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WHITEBAIT

Mr David H. Graham, a Marine Fisheries Investigation and Biological Station Biologist began a life long study of New Zealand fishes in 1897 which he later recorded in a book entitled 'The Treasury of New Zealand Fishes'.

These writings show that there was a correlation in timing between the decline in Whitebait numbers and a similar decline in populations of Herrings, Horse Mackerel, Pilchard and Sprat. It is worthy of note that by 1930 and in a similar time frame, there was also a noticeable decline in Kahawai numbers even though the species had not before then been over fished.

I suggest therefore that in addition to my previous submissions, the key to the productivity of this country's coastal pelagic fishery is an abundant saline Whitebait population. Further supportive of this opinion is the fact that the Grayling, a fine edible and sporting fish which was abundant in Bay of Plenty rivers prior to 1900, did in fact disappear before Trout were liberated and I surmise as Inanga, Koaro and Kokopu numbers declined.

The Inanga is the parent of our Whitebait and does live in any fresh water that has an outlet to the Sea. Unless steps are taken to preserve its breeding grounds, it will or has become, like many more of our fish, a thing of the past.

Graham quotes Sprats as being taken from the stomachs of 17 species of fish which had been feeding on them at varying depths down to 50 fathoms. Sprats were to be found up and down the coast in vast shoals.

"Pilchards were found in the stomachs of commercial fish caught down to 80 fathoms. They were also found in the stomachs of some bottom dwelling fish including Flat Fish. At times large shoals were so abundant one felt it might be possible to walk on them. They were observed in hundreds and perhaps thousands of tons, a sight which could only be described in superlatives. Shoals were seen a mile or more wide and almost continuous in length. So plentiful were they that the water with the sun shining brightly had the appearance as if heavy rain was falling. This was due to these small glistening fish jumping out of the water to escape the fish which were pursuing and devouring them.

There was no more interesting sight than to be in a launch speeding ahead and to see shoals of Pilchards, as far as the eye could see, swimming closely packed side by side, tier above tier, moving rapidly ahead darting hither and yon as they leapt and turned chasing food. They prey on minute sea forms and are in their turn the prey of every fish and many birds. These small fish play an important part in the food of larger fishes, including all surface and shoal fishes. Twenty four species of fish were found to have been feeding on Pilchards and no doubt many others would qualify as predators.

Shakespeare was quoted thus: "I marvel how the fishes live in the sea. Why, as man do a-land; the great ones eat up the little ones".

It seems to follow that if New Zealand recreated more inanga habitat in connection with inanga spawning habitat and if we protected whitebait and inanga from predation by man, we would build sprat and pilchard and other small and juvenile fish numbers which would in turn create much higher production from our very exportable pelagic fishery. (Don Paterson).

A TREASURY OF NEW ZEALAND FISHES BY David H. Graham

Probably no other species of fish is as much discussed as the New Zealand Whitebait, our choicest freshwater delicacy, which was so extremely abundant but, though still plentiful, is now becoming scarcer so that before long, unless steps are taken to preserve its breeding grounds, it will become, like many more or our fish and plants, a thing of the past. Future generations will wonder why, for it is truly said that we are responsible for the future of our fauna and flora, but like human beings we follow the line of least resistance and little or nothing is done.

All kinds of questions arise. What is Whitebait? Where does it come from? Where does it go to? What does it turn into? Do other countries have Whitebait? Why does it deposit its eggs on ground which later is without water?

For a long time it has been known to the Maori and to Europeans that our New Zealand Whitebait is the young of a native freshwater fish commonly known as Minnow or Inanga or Howe to the Maori, and erroneously called a Trout. The Inanga or Minnow, is a fish 4 to 6 inches in length, very rarely 7 inches long, and is known to science as *Austrocobitis attenuatus.* The early settlers called it Maori Trout, Native Trout, Rock Trout and Minnow. But it is not a Trout. Nor is it a Minnow, though it resembles the English freshwater Minnow. While the name Trout is not correct, it is and will always be known as such by farmers and naturalists. In the Bay of Plenty, Whitebait is known to the Maori as Porohoe.

The Minnow, Inanga or Native Trout, whatever you like to call it, is the parent of our Whitebait and lives in the upper reaches of New Zealand rivers, lakes, creeks, drains and any sheet of water having an outlet to the sea. In all my mosquito investigations in the Auckland Province, I never found a Minnow living in any water that did not have an outlet to the sea. It will live in large areas of very slowly moving water, even in the most stagnant, swampy places that are growing raupo, rushes and toetoe grass, but there is always an outlet to a creek or river.

The old-time Maori knew that the Inanga migrated downstream to spawn, and was under the impression that it spawned in the sea. He was not far out in his observations. In 1868, Mr L. Powell watched the growth of Whitebait at the Christchurch Acclimatisation Society's Trout Hatchery. In 1904, Mr D.H. McKenzie published in the *New Zealand Illustrated Magazine* and account of the breeding habits of the Minnows seen on the Rangitikei River.

In February, 1911, Mr W B Brandon of Hokitika, recorded the spawning of Minnows. Previously men who had seen Minnows congregating at high tide gave the fish the name Cowfish because of the milkiness of the water, due to the amount of milt from the males and ova from the females which they extruded as they were lifted in a net from the river. Mr Brandon writes: "The fish appeared to be whirling over each other as their backs rose continually to the surface. The spawning fish made no attempt to escape when an endeavour was made to capture them". In 1929, Captain Hayes, Marine Department, obtained ripe Inangas of both sexes and artificially fertilised the eggs, successfully hatching out healthy fish in salt water, brackish water and in fresh water, a notable achievement and discovery.

It appears that the Inangas are ready to spawn in February, March and April, migrating down stream to that part of the river bank where the high spring tide meets the fresh water and covers the surrounding land with a mixture of sea water and fresh water. During the high tide, the eggs are anchored to rushes, weeds, grasses, clover and other vegetation being deposited in clusters on the stems where they will be most protected, and even on the ground about the roots of the stems of the plants mentioned. As time and tide wait for neither man nor fish, all must be done quickly before the tide recedes. During the time the female Minnow is depositing her eggs, the males are busy extruding milt to fertilise the numerous eggs.

Statements have often been made by my Maori and Pakeha friends that the Inanga spawns more than once a year. I can only quote Mr S.E. Webb of Opotiki whom I have known intimately for 40 years and I know him to be a keen and accurate observer of Nature. He assures me that he has known of the Inanga spawning both in autumn and in the spring. In September of 1944, in the early morning at neap tide, he saw Inangas being caught from the Otara River, Opotiki, Bay of Plenty, about 2 ½ miles from the sea. Men had no difficulty in netting a sack of about 200 pound weight of Inangas 2 ½ to 3 inches in length. The females were ripe and ready to spawn, so much so that during netting and while being tipped out of the net and into the sack, ova were being freely extruded.

It will be seen that the eggs are left high and dry between the high spring tides. One cannot help but wonder why a fish should spawn where the water covers the ground once a fortnight or less. Once the eggs are fertilised, the young fish begin to develop in spite of the lack of water. One reason put forward is that the eggs are protected from attacks of water inhabitants and predatory enemies. When the next spring tide occurs, perhaps weeks later and the eggs are again submerged, the eggs hatch and the larval Minnows are carried away by the ebb tide.

That the eggs can withstand a fortnight of dryness is remarkable, but it is still more amazing that, if the tides do not reach the eggs within a fortnight after spawning, they are able to wait till the next spring tide, or even to extend that time to six weeks - a wonderful provision of Nature: as John Dry said said: "For Art may err, but Nature cannot miss".

Before the arrival of the Pakeha, the eggs were safe, not only from water enemies but reasonably safe from land enemies as well. But today, with the advance of agriculture things have changed for the worse for Whitebait, since horses, cattle, not to mention human beings, destroy enormous numbers of developing eggs by tramping down the vegetation on the banks of rivers, where the Minnow deposits her eggs.

After the eggs have hatched, the outgoing tide carries away the larval fish seawards, where they attain strength and resistance for their future swim upstream to the home of their parents. The immature Whitebait frequently go far out to sea, and from those I have found in the sea, it appears they live on diatoms before beginning their ascent upstream. They in their turn are preyed upon for I have frequently found them in the stomachs of Sea fish. Whitebait have other enemies in the introduced Trout and Salmon.

An interesting record was the catching of a number of Whitebait 3 ¼ inches in length in a Garfish Bunt in the Otago Harbour in February, 1931. This raises an interesting point as to what these small fish were doing in this locality. Had they lost their sense of direction, missed the river from which they had descended, and stayed in the harbour?

To those who are familiar with our fast-running rivers, many of which have rapids and falls, it is one of the miraculous wonders of Nature that these tiny fish can surmount such places to their homes. In the Waikato River, for instance, the ascending of Whitebait past the Aratiatia Rapids and the Huka Falls on their journey to Lake Taupo in countless numbers must be regarded as an extraordinary achievement.

Sometime prior to 1900, as a boy, at Brunnerton on the grey River, West Coast of the South Island of New Zealand, I can well remember catching Whitebait as they ascended that river. Day after day, week after week, during the spring months shoals of these small fish pursued their way up the river. It was no trouble to catch a bucketful in a few minutes. So plentiful were they that if I received 6d. or 1/- for a bucketful it was considered a good price. They were fed to the fowls and ducks until the eggs had a fishy taste. I can remember my father using Whitebait as garden manure. The supply exceeded the demand.

Galaxias attenuatus, Minnow or Inanga (the parent of Whitebait), is greenish-yellow in colour and sometimes spotted with brown. The spots are composed of numerous minute dots. This fish has the dorsal fin well back towards the tail and opposite the underneath, or anal fin. The fish is smooth and devoid of scales. The female Inanga begins to breed when not quite three inches in length.
It is a very prolific fish and a female not quite 3 inches long was found to carry 1,500 eggs. One over 5 inches in length had over 13,000 eggs.

I have often been asked the record catch of Whitebait for one man in one day. In 1925 one man caught 240 pounds in the Waimakariri. The best catch in my records is from Wataroa River, West Coast of the South Island, when Mr J. Howden secured over 1,100 pound single-handed one day in November, 1928. Mr Howden not only caught half a ton of Whitebait but packed it that day on horseback to Matanui Township from whence it was sent to Christchurch.

During my mosquito investigations in the Auckland district, it was found that the parent Inanga was fond of mosquito larvae and any sheet of water inhabited by the fish was kept free from mosquitoes in the water stages.

The pollution of streams by sawdust is no small menace to the ascending Whitebait. The erection of hydro-electric plants, and the felling and burning of native bush adjacent to rivers are other causes of their destruction. The Whitebait industry is decreasing and one cannot help wondering if the day will come when the known breeding grounds will be made sanctuaries during the spawning months, a proposition bristling with difficulties.

The men who catch Whitebait for a living want fewer restrictions. The Trout fishermen urge a restriction of the season of Whitebait to increase the food for Trout. The Maori wants to continue to catch the Inanga on its downward journey, his plea being the fact that the Inanga is part of his food supply and comes under the treaty of Waitangi.

English Whitebait is made up mostly of young Sprats, mixed with the young of Skad, Herrings, Sticklebacks, Gobies and Shrimps. In Japan the young of Sea Perch are called Whitebait, and in Germany the young of various sea fish go under that name. In Italy it is the same, but in each case the fish are of a bony nature and inferior to New Zealand Whitebait. *Galaxias attenuatus* is also around in Australia and South America, but not as abundantly as in New Zealand. The adult is known in Australia as Jollytail.

The Inanga, when descending rivers to spawn, were taken by the Maori in great numbers. These adults and also Whitebait were dried on mats in the sun and preserved for future use.

Another method was to make a hot fire over stones, clear away all debris, pile the Whitebait on the stones, and cover with mats and earth. After about half an hour the Whitebait were packed into kits, in which they would keep in an edible condition for some months.

When the first catch of Whitebait was made, some were set aside as offerings to the gods and the rest were consumed in a ceremonial feast. The cooking was done in five different Ovens for different eaters: one for the Priest, one for the Chiefs, one for the Women, one for the Fishermen, and another for the bulk of the people. All such ceremonial performances were held to be highly necessary.

I have had verbal records of Inangas being kept in captivity, but the most authentic is in a letter from Mr A.H. Johnstone, of Koromiko Street, Christchurch, who caught an Inanga in the Waimakariri in March 1940 about 4 inches in length. It was taken to his home and liberated in a goldfish pond where it lived and thrived. It was fed on oatina, worms and life in the freshwater pond. In March, 1948, this Inanga had grown to about 6 inches long so that in eight years, it had grown 2 inches. This Inanga is tame and enjoys being ticked "guddled" and will accept that attention with apparent pleasure until the person is tired.

KAHAWAI

During 1930 to 1934, Kahawai were still numerous, but according to fishermen who have been fishing for over forty years in Otago waters, not as abundant as in former times when boats and launches could be filled easily with these fish. There is no apparent reason for this change in abundance as the Kahawai has not been over fished like other fish.

The largest specimen I have seen caught or on the fish market measured twenty-nine inches in length and weight nine pound. Others measuring twenty seven and twenty five inches weighed eight and seven pound respectively. In a case of Kahawai it was found that the fish averaged twenty seven inches in length and eight pound in weight.

Kahawai will take almost any bait but prefer a moving bait, and thus large numbers are taken on the Barracuda "paw" or by drawing a bright hook behind a fast moving launch.

In 1922, the late Mr George Tulloch caught large numbers in set nets while fishing for Quinnat Salmon off the Waitaki River mouth. Although they are as a rule surface fish, they are caught in deep water in various localities. We have caught them off Otago Heads and off The Rock in fifty fathoms on a Blue Cod hook with a piece of Pigfish as bait. They were also taken by steam trawlers in the otter trawl, and hundreds have been secured in one shoot and thrown back into the sea.

In September, 1933, D.G. Gilberd wrote to me stating that M.J. Channing, of Wanganui, caught a Kahawai at Castlecliff, which when cleaned, weighed seventeen and a half pounds and was 37 inches in length, which, as far as I know, is a record for New Zealand.

I was not able to obtain female Kahawai with fully ripe roes. In some specimens examined in February of 1932 and again in 1933, I found ovaries so well developed as to suggest they would be ripe in March or April, but where they go to spawn remains a mystery.

The economic value of the Kahawai is small. In 1930 - 34 this fish sold on the Dunedin Fish Market at from 3d. to 3d. apiece; there was little demand and a dozen on the market was ample for one sale day unless other fish were exceptionally scarce, when odd ones have been sold for 10d.

The following is a list of interesting facts that I have taken from "The New Zealand Whitebait Book" authored by R.M. McDowall. (Don Paterson).

1. Koaro Whitebait (Galaxias brevipinnis) penetrate great distances inland and have been found in the uppermost reaches of river systems in many areas, including the Rotorua Lakes.

2. In pre-European times, Lake Taupo carried massive populations of Koaro.

   (Graham: 'The ascending of Huka Falls by Whitebait on their journey to Lake Taupo in countless numbers'- Don Paterson).

3. It seems that the introduced trout have had quite disastrous effects on galaxiids, extinguishing populations in some areas and causing a decline in population in others.

4. The decline in trout condition in Lake Taupo in the 1920's followed the decline of Koaro under heavy predation by Trout.

5. A.H. Hefford, Chief Inspector of Fisheries (1944); 'The Trout is one of the least of many factors operating against the Whitebait'.

   (Lake Atiamuri Hydro-dam on the Waikato River was commissioned in the 1920's – Don Paterson).

6. Banded Kokopu Whitebait (Galaxias fasciatus) penetrate substantial distances inland reaching localities that seem inaccessible.

7. Short jawed Kokopu Whitebait (Galaxias postvectis) move well inland.

8. Giant Kokopu Whitebait (Galaxias argenteus) seldom seem to move far inland.

9. **Inanga Whitebait (Galaxias maculatus) move into lowland waters rarely penetrating more than a few kilometres.**

10. Every lowland water that is still or gentle flowing will have shoals of maturing Inanga by the beginning of summer.

11. Of the five species of Whitebait, only three - the Inanga, Koaro and Banded Kokopu - are caught in significant numbers.

12. **Captain L. Hayes (1932); 'Within tidal limits are mudflats bristling with salt rushes. Inanga spawn amongst rushes. Fairly long, thick growing grasses and rushes or similar vegetation is usually chosen. In March, I noticed Inanga evidently spawning everywhere amongst the rushes.'**

13. **D.H. McKenzie (1904); 'During the months of March and April may be seen at high water spring tides, countless myriads of small fish from 4 to 6 inches in length, making the water literally boil, wherever any rushes exist.'**

14. Thomas Brunner (1831); 'Whitebait entering the rivers with the tide are in good numbers. They are in such shoals that I have seen dogs lapping them from the stream.'

15. The early Maori were careful conservers of their resources.

16. Best and Hiroa; 'The first or last Whitebait run was allowed to escape to ensure that the stocks were not depleted.'

17. **R. McDonald; 'In the old days Maoris would not catch the Whitebait coming up the Hokio preferring to wait and take them when full grown they ran to sea to spawn.'**

18. In 1925, seven tons were canned from the Waikato River in one day.

19. When runs were particularly heavy, even the canneries could not cope. For example, the cannery in Hokitika worked night and day but could process only a small proportion of the Whitebait available.

20. By 1930, a substantial number of Whitebait canneries were busy.

21. In 1944, 61,000 kg were canned from the Haast River. In that year, there was so much Whitebait it was dumped by the dray load.

22. By 1950, the industry was in recession and many factories were closing down.

23. The policy seemed to be to get all you could then and let the future look after itself.

24. The gaunt remains of the Waikato cannery at Tauranganui stand as a reminder of a formerly thriving industry.

25. The first whitebait regulations were drafted in 1894.

26. 1912 saw a 10 month closed season on the Waikato River followed by its revocation the following year.

27. The difference between Whitebait fishing in 1928 to what it was before is as a cupful to a dray load!

28. **A.H. Hefford (1927); 'The amount of Whitebait devoured by fish is a very small item indeed as against the huge number that Whitebait netters take from the stream.'**

29. **There are no records at all of the quantities of Whitebait caught in New Zealand water until 1927. In 1927, the Marine Department reported that depletion had been almost universal.**

30. C.A. Whitney (1930); 'By this time it must be evident to the Government that the Whitebait is slowly being wiped out.'

31. The first comprehensive regulations on Whitebaiting were drafted in the 1930's.

32. **Hefford, Chief Inspector of Fisheries (1930'S); 'It would be disastrous to wait until depletion and deterioration were so marked as to be patent to all. The time has come for restriction upon Whitebaiting'.**

    (D.H. Graham (1930); 'Kahawai not as abundant, with no apparent reason for change, as Kahawai has not been over fished like other fish'- Don Paterson)

33. **McDowall; 'Manawatu river productivity in the early days was undoubtedly due to vast areas of lowland swamp. These provided extensive habitat for Inanga, Giant Kokopu and Banded Kokopu. Swamps have been drained, streams channelised, the forests felled and the Whitebait have largely gone. Low lying esturine vegetated flats at the river mouth for spawning have also disappeared. It is no wonder that the fishery isn't what it was.'**

    Early on three prime causes of decline were identified: excess take by Whitebaiters, predation and the draining of swamps, backwaters and creeks near to and adjoining tidal waters. Opinions varied on the amount that each of these contributed.

    Captain Hayes stressed the vulnerability of the spawning grounds and how the preservation of the habitat is critical to the survival of the fishery.

34. Hayes; ‘Inanga spawning rendered the embryos liable to considerable destruction under the conditions which now prevails. The danger from the trampling of grazing stock and the annihilation of possible spawning grounds as a result of grazing have been found to occur in practically all the localities investigated. One hoof mark would be sufficient to wipe out thousands of eggs, while it appears as if a herd of cattle could exterminate a whole bed of spawn. There would be no point in extending the possible spawning areas for a stock of fish which was too small to make use of such facilities.’

35. **McDowall; ‘Captain Hayes emphasised the desirability of providing sanctuaries or feeding grounds for the adult fishes. Such feeding grounds have of course been greatly diminished in the course of civilised settlement by the drainage of swamps and lagoons and their conversion to agricultural lands. It would appear, however, that there are many places, areas of swamps, which are of little or no value to agriculture and in which permanent lagoons, which would accommodate considerable numbers of Inanga, might be formed as a result of comparatively simple and inexpensive work.**

36. High catches in 1947 were followed by poor ones in 1948.

37. Roland Stead (1982); ‘There are those who would prefer to continue the unrestricted fishing in their time rather than give any thought to conservation for the future.’

38. **McDowall; ‘Wetlands are possibly one of the most endangered habitats in New Zealand, with thousands of hectares drained and converted to pasture each year. 84% of the wetlands in the Waikato Valley have disappeared in the last 140 years. Wetlands are undoubtedly a crucial habitat for Inanga. The populations of the various species have all declined because there is nowhere for them to live. It seems almost too simple to be true. And that’s not all. Whitebait spawn in estuaries, and out of all the aquatic habitats, estuaries seem most fragile and prone to damage. Towns release effluent into estuaries often with minimal treatment. Further change is brought about by channelling river mouths, constructing groynes, etc.**

    Is it any wonder then that Whitebait have declined with the loss of habitat for the adults to live and grown in, and the loss of the spawning grounds where the eggs are laid and the young hatch before going to sea? Of all the reasons suggested for the decline of Whitebait, the destruction or modification of the habitat is in my opinion, a prime cause.

Something could possibly be done to revegetate the esturine spawning grounds. But for the most part it's too late. Forests and swamps have gone, streams have been realigned and channelled, vegetation in the estuaries has been killed by pollution or covered with fill and there is nowhere left for fish to live or breed. It is a sad story but by no means unusual. And it is still going on. If we don't protect Whitebait habitat one day there will be nothing.'

Don Paterson: 'Is it any wonder that the New Zealand Coastal Fishery is depleted? Fish eat fish and if the population size of the smallest fish is depleted then that must in turn restrict the population size of bigger fish. To further cripple coastal pelagic fisheries production, I suggest that one has only to harvest an already diminished resource while it is spawning, harvest it with set nets, with trawl nets and horsepower, or harvest it with seine nets and aeroplanes within the 12 mile limit. Or increase the population size of a significant competitor for the remaining Whitebait, the Scad (Decapterous Koheru), by removing most of one of that competitor's population regulating predators, the Striped Marlin. Is it any wonder indeed?

The New Zealand coastal fishery could, I believe, be rebuilt from the bottom up with whitebait, if there was a mind to do it. Lowlands within a few miles of the tidal reach could be reflooded and Whitebaiting could be outlawed. Native flora could be replanted along stream banks, pollution stopped, sediment traps built on tributaries in the form of ponds, and fish ladders could be built up waterfalls and hydro-dams. Stopbanks around tidal estuaries could be removed and wetlands made inaccessible to stock. Productivity of the New Zealand coastal fishery may in future be limited only by the degree of action that is now taken to restore it.

Past seasons of significant whitebait harvest have been followed by a decline in harvest during the following season. This may indicate a depressing effect that harvest is having on future population size and supports the assumption that Galaxius marine life is six months. It follows therefore that protecting Inanga and Whitebait stocks from predation by man might most quickly rebuild the coastal fishery.

Migrating Whtiebait swim near the surface of dirty water and deeper when water is clear or when in sunshine. Whitebait feed predominantly on stream bottom invertebrates, so perhaps that behaviour has been learned at sea. Much marine life rises towards the surface at dusk and retreats from light during the day. Whitebait which are thought to be six months old when they enter fresh water from the sea have not been detected in any numbers in the oceans around New Zealand since Graham 'frequently found them in the stomachs of sea fish.

Galaxii occur in South America, South Australia and New Zealand, all of which share similar latitude and prevailing winds. One was found between Bounty Island and Antipodes Island, many hundreds of miles south-east of New Zealand. Perhaps lateral drift is moving some of them around the globe. It seems illogical to me that they would perish while juvenile and surrounded by food. Whitebait from South Westland Rivers are bigger and fatter than those taken from other parts of New Zealand. Inangas were in the distant past reported as returning from the sea which may or may not suggest an extended salt water visit for some.

I believe that this Country's Coastal Fishery holds greater potential for future economic gain than does the production of pasteurised butterfat. I believe that significant opportunity could be created from the harvest of a well managed coastal fishery. Restoration of an abundant and far more productive coastal fishery could, I believe, be led by a Maketu Estuary - Kaituna River restoration example'.

39. Douglas (1860); 'Those Whtiebait were created by nature to fill a large gap somewhere in the World of waters'.

Graham (1953); 'The place was over fished even during the spawning season and consequently much smaller hauls were evidenced. The prevailing wanton methods of fishing, including over fishing had in 1930 - 34 intensified exploitation during the spawning season, resulting in a serious decline in numbers and size of the fish and called for control over the situation. Roes containing a million eggs per pound weight were sold. If this waste was going on, what must have been the total loss to New Zealand?

Such a loss, appalling in its magnitude, even in a marine environment could not be viewed with equanimity. The maintenance of a stock of fish and its relative abundance from year to year, and its continuity depend more probably on how many fish were allowed to spawn rather than on the loss of the young fry from predatory fish. It is surprising that a thinking community would permit this to go on.'

Don Paterson: 'And it is still going on!

Devonport Whitebait that are caught illegally in the north under lights are juvenile Anchovies. Herrings are Yellow Eyed Mullet. Smelt which live in salt water, return to and spawn in fresh water. Smelt populations in Lakes Rotorua and Taupo have been acclimatised. Bullies spawn in fresh water and are washed out to sea where juvenile Bullies are called Whale feed. I suggest that all of these little fish are important to the productivity of our coastal fishery.

The following is a list of interesting facts about Whitebait that I have taken from a Marine Department, Fisheries Research Division, Fisheries Research Bulletin entitled 'Galaxius maculatus, the New Zealand Whitebait,' authored by R.M. McDowall.

1. **Galaxius maculatus is the most important Whitebait species and makes up 85% of the population.**

2. The breeding biology of Galaxius maculatus and factors affecting the juvenile migration are most significant and relevant.

3. For breeding purposes, Galaxius maculatus migrates downstream into tidal estuaries and downstream migration occurs before spring tides.

4. The majority of Galaxius maculatus migrate downstream to breed in tidal estuaries between January and April and sometimes much later.

5. Spawning occurs after spring tides and fecundity is up to 13,500 eggs.

6. Few Galaxius maculatus appear to survive spawning.

7. Galaxius maculatus spawns in tidal estuaries and either in salty or fresh water but usually in areas affected by an upstream tidal push.

8. Spawning takes place in tidal estuaries and typically on flat grassy banks which are exposed at all times of the tidal cycle except at high spring tides.

9. Spawning beds are most often found where the ground is covered by spring tides but not by normal high tides, although sometimes they are found below this level.

10. Thick vegetation, usually grass, is generally necessary for spawning.

11. Eggs are sticky when spawned but only until fertilised.

12. Eggs develop amongst vegetation and above normal high tide level.

13. Since much of the breeding habitat of Galaxius maculatus is above normal tidal levels, egg predation is unlikely to be a factor of much significance.

14. Eggs usually develop within two weeks and hatch at the next spring tide cycle but may still hatch after two months without immersion in water.

15. Hatching is stimulated by immersion in water.

16. Eggs will hatch in fresh or salt water.

17. Larvae hatch at between 6 and 8mm.

18. Larvae are washed out to sea upon hatching and are predatory carnivores.

19. Larvae are pelagic. Upon their return to fresh water they feed on a wide range of stream bottom invertebrates with a small proportion of surface forms.

20. Whitebait migrate from the sea at all times of the year.

21. Most Whitebait migrate between August and November with some late runs of significance until January.

22. Galaxius maculatus shrinks as it enters fresh water from the sea.

23. Regional differences in the size of migrating Whitebait suggest that there is not free mixing of the Whitebait stocks in the seas around New Zealand. This is further supported by regional differences in the composition of the Whitebait catch observed.

24. Stokell (1955) believed the age of Whitebait at migration from the sea to be 18 or even 30 months.

25. McDowall believes that the adult Galaxius Maculatus (Inanga) breeds at an age of about one year and that the life cycle is basically an annual one.

26. Whitebait hatched in captivity reached 15mm in length at an age of 3 ½ months which poses the question whether they could reach their migratory length of 50mm in just six months.

27. McDowall believes that juvenile marine life is probably 6 months and that Galaxius maculatus matures during the first summer in fresh water and breeds during the following autumn.

28. Graham (1956) noted instances of Galaxius maculatus breeding during September in the Bay of Plenty. (He also noted that an adult Inanga in captivity in Christchurch grew from 4 inches long to 6 inches over a period of 8 years.)

29. Not all Galaxius maculatus are one year old when breeding. Some are 2 or more years of age and comprise mostly females.

30. Maiden late spawners have been further up the river and produce more eggs than younger females.

31. Evidence of breeding survival shows that few Galaxius maculatus may breed more than once.

32. The downstream limit for Galaxius maculatus habitat is the upper estuary. (Graham noted the presence of adult Inanga in Otago Harbour while not in spawning condition – Don Paterson))

33. **There is a higher density of adults in the lower river and they are found in predominance in brackish backwaters.**

34. There are proportionately more males in the lower estuary.

35. **From the high fecundity (number of eggs) and the large size of fish living in them, lowland bush swamps with brown water appear to be the ideal habitat for Galaxius maculatus.**

36. Five species of Galaxius frequent the Whitebait net as well as two species of Retroprinna, one Stokellia, three Eleotrids and two Elvers.

37. In most parts of New Zealand, the five species of Galaxius are the only fish of commercial importance, although in the Waikato River and some Thames rivers Retropinna species are commercially significant. Retropinna is more commonly called Smelt. (The Rotorua Smelt is Retropinna Lacusdris - Stokell.)

38. Galaxius maculatus is probably a source of food for several large predatory fishes.

39. McDowall (1966); 'There is no evidence from published figures to indicate that there has been a permanent decline in the catch of the West Coast fishery since records began.'

40. McDowall (1966); 'There seems little reason to conclude that the recent poor years are anything more than a normal irregular fluctuation of the fishery which cannot, at present, be explained.'

41. Waugh, Director, Fisheries Research Division, New Zealand Marine Department (1966); 'Considerable concern has been expressed about the possible effect on Whitebait stocks of intense fishing and of agricultural and industrial development in the river catchments. Populations are subject to considerable natural fluctuations irrespective of these factors.'

42. **Philips (1940); compared the remarks of Mr A.J. Rutherford who had seen cartloads of whitebait coming from the Hutt River in 1880 with the situation there in 1940, when there were "seldom enough Whtiebait to entice the local fishermen to catch them".**

43. In 1965, the commercial catch of Whitebait in New Zealand was valued at $232,856.

44. **Clark (1899); 'The extent of the shoals in the South Island West Coast rivers at times were incredible. Often, I have seen surface areas several acres each in extent, covered some inches in depth, with these fry used as topdressing manure. One hopes that the supply will last and be properly fostered to allow sufficient to be left for annual reproduction.'**

45. **Graham (1956); described the taking of Whitebait as they ascended the West Coast rivers before 1900 when a bucketful could be caught in a few minutes. "They were fed to fowls and ducks until the eggs had a fishy taste. I can remember my father using Whitebait as garden manure. The supply exceeded the demand."**

46. Hope (1928); 'The Whitebait fishery is a valuable, national asset but under the present system of fishing the Whitebait is in extreme danger of extermination.'

47. Hayes (1932); 'There are dangers from the trampling of stock and annihilation of possible spawning grounds through grazing. Deciduous trees make the ground beneath them unsuitable for the herbage necessary to give cover to the spawn, the effect of willows on the banks of streams, swamp drainage and use of chemical weed killers.'

48. **Stockell (1955) considered that a major influence had been drainage of swamps and lowland streams.**

49. McDowall (1966); 'Other likely causes are changes in rivers through land development and overgrazing of pasture land which has caused flooding, chemical pollution from use of fertilisers, man's wasteful exploitation of whitebait in the early days of the fishery. The number of Whitebait fishermen has increased considerably as better roads have made rivers more accessible. Habitat range has been restricted by weirs and hydro-dams.'

50. There are numerous reasons for the decline in the Whitebait fishery.

51. **Stockell (1955); 'A major influence has been the drainage of swamps and lowland streams. The protection of its habitat in certain localities would be in the interests of the fishing industry.'**

52. Externally imposed changes in habitat (for example, by man) are probably less important in the rivers of the south than those of the north.

53. The fishery in the little modified southern rivers remains highly productive.

54. The remote underdeveloped West Coast of the South Island is the only Whitebait fishery left.

55. In 1964, the rivers of Fiordland between St. Anne Point and Puyseger Point were closed to Whitebaiting.

    Don Paterson: 'What sacrifice is made to our coastal fishery by the removal of a single returning juvenile Whitebait, so stopping many thousands of its progeny from following it in ensuing years? Whitebaiting in New Zealand is now comparatively non-existent and so is our coastal fishery'.

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