85. Monthly sampling was then undertaken until October 1985 when fortnightly sampling resumed. Two unbaited modified commercial fyke nets were set on each sampling occasion at four sites close to the power station (Fig. 2). The modification to the nets included the addition of a third funnel trap, a covering of 1mm mesh netting and a 3 metre extension to the trap leader.

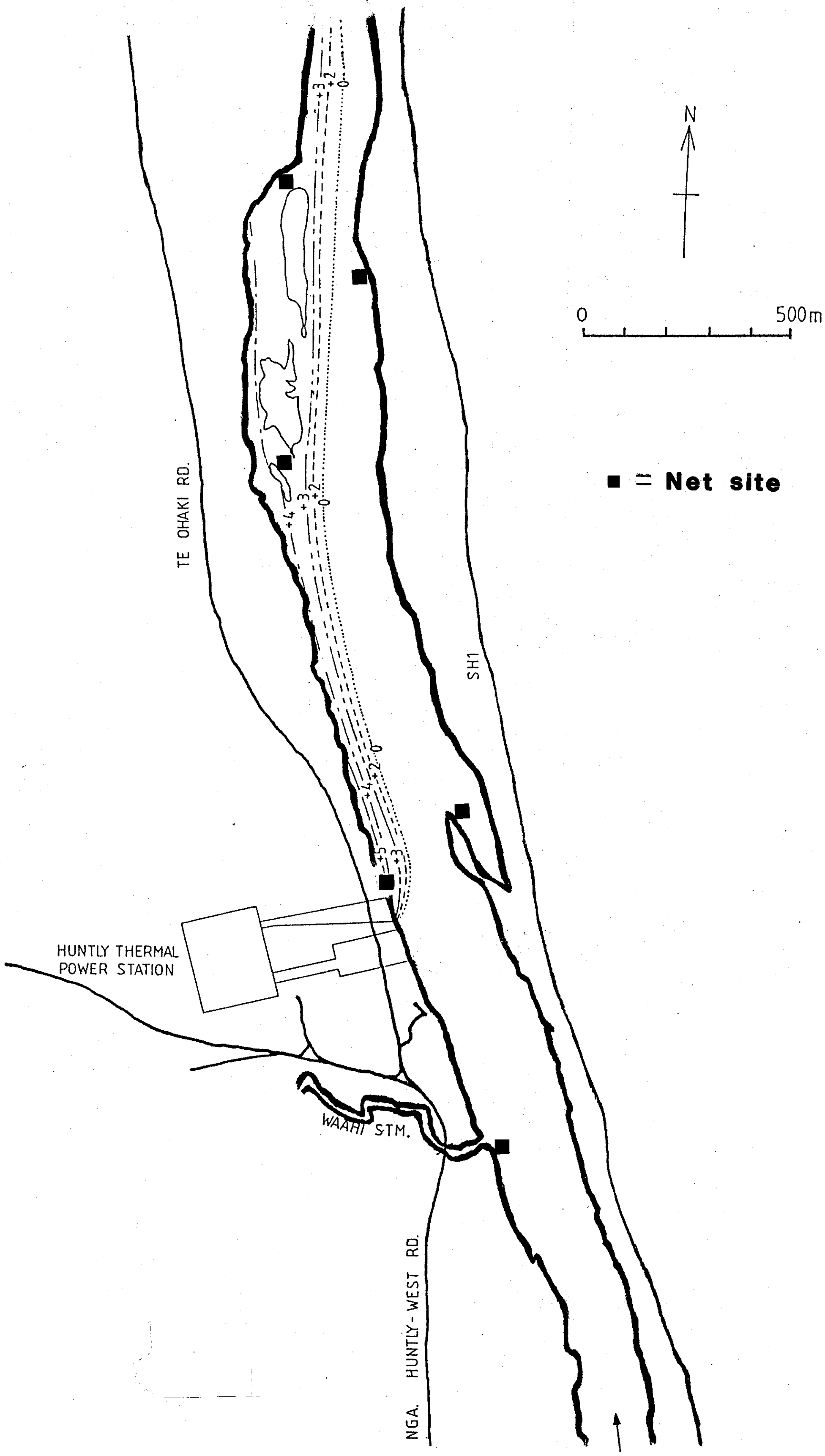

FIGURE 1. Location of sampling sites for the 25mm mesh fyke nets at Huntly. Approximate shape of the thermal plume on 29 April 1985 also shown.

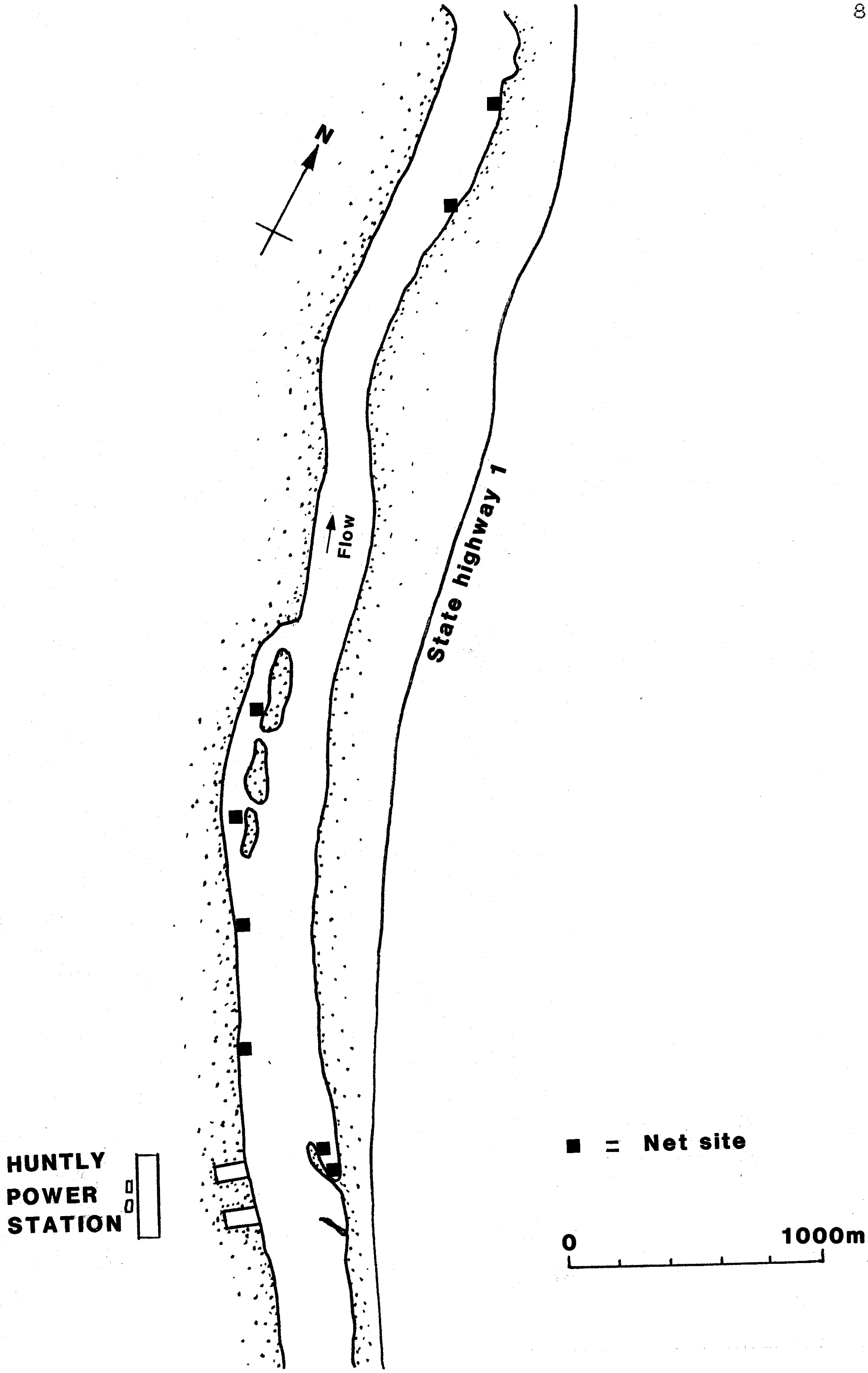

FIGURE 2. Location of sampling sites for 1mm mesh fyke nets at Huntly.

2.3 Analysis of the catch

Catches made from sites where water temperatures were above ambient were classified as 'plume' and separated from ambient catches. Catch per unit of effort (CPUE) was defined as the mean number of fish caught per net (overnight set).

In addition to counts, sub-samples of eels, catfish, and goldfish collected in the 25mm nets (January 84 to April 85) were weighed to the nearest 10g and measured to the nearest 1mm. Condition factors were calculated using:

$$K=\frac{W\times 100}{L^{b}}$$

Where:
K= condition factor
W = weight in grams
L = length in centimetres
b = slope from log length versus log weight regression equations.

2.4 Physical parameters

Water levels were obtained from the Huntly power station daily records (based on Moturiki Datum).

3.0 RESULTS

3.1 Water levels

Water levels during both sampling periods were generally high from June to September and low at other times. Superimposed on these general trends were periods of peak flows (Fig. 3).

3.2 Eels

Shortfinned eels were the most common 'large' fish species taken during both sampling periods (Table 1). Catches of eels were larger in summer than in winter (Figs. 4,5). Largest catches were mostly made when sampling coincided with high river levels but two large catches were made when the river level was unusually low. In some cases large catches coincided with the new moon lunar phase (Figs. 3,4,5).

3.2.1 Longfinned eels

Similar numbers of longfins were taken in the 25mm meshed fyke nets set in ambient and plume sites. However, with the 1mm meshed fyke nets, larger numbers of longfins were captured in the plume (Table 1).

There was no significant difference in the condition of longfins caught in the plume and ambient sites (Table 2, Fig. 6)

3.2.2 Shortfinned eel

CPUE of shortfins in 25mm fyke nets was larger in ambient sites than in sites affected by the thermal plume (Table 1, Fig. 4). This overall difference in catch was not recorded in the 1mm fyke nets.

Shortfins caught in the 25mm nets were significantly larger in the plume than in areas at ambient but their condition was the same in both areas (Table 2). Condition did not change markedly with season (Fig. 6).

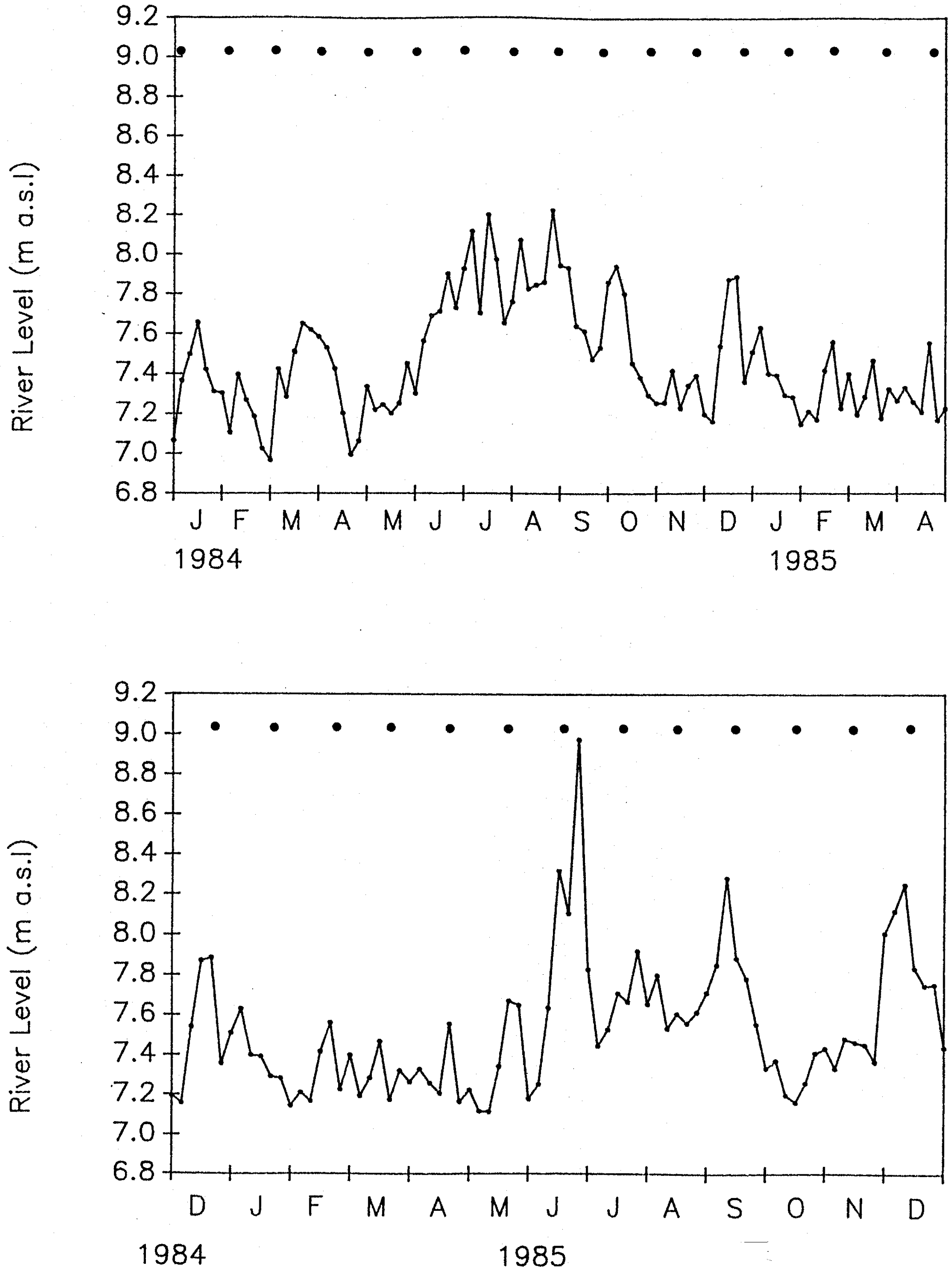

FIGURE 3. Five day mean river level at Huntly and timing of the new moon during the two periods studied.

Table 1. Mean Catch Per Unit Effort (CPUE) of fish and shrimp caught at Huntly in areas affected by the thermal discharge and in areas at ambient. The 25mm mesh fyke nets were set from January 1984 to April 1985 (19 visits). The 1mm mesh fyke nets from December 1984 to November 1985 (21 visits).

	Plume		Ambient	
	CPUE	S.E	CPUE	S.E
<u>25mm meshed fyke nets</u>				
Longfinned eel	5.39	0.87	4.53	1.67
Shortfinned eel	9.99	2.34	19.79	4.80
Catfish	5.87	6.27	1.59	0.40
Goldfish	2.06	0.51	1.01	0.26
<u>1mm meshed fyke nets</u>				
Longfinned eel	6.08	-	2.24	-
Shortfinned eel	34.42	-	33.27	-
Goldfish	0.44	-	0.20	-
Common bully	3.79	-	3.16	-
Shrimp	84.14	-	32.28	-
Mosquitofish	95.33	-	35.17	-
Inanga	1.37	-	3.92	-

\- = not available.
S.E = standard error.

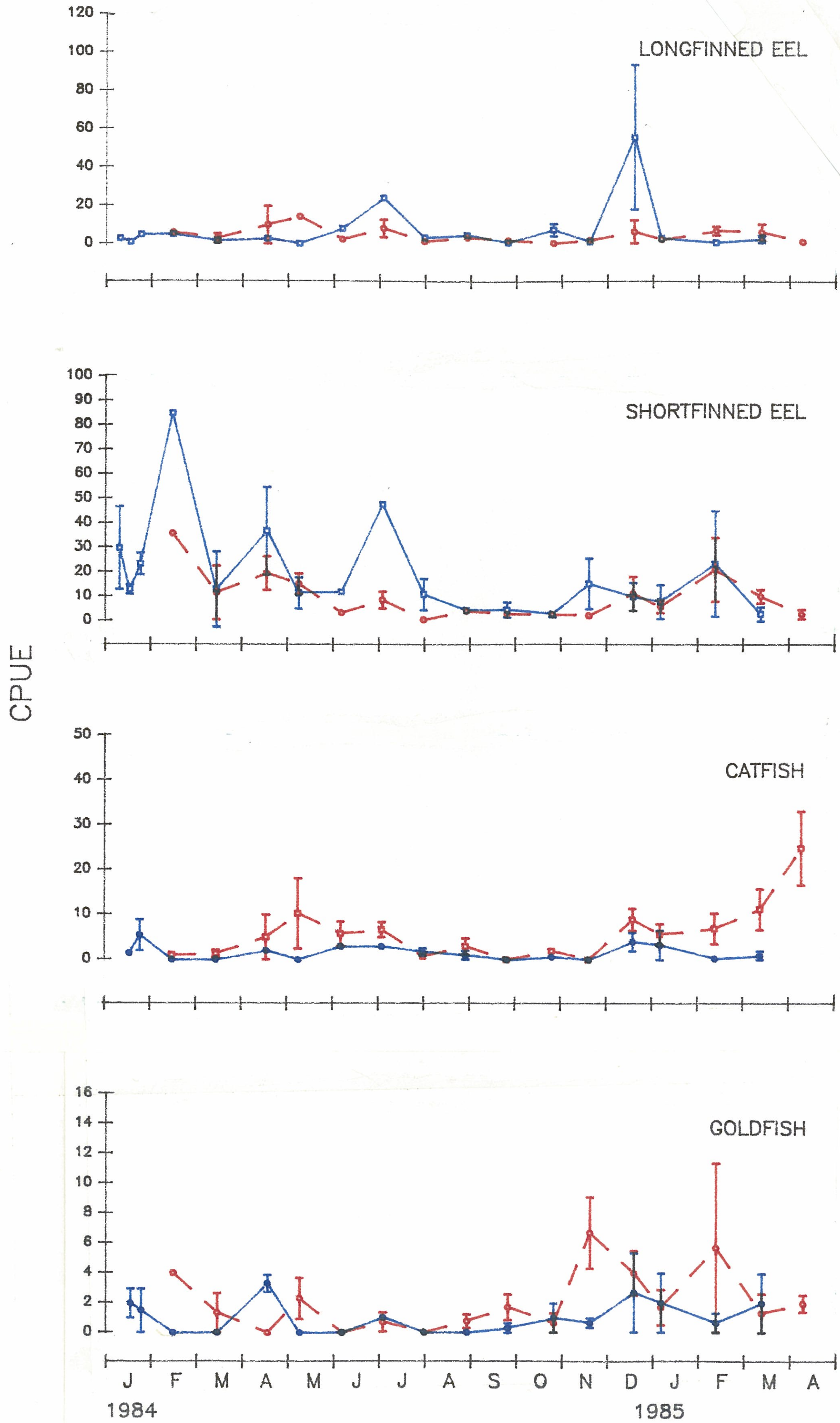

FIGURE 4. Mean catch per unit effort (CPUE) of fish caught in 25mm mesh fyke nets set at Huntly in areas at ambient (solid line) and in those affected by the Huntly power station thermal discharge (dashed line).

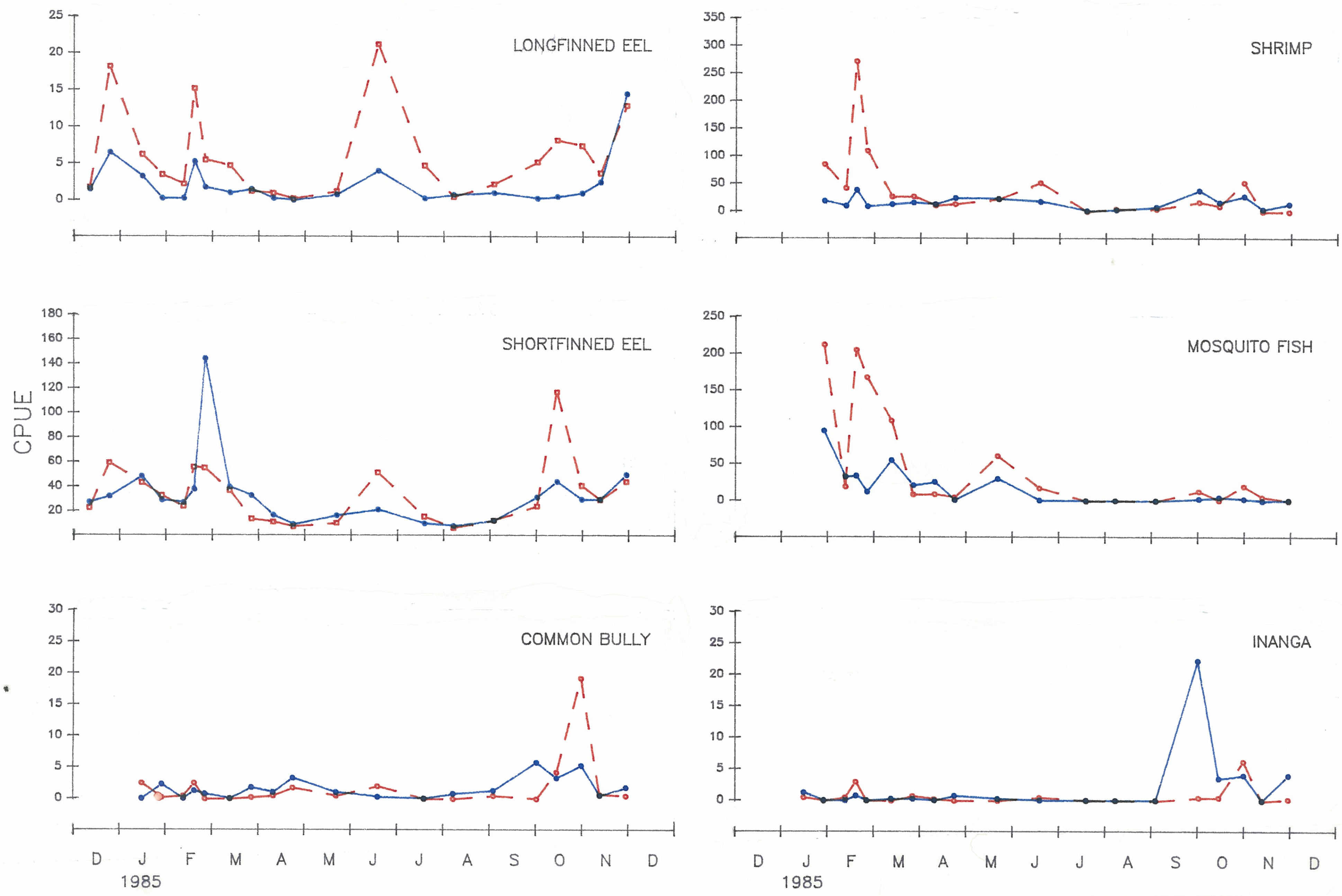

FIGURE 5. Mean catch per unit effort (CPUE) of fish and shrimp species caught in 1mm mesh fyke nets set at Huntly in areas at ambient (solid line) and in those affected by the Huntly power station thermal discharge (dashed line).

Table 2. Comparison of mean length, weight and condition factor for longfinned eel, shortfinned eel and catfish caught in 25mm mesh fyke nets set in areas of the Waikato River affected by the Huntly Thermal power station discharge and in areas at ambient. The slopes of the weight versus length regressions which were used to calculate the condition factors are given in Table 3. Number of fish analysed are given in brackets.

	Plume	Ambient	P (ANOVA)
Longfinned eel			
Condition factor	0.047 (160)	0.049 (292)	0.026
Total length (mm)	39.37 (162)	39.74 (293)	0.634
Weight (g)	150.0 (243)	161.5 (448)	0.187
Shortfinned eel			
Condition factor	0.107 (224)	0.107 (352)	0.997
Total Length (mm)	44.03 (224)	41.13 (352)	0.000
Weight (g)	181.7 (361)	147.3 (548)	0.000
Catfish			
Condition factor	0.677 (234)	0.706 (53)	0.030
Total length (mm)	25.80 (234)	28.74 (54)	0.002
Weight (g)	288.3 (253)	380.4 (53)	0.003

Table 3. Log length versus log weight regression equations for shortfinned eels, longfinned eels and catfish caught at Huntly in 25mm mesh fyke nets. Weights (W) are in grams and lengths (L) in centimetres. Numbers of fish analysed (N) are also given

Species	N	Regression equation	R^2
Longfinned eel	452	W= -3.32 + 3.43L	89.4%
Shortfinned eel	576	W= -2.98 + 3.16L	91.1%
Catfish	287	W= -2.18 + 3.21L	95.9%

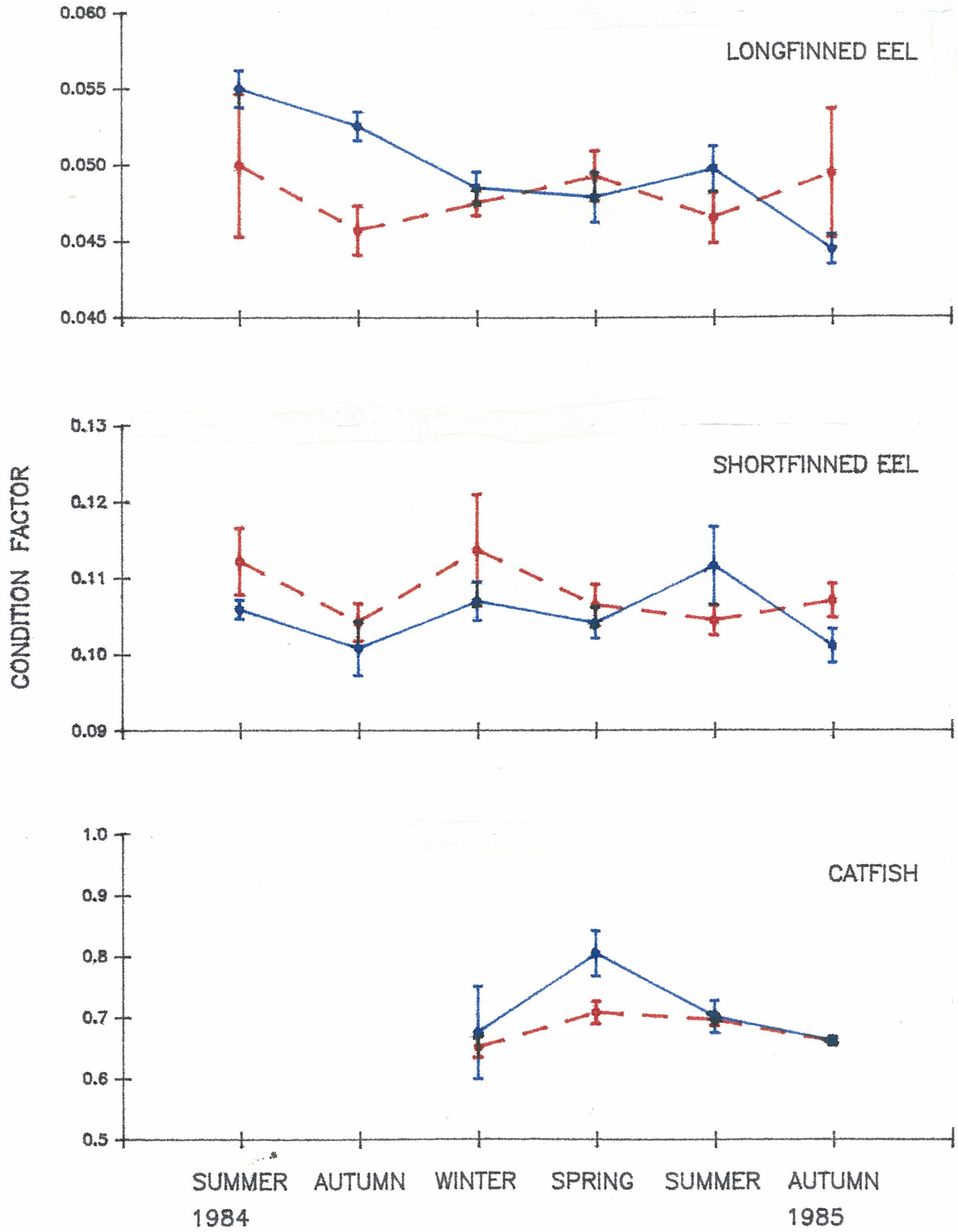

FIGURE 6. Seasonal condition factors for longfinned eel, shortfinned eel and catfish caught in 25mm mesh fyke nets set at Huntly in areas at ambient (solid line) and in those affected by the Huntly power station thermal plume (dashed line).

3.3 Catfish
Catfish numbers in ambient areas were stable throughout the sampling period. In the plume however where catches were slightly larger, numbers increased markedly in autumn especially in 1985 (Fig. 4).

Catfish were in better condition in ambient areas than in those influenced by the thermal plume especially in winter and spring (Table 2, Fig. 3). Catfish were also significantly larger in ambient sites (Table 2).

3.4 Goldfish
Only a small number of goldfish were captured during the sampling period. CPUE was larger in the plume than in areas at ambient (Table 1). Largest catches were made in summer (Fig. 4). Insufficient numbers of goldfish were captured to accurately assess condition factors.

3.5 Common bully
Overall the distribution of the common bully did not appear to be affected by the thermal discharges (Table 1). CPUE remained constant for most of the sampling period but increased markedly from September to November especially in the plume (Fig. 5).

3.6 Shrimp
Catches of shrimp were greater in the plume than in areas at ambient (Table 1). This was mostly due to large catches in the thermal plume in the summer (Fig. 5).

3.7 Mosquitofish
Mosquitofish were most abundant in summer, particularly in the plume (Fig. 5).

3.8 Inanga
The CPUE of inanga was greatest during the spring and summer months (Fig. 5). Larger numbers of inanga were found in ambient sites than in the plume (Table 1) but this was largely due to a large in a single net.

3.9 Other fish species
In addition to the fish species mentioned above, smelt, koura, torrent fish, kokopu, koi carp, brown and rainbow trout were captured. However, the effects of thermal discharge on these species could not be determined due to low capture rates.

4.0 DISCUSSION

4.1 Eels
The predominance of shortfins at Huntly is typical of lowland waterways, with longfins preferring fast flowing waters (Cairns, 1941; Burnet, 1969). Such habitat preference had a marked effect on catches by individual nets. Catches of both species were also markedly affected by flood events at which time eels feed actively on land invertebrates present on the water covered margins (Chisnall 1987). Conversely, during periods of low water levels, large catches were also made, presumably because at these times eels were concentrated into a reduced habitat. There was in addition a possible link between the large catch events and the new moon phase. It is not known if this is a direct lunar effect on eel activity or a link with climatic events or simply coincidence.

By comparing only nets that were set in similar conditions, Chisnall (1987) reported catching greater numbers of eels in the plume when river ambient temperatures were low, but more in areas at ambient in summer. This he attributed to higher mobility of eels and/or greater abundance of prey items in the plume during winter and, to an avoidance of the warmer water at the height of summer.

Many physical and environmental factors affect individual net catches. Furthermore, eels in the Waikato River are heavily exploited, and population density and structure could be influenced by localised commercial and/or recreational fishing. Any conclusions on the effect of thermal discharge on the eel population structure and density must therefore be viewed with caution.

4.2 Catfish

Catfish appear to have been attracted to the plume. This observation is consistent with their reported high temperature preference of 23 to 31°C (Crawshaw 1975 in Coutant 1977, Massengill 1973, Richards and Ibara 1978). Catfish from areas affected by the thermal plume tended to be in poorer condition than in areas at ambient. The reasons for this are unclear but may be due to higher activity in the plume and/or competition for food especially during the winter months.

Catfish have been reported to become piscivorous in thermal discharges (Patchell 1981). In the thermal plume at Huntly, catfish feed heavily on shrimp but fish have never been recorded in their diet (Boubee, unpublished data). This diet is probably a reflection of the greater availability of shrimps in areas affected by the thermal discharge.

4.3 Goldfish

Wild "dull" coloured goldfish were caught throughout the sampling period. Catches were greatest during warm summer months. Since goldfish do not undertake extensive migrations the larger summer catches probably reflect a greater activity at these times.

Goldfish are temperature dependent spawners. In the Waikato River at Huntly, goldfish breed in October when river temperatures reach 16°C (Meredith et al, 1989). In the thermal plume however some spawning took place in September, when ambient river temperature was approximately 14°C but plume temperatures ranged from 16-17°C (Meredith, 1988). The discharge of thermal effluent at Huntly power station therefore extends the breeding season of goldfish and is therefore likely to benefit this species.

4.4 Common bully

Numbers of bullies increased markedly in the plume during October. Seine and trap data (Boubee et al, 1986) also indicate large numbers of common bullies in the plume during the spring. This population increase in the plume may have been in response to elevated temperatures, but might also be attributed to an influx of bullies from Waahi Stream.

4.5 Shrimp

In the Lower Waikato River, shrimp are an important food source for many fish species, especially eels. Shrimp appear to be attracted to the thermal plume, but this conflicts with the findings of Simons (1984) who reported that they have a low thermal tolerance. As few shrimp have been found migrating through the power station outfall (Boubee et al. 1986), it is possible that the higher catch rate in the plume was caused by migrating shrimps being delayed by the station discharge. The greater periphyton growth on which shrimp feed could nevertheless also have attracted them. In both cases higher concentrations of shrimps in the plume could lead to greater predation pressure and further studies on this species are required.

4.6 Mosquito fish

Mosquitofish are a warm water species and were particularly common in the plume. Mosquitofish provide good forage for eels in the lower Waikato. However they compete for food with native species such as elvers, inanga, smelt and bullies (Boubee unpublished data). Mosquitofish also predate larval forms of native fish species (Wakelin 1985). The significance of these interactions is unknown.

4.7 Inanga

Inanga were present in the catch mainly in spring and summer with greatest catches made in ambient sites than in the plume. Inanga are schooling fish and the large catch recorded on the ambient margin is likely to have been due to a chance capture. However, Boubee et al (1986) using traps and seines also recorded greater catches of inanga in areas at ambient.

Laboratory experiments suggest that the preferred temperature of inanga is approximately 20^{0}C with total avoidance around 29^{0}C (Boubee et al 1988). Stancliff et al (1988a) also found that juvenile inanga did not migrate through the Huntly Power Station's thermal plume when discharge exceeded 27^{0}C. It is therefore likely that the distribution of inanga at Huntly is affected by the Huntly power station thermal discharges.

5.0 CONCLUSION

Thermal discharges from the Huntly power station provides ideal conditions for introduced coarse fish such as catfish, goldfish and mosquitofish. Shrimps also were more numerous in the plume but the reasons and significance of this are unclear.

Difficulties were experienced in separating thermal effects on eels from all the other environmental factors that affected the catch. Only strictly controlled laboratory studies could elucidate this problem.

LITERATURE CITED

Boubee, J.A.T., Stancliff, A.G., and Mitchell, C.P. 1986. Fish and fish communities in the lower Waikato River, Part 1: Impacts of thermal power station development on migrant and resident fish. Unpublished report to Electricorp. MAF Fisheries, Hamilton.

Burnet, A.M.R. 1952. Studies on the ecology of the New Zealand Longfinned eel, Anguilla dieffenbachii gray. Australian Journal of Marine and Freshwater Research 3: 33-63.

Cairns, D. 1941. Life history of two species of New Zealand freshwater eel. Part 1. Taxonomy, age and growth, migration and distribution. New Zealand Journal of Science and Technology, Section B 23: 53-72.

Chisnall, B.L. 1987. Juvenile eel biology in the backwaters of the Waikato River. Unpublished MSc. thesis, University of Waikato. 152pp.

Coutant, C.C. 1977. Compilation of temperature preference data. Journal of the Fisheries Research Board, Canada. 34: 739-745.

Massengill, R.R. 1973. Changes in feeding and body condition of brown bullheads overwintering in the heated effluent of a power plant. Chesapeake Science 14: 138-141.

Meredith, A.S. 1988. Waikato Catchment Board File 20/GV/004/2.

Meredith, A.S., Empson, P.W., Boubee, J.A.T., Mitchell, C.P. (1989). Ichthyoplankton studies on the lower Waikato River. Part 2 Larval Distributions at Huntly. New Zealand Freshwater Fisheries report No. 109. 58pp.

Patchell, G. 1981. Catfish in New Zealand. Freshwater Catch, Autumn 1981.

Richards, F.P., Ibara, R.M. 1978. The preferred temperatures of the brown bullhead, Ictalurus nebulosus with reference of it's orientation to the discharge canal of a nuclear power plant. Transactions of the American Fishery Society 107(2): 288-294.

Simons, M.J. 1984. Resistance and acclimation responses of the freshwater shrimp, Paratya curvirostris, to elevated water temperatures. Waikato Valley Authority Internal Report. July 1984.

Stancliff, A.G., Boubee, J.A.T., Palmer,D., and Mitchell, C.P. 1988a. The upstream migration of whitebait species in the Lower Waikato River. New Zealand Freshwater Fisheries Report 96.

Stancliff, A.G., Boubee, J.A.T., Palmer, D., and Mitchell, C.P. 1988b. Distribution of migratory fish and shrimp in the vicinity of the Waikato thermal power stations. New Zealand Freshwater Fisheries Report 99.

Stancliff, A.G., Boubee, J.A.T., and Mitchell, C.P. 1989. Cross-channel movement of small migratory fish and shrimps in the Waikato River at Huntly. New Zealand Freshwater Fisheries Report 107.

Wakelin, R. 1985. The biology of Gambusia affinis (Baird and Girard) in Lake Waahi, Huntly. Unpublished MSc. thesis, University of Waikato. 93pp.