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JAPANESE KOI (CYPRINUS CARPIO)

IN THE

WAIKATO RIVER SYSTEM

REPORT NO. 1 APRIL 1984

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INTRODUCTION

This report covers previous occurrences of koi in New Zealand, the first finding of a koi in the Whangamarino River, and the results of a follow-up survey in the Whangamarino River system. Some taxonomic notes and other comments on specimens that were obtained are presented. Conclusions and recommendations for further investigation are included.

PREVIOUS OCCURRENCE OF KOI IN NEW ZEALAND

Koi have been present in tanks and ponds in New Zealand for some time and ever since their presence in New Zealand was known, concern about their environmental dangers has been expressed by the Fisheries Management Division of the Ministry of Agriculture and Fisheries.

Controls on the importation of ornamental fish into New Zealand has been the responsibility of the Fisheries Management Division and policed by the Agriculture Quarantine Service. Prior to 1972, imported fish were quarantined for two weeks so that the fish could be identified and to reduce the risk of introducing diseases. This was necessary as New Zealand's native and introduced fish were relatively disease-free. The only serious disease known to be present in New Zealand is Whirling Disease.

The first imports of koi would have occurred in the 1960's and were usually imported as goldfish or mixed with goldfish. They were usually small specimens, about 3-5 cm long and because of their small size, the barbels were quite rudimentary and they were consequently difficult to detect in a consignment of goldfish.

In 1972, importation of goldfish was prohibited because of the risk of introducing some potentially serious diseases known to be carried by goldfish. This prohibition prevented further imports of koi and those now present in New Zealand are either these original fish or their descendants.

In 1980, noxious fish regulations came into effect. These regulations were amendment No. 16 to regulation 19 of the Freshwater Fisheries Regulations (these are now regulation 65 of the Freshwater Fisheries Regulations 1983). Under these regulations, *Cyprinus carpio* (including their hybrids and Japanese koi) were declared noxious.

To deter owners of koi liberating their fish when they were declared noxious, a permit system was introduced - these were issued only to people who had possessed the fish prior to 1980, and where there was no possibility of the fish escaping or to zoos that were registered under the Zoological Regulations of the Animals Act 1967.

Some farm ponds in Taranaki were found to contain populations of koi. They were well contained as they were large fish with a fork length (distance from the snout to the fork in the tail) between 40-55 cm and could not escape through the culverts into the streams the overflow entered. However, there was a real risk of fry produced by spawning of the koi escaping into the streams. After several attempts to eradicate these fish

with the use of poisons and explosives, only two fish remain.

In November 1978, a large koi was caught in the Auckland Domain by an officer from the Auckland Acclimatisation Society. This fish weighed 8 kg and a fork length of 60 cm and is one of the biggest fish on record and estimated to contain 880,000 eggs.

In March 1983, a large koi, specimen K19*, was caught in the Waimapu River in Tauranga. This weighed 6.7 kg and a fork length of 60 cm. No other fish have since been found in this area.

A consignment of koi imported in January 1984 was detected and quickly confiscated.

FIRST SPECIMEN REPORTED FROM THE WAIKATO RIVER SYSTEM

On 29 November 1983, a large koi, specimen K84, was caught by an eel fisherman in a fyke net. The fish was caught in the Whangamarino River (map ref. NZMS 260 033262) near the junction of the Pungarehu Stream. This was a mature male fish weighing 5 kg and a fork length of 61 cm. The fish was in spawning condition and the testes comprised 8.2% of the total weight of the fish.

RESULTS FROM A FOLLOW-UP SURVEY

A brief survey was conducted with the assistance of the Auckland Acclimatisation Society on 14-17 February in the Whangamarino River, Pungarehu Stream and Lake Waikare. The survey involved the use of drag nets, set nets, fyke nets and explosives. Results of the survey are shown in the Appendix.

Seven specimens of koi, specimens K89-95, were caught in the Pungarehu Stream. One (K93) had been attacked by eels with only the head remaining. Two (K94 and K95) were kept alive. All these fish were a similar size and were considerably smaller than the first specimen captured (K84). Unfortunately, most of the set nets had large meshes (10-16 cm); the only set net to catch fish was a 6 cm mesh net. The most successful method of capturing the fish was seining.

DESCRIPTION OF THE CAPTURE SITE

The Pungarehu Stream (see map), where the seven koi were caught, is the outlet from Lake Waikare and flows into the Whangamarino through a culvert. At the time of the survey the flood gate on the Pungarehu Stream at Lake Waikare was closed and consequently the Pungarehu Stream was under the tidal influence which affects the Whangamarino River. In fact, the flow through the culvert alternates according to time of the tide. At high tide, the reverse flow into the Pungarehu Stream is quite noticeable. The lag time between the culvert and the tide at the Waikato River was estimated to be 5½ hours.

*The specimen number is a reference number used to catalogue specimens examined by the Fisheries Management laboratory.

The stream is surrounded by low-lying swamp land and the stream bed is a muddy bottom with occasional lumps of clay; no weeds were observed in the stream.

High populations of Catfish (*Ictalurus nebulosis*), wild goldfish (*Carassius auratus*) and eels (*Anguilla* spp.) were evident in the stream.

Since the survey (and after some rain) the flood gate has been opened and there is now a continuous strong flow into the Whangamarino River. The water level in the Pungarehu Stream has risen and it now floods low-lying swamp land nearby. It is possible large numbers of fish have been flushed into the Whangamarino River. This river and the Pungarehu Stream provide an ideal habitat for koi.

POPULATION SIZE

While this survey only proves koi are present, the relative ease with which these fish were caught (four koi in three seins) and earlier (unsubstantiated) reports of eel fishermen catching fifty or more fish indicates there could be a large population present.

RESULTS FROM EXAMINATION OF CAPTURED KOI

The fish were examined in the Fisheries Management Division's laboratory and meristic and morphometric data were obtained.

<u>Specimen No.</u>	<u>K84</u>	<u>K89</u>	<u>K90</u>	<u>K91</u>	<u>K92</u>	<u>K94</u>	<u>K95</u>	<u>G1*</u>	<u>G2*</u>
standard length (cm)	55.2	13.6	15.6	15.16	15.72	-	-	20.4	17.8
fork length (cm)	60.5	14.8	17.4	16.5	17.2	14.6	14.1	24.0	20.3
weight (gm)	4700	64.5	11.8	10.7	14.7	58.9	49.2	27.5	19.1
lateral line scales	36	33	34	34	36	-	-	29	28
dorsal fin-spines (a)	1	1	1	1	1	1	1	1	1
dorsal fin-soft rays	20	21	21	20	21	-	-	16	19
gill rakers (c)	24	?	24	24	24	-	-	45	41
anal fin-spines (a)	1	1	1	1	1	1	1	1	1
anal fin-soft rays	6	6	5	6	6	-	-	6	6
colouration (b)	1	3	1	3	2	2	1		
length barbel 1 (d)	4.3	11.8	6.4	2.0	11.5	-	-	0	0
length barbel 2 (d)	2.4	2.1	3.1	2.0	2.7	-	-	0	0
snout length (d)	7.95	10.5	10.4	10.5	10.8	-	-	8.8	7.5
head width (d)	17.2	15.4	15.5	17.4	18.9	-	-	19.6	19.9

*wild goldfish from the Pungarehu Stream

(a) Excludes procurrent spines (usually 2)

- (b) Code: 1 reddish orange hues with black blotches predominantly on dorsal area
 2 pink brassy colour with virtually no black colouration
 3 intermediate between above
- (c) Outside of 1st gill arch
- (d) Expressed as percentage of standard length

COMMENTS ON THE DEVELOPMENT AND EXAMINATION OF THE KOI

(a) Genetic development of the koi

Few references are available on the koi and even fewer mention their origin. They were developed in Japan as an ornamental fish and in fact the koi is often referred to as Japanese coloured carp. Mystery surrounds its origin; some references (Walker 1973 and Vanderplank 1972) mention they are a complex hybrid with the European carp (*Cyprinus carpio*) and Crucian carp (*Carassius carassius*) and perhaps Prussian carp (*Carassius auratus gibelio*), other references (Axelrod 1973 and Anon. 1972) state that koi are simply a domesticated form or a colour strain of European carp. A comparison of the taxonomic features of the koi with European carp, the goldfish (*Carassius auratus auratus*) and the first filial hybrid between these two (i.e. F1 hybrids), indicates there is little difference between the koi and the European carp except for their colouration and perhaps a small difference in the number of lateral line scales.

(b) Hybridisation with goldfish

It has been documented (Taylor & Mahon 1977) that European carp will hybridise with *Carassius auratus* and we initially suspected that the specimens we caught (K 89-95) were hybrids between the wild goldfish present in the Pungarehu Stream and escaped koi as these specimens were deeper bodied than koi previously examined. The main differences between goldfish and koi are the lateral line scale counts; gill raker counts and the number of barbels. These features are often used to identify hybrids and in fact F1 hybrids between *Carassius auratus* and European carp possess only one pair of barbels which are usually shorter than those in the European carp.

A comparison between koi, feral goldfish and data in references on hybrids show that the koi from the Pungarehu Stream are identical to koi examined from other sources; the deeper body being due to a good food supply.

(c) Internal examination of the fish

It was not possible to carry out a complete examination of internal organs of the captured koi that died as internal organs had become liquified. Sex could not be determined and no development of gonads could be observed.

(d) Age of fish

The scales of the koi were examined by scientists from the Fisheries Management Division, who have used the technique of reading scales and otoliths to estimate the age of fish.

The scales from the first koi caught, specimen K84, showed a characteristic pattern of rings separated by growth bands. However all scales examined from K84 showed regenerate centres, and could not be aged accurately. Five rings were apparent outside the regenerate centre. If it is assumed that the rings represent annuli, formed during the winter period when growth ceases or slows, as is characteristic of many fish species, then this fish was at least five years old.

Examination of the scales from the smaller fish (K 89-92) revealed no clear rings which could be interpreted as annuli and all circuli appeared quite regular with no regenerate centres. On the same assumption as above, this would indicate the fish are less than a year old. Under ideal conditions, koi will grow rapidly. It has been reported (Pullan 1978) that koi can grow from 25 cm to 50 cm in 8 months in New Zealand. If these fish are in their first year they appear to have grown from birth up to 17.4 cm in less than a year, which appears not unusual when compared with growth rates reported previously.

(e) Unusual features of the captured koi

Some unusual features were observed. The barbels were quite long and well developed when compared with tank raised specimens of a similar size. A small hump on the snout above the mouth was seen on all the small fish. These features may have developed from their feeding habits of scavaging for food; tank-raised fish would have a ready food supply.

One unusual and disturbing feature was the colouration of the captured koi (K 89-95). Most koi observed prior to this survey (including the large one caught in the Whangamarino River, K84) were of a similar colour, a red-orange base colour with large black blotches, mainly on the dorsal half of the fish. Some of these fish, notably K92 and K94, had no black colour and the base colour was a brassy-pink, approaching the colouration of the feral goldfish. The development of this colour suggests a feral form of the koi could be developing and thus they may have a better chance of survival than the normally highly coloured koi. Any trend towards a more suitable colour will, however, become more evident over a period of time.

SOURCE OF FISH

It is probable that the koi, K 89-95 have been bred in the wild, whereas K84 is an escaped fish, possibly part of the parent stock for the smaller fish. If this is the case, other large fish must be present. The source of the parent stock is unknown, but they could have originated from ponds on a fish breeder's property. These escaped during heavy flooding in 1979 (prior to the koi being declared noxious).

The age of the koi, K84 (at least 5 years) is consistent with this possibility. The present locality of the parent stock is unknown.

CONCLUSIONS

Evidence supports the fact that there is a large population of juvenile koi

in the Whangamarino system and possibly a number of large fish which may have acted as a breeding stock.

These juvenile fish have adapted well to their environment and, if their growth rate is correct, will quickly grow to large fish of at least 60 cm and to 8 kg. In about two years they will be breeding size and, with high fecundity and a spawning period from October to February, they have an excellent chance of multiplying rapidly.

So far, no reports have been received of fish in the Waikato River (as at 1 April 1984), however there is no natural barrier preventing the fish entering the Waikato River and it is only a matter of time before they are reported there.

While the koi may not be as hardy as the wild European carp, they have the same undesirable habits during spawning and feeding of disturbing bottom sediments and uprooting aquatic vegetation.

In my opinion, the presence of koi in the Whangamarino River system is a serious problem. Further work is required to assess how serious the problem is and thus what control measures, if any, can be implemented. From an environmental point of view, the koi should be considered as much of a pest as the European carp until proven otherwise.

RECOMMENDATION

1. Publicity should be issued to advise fishermen who fish in the Waikato River that the fish is present, how to identify it and to report any sightings. This should be expanded to include the general public.
2. Isolation of the Whangamarino system from the Waikato River to contain the fish in the Whangamarino River should be investigated. The flood gate on the Whangamarino River where it enters the Waikato River may accomplish this.
3. More detailed surveys be conducted around the Whangamarino River system, expanding to other areas depending on findings of koi. All available sampling techniques should be used.
4. If any breeding populations are found, attempts should be made to eradicate them and at least delay the spread of the fish.
5. Further work be carried out to understand more about their biology, taxonomy, their growth rate and their likely impact on our fresh water fisheries.
6. The feasibility of eradicating the koi should be examined, however even at this stage it appears eradication attempts may be futile.

This work should be carried out with all urgency as if these are first year fish they may be capable of spawning this year and already they appear to be developing into a feral form.

Further reports will be issued as information comes to hand.

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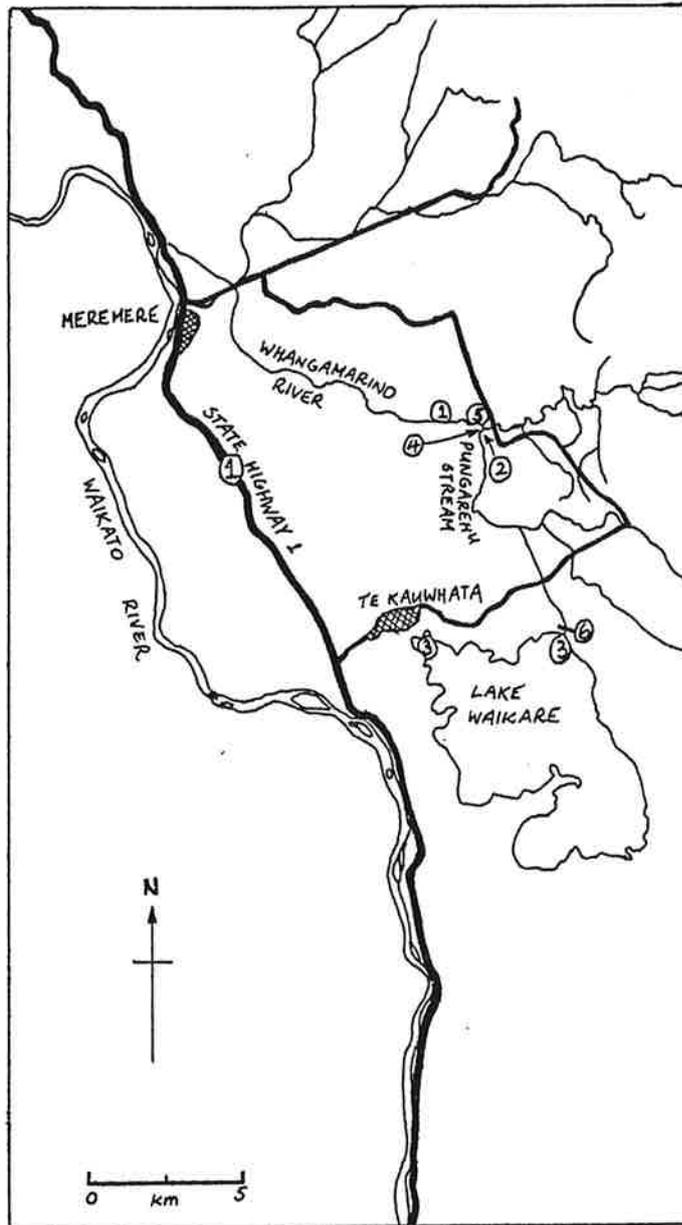
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WHANGAMARINO RIVER AND PUNGAREHU STREAM AREA



CODE

- 1 Survey 15 February
- 2 Survey 16 February (K 89-95 captured)
- 3 Survey 17 February
- 4 Culvert
- 5 Site K 84 captured
- 6 Flood gate

APPENDIX

RESULTS OF SURVEY 15-17 FEBURARY

15 FEBRUARY

Site

Whangamarino River (NZMS 260 S13 033261) 1 km surveyed upstream from Pungarehu Stream junction.

Fishing Methods

12 fyke nets and 8 set nets were set on the 14th. Three seines with a drag net were conducted.

Water Quality

Temperature 20.c°C Secchi 28 cm pH 7.4. Water turbid, low flow and many weed banks, mud bottom. Tidal influence present.

<i>Catch method</i>	<i>Eels</i>	<i>Goldfish</i>	<i>Catfish</i>	<i>Smelt</i>	<i>G. Mullet</i>	<i>Rudd</i>	<i>Inanga</i>
Set nets	0	0	1	1	5	1	0
Fyke nets	107	17	39	0	0	0	4
Drag net	2	131	12	—	—	—	—
TOTAL	109	148	52	1	5	1	4

Comments

1. Eels were predominantly shortfinned eels
2. Goldfish were ripe - milt and eggs readily released. For 63 fish, average fork length = 9.65 cm
3. Catfish were also ripe. For 31 fish, average fork length = 28.6 cm average weight = 350 gm
4. Common bullies and gambusia were present in large numbers
5. FRD Freshwater Fish Survey Card No. 02855 completed

16 FEBRUARY

Site

Pungarehu Stream (NZMS 260 S13 032260). 30 metres surveyed 10 metres from culvert. At this site, the seven koi (specimens K 89-94) were captured.

Fishing Methods

11 fyke nets, 4 set nets were set on the 15th, 5 seines with drag net and small explosives.

Water Quality

Temperature 22.5°C Secchi 28 cm. pH 7.0. Water turbid. No weeds present and muddy bottom. Flow slow and changes direction according to the tide.

<i>Catch method</i>	<i>Eels</i>	<i>Goldfish</i>	<i>Catfish</i>	<i>G. Mullet</i>	<i>Rudd</i>	<i>Koi</i>
Set nets	0	5	29	22	1	2
Fyke nets	124	3	564	2	0	0
Drag nets	0	*	*	0	0	4
Explosives	0	19	0	0	1	1
TOTAL	124	27+	583+	24	2	7

*Large numbers caught, not counted

Comments

1. Eels predominantly shortfinned eels
2. Goldfish and catfish ripe
3. Gambusia present in large numbers
4. 2 koi caught in a 57 mm net. One (K93) was badly damaged by eels - head only left
5. Four koi caught in drag net caught in two consecutive seines (2 in each)
6. FRD Freshwater Fish Survey Card No. 02856 completed

17 FEBRUARY

Site

Lake Waikare near, and in, outlet and bay adjacent to Te Kauwhata.

Fishing Methods

4 fyke nets, 2 set nets, throw net and several seines with drag net.

<i>Catch method</i>	<i>Eels</i>	<i>Goldfish</i>	<i>Catfish</i>
Set nets	0	1	0
Fyke nets	10	1	0
Drag nets	0	2	0
Throw net		6	14
TOTAL	10	10	14

Comments

1. Throw net used on opposite side of outlet flood gate
2. Goldfish in drag net were large red specimens