INVESTIGATION INTO THE MANAGEMENT OF THE WHAKAKI LAGOON

Background Report

Office of the
Parliamentary Commissioner for the Environment
Te Kaitiaki Taiao a Te Whare Pāremata

PO Box 10-241, Wellington

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Copies of the Main Report are available from this Office on request.

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Abbreviations used in the text

DMA	Department of Maori Affairs
HBCB	Hawke's Bay Catchment Board
NCC	Nature Conservation Council
NWASCA	National Water and Soil Conservation Authority
SC&RCC	Soil Conservation and Rivers Control Council
WCC	Wairoa County Council
WDB	Whakaki Drainage Board

1.0 INTRODUCTION

Whakaki Lagoon is situated in the East Coast of the North Island, between Wairoa and Nuhaka, and prior to farmland development was part of an extensive coastal wetland network (Figure 1). Until the early 1900s exit of lagoon waters to the sea occured only when flood waters naturally overtopped the sand bar, or tangata whenua opened the bar manually to facilitate subsidence of flood waters. Oral tradition tells of at least one direct opening made to the sea at Te Awa Waahi, but from at least 1899 to 1956 the artificial openings were usually made at Paakaa and flood waters would then exit via the Rahui Channel and Patangata Lagoon (Figure 2).

As from 1956, through the actions of successive central and local government agencies, flood waters have been released through direct sand bar openings, bypassing and effectively reversing the direction of drainage through the Rahui Channel.

Major ecosystem changes began to be apparent in Whakaki Lagoon in the early 1970s, and were attributed by tangata whenua, recreational hunters, and Wildlife Service staff to the bypassing of the Rahui Channel. Submissions to Government to restore the Rahui Channel and Paakaa outlet began in 1973, and culminated in a proposal for joint funding from the then National Water and Soil Conservation Authority (NWASCA)[1] (60% contribution for half the total cost, with the Hawke's Bay Catchment Board to confirm the other 40% as the local share) and the Wildlife Service of the Department of Internal Affairs 50% of the total cost. However, the project lapsed in 1987 as the Wildlife Service contribution did not eventuate before that agency was disestablished.[2]

As part of this lapsed restoration plan the Trustees of Whakaki Lagoon, owners of the bed of the Rahui Channel and some of the immediately adjacent lands, were granted a water right in 1982 to discharge through the Rahui Channel.[3] However, until the Rahui Channel can be re-opened, the Hawke's Bay Catchment Board and its successor the Hawkes Bay Regional Council have the right to continue discharging through the direct opening, and the obligation to maintain minimum and maximum levels set by NWASCA. In practice, however, these bodies have not enforced the minimum level set by NWASCA, allowing continued dewatering and intrusion of salt water in Whakaki Lagoon.

In November 1990, the Maori Standing Committee of the Hawke's Bay Regional Council recommended that the issue of Whakaki Lagoon openings be taken up with central Government once again. A Whakaki Lagoon Working Party was established to review the

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1 NWASCA was established under the Water and Soil Conservation Act 1967. Its predecessor, the SC&RCC was established under the Soil Conservation and Rivers Control Act 1941. Both organisations were responsible for providing the Government, through the Minister of Works, with advice on water and soil management, and for providing overall direction for catchment authorities. Both organisations were serviced by the Ministry of Works.

2 Restructuring of environment and conservation agencies including the Wildlife Service commenced in 1985, and Government reluctance to approve the Wildlife Service share has been attributed primarily to this restructuring process (D. Stack, letter of 14 December 1992).

3 Levels were set separately by NWASCA at max. = R.L. 11.8 and min. = 10.5, set by NWASCA on 1/9/86. The water right to discharge through the Rahui Channel was first approved in November 1982. It expires in May 1995.

situation,[4] and wrote to the Minister for the Environment in December 1991 seeking assistance in restoring the former outlet at Paakaa. The Minister declined the request but suggested that following the development of a management plan for Whakaki Lagoon and its catchment, he would be prepared to reconsider a proposal, providing a significant national interest was determined.[5]

In May and June 1992, the Parliamentary Commissioner for the Environment received complaints from members of the Whakaki Lagoon Working Party about the management of the Whakaki Lagoon. The issue, as presented to the Commissioner, involved the need to obtain funding to return Whakaki Lagoon opening regime to its traditional site at Paakaa, via the Rahui Channel which had been bypassed since 1956 and had since silted in. The bypass of the Rahui Channel through creation of the direct opening was said to have been initiated by the former Ministry of Works, and the complainants held that the subsequent direct openings of Whakaki Lagoon to the sea were responsible for the decline in habitat for various species of cultural and recreational significance and the loss of a traditional waterway.

In August 1992, staff of the Commissioner's Office visited the Whakaki area and met with interested parties to clarify the issues. They reported back to the Commissioner who decided to investigate the matter further under section 16(1)(c) of the Environment Act 1986.

NOTE: **This Background Report should be read in conjunction with the Main Report, which contains further details on hydrology, discussion of options, conclusions, and recommendations.**

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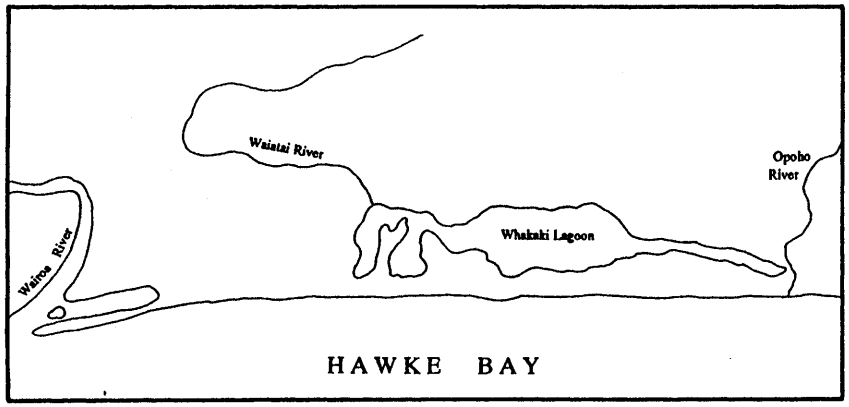
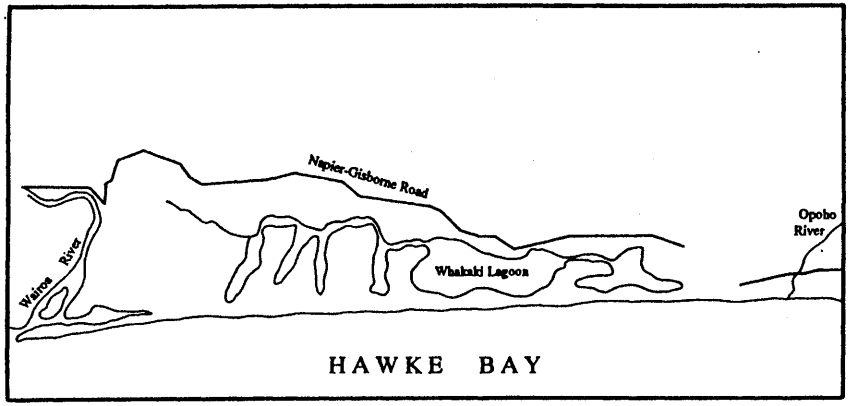
[4] Members of the Working Party consist of the Whakaki Lagoon Trustees (tangata whenua), the Hawke's Bay Regional Council, the Wairoa County Council, the Whakaki Drainage Committee, the Eastern Fish and Game Council, the Department of Conservation, the East Coast Conservation Board and various landowners.

[5] Letter from the Minister for the Environment 9 March 1992. However, a comprehensive catchment plan had already been pursued by the Hawke's Bay Catchment Board in 1980. Despite initial support by all parties, when details of ratepayer contributions became known, the plan was rejected by local landholders, and an attempt by the Wairoa District Council in 1991 to revive the scheme met a similar fate. The principal objection was to the expense and perceived lack of landholder benefit of extensive planting in the wider catchment.



1874



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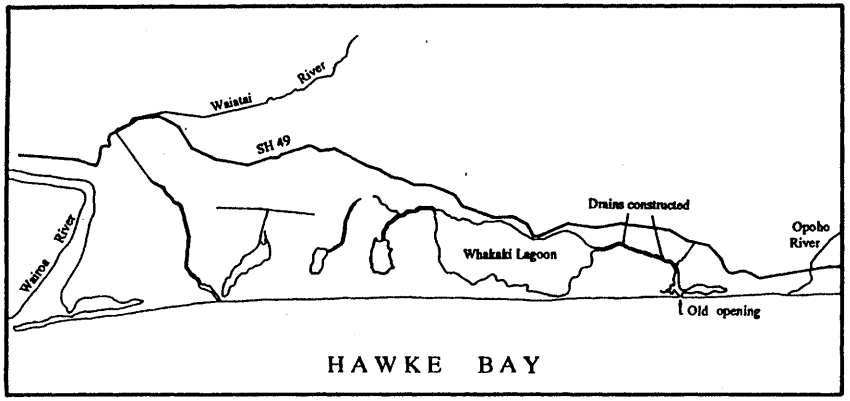

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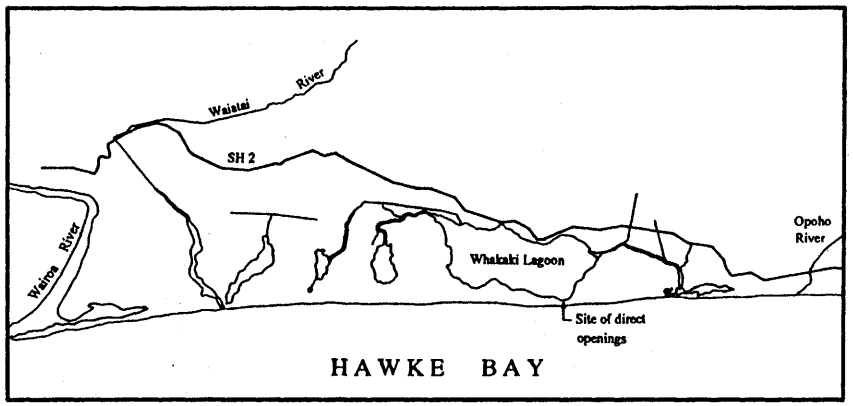
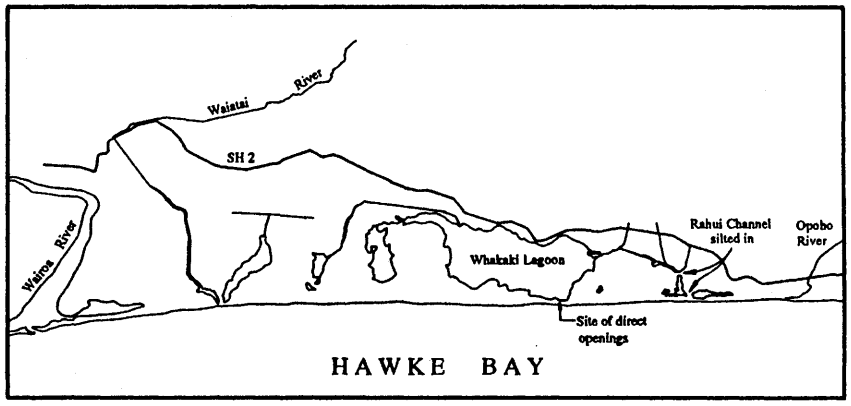


1978



1990

Figure 1: Transformation of coastal wetlands between Wairoa and Opoho Rivers, 1874-1990

Drawn by the Department of Survey and Land Information from maps and aerial photos on record.

Note: **The originals of the 1874 and 1899 maps do not provide detail on smaller streams entering the Whakaki Lagoon system (eg Waikatuku, Ramarama, Tuhara), and the 1899 original provided no information on the location of the Waiatai River at that time.**

Department of Survey & Land Information

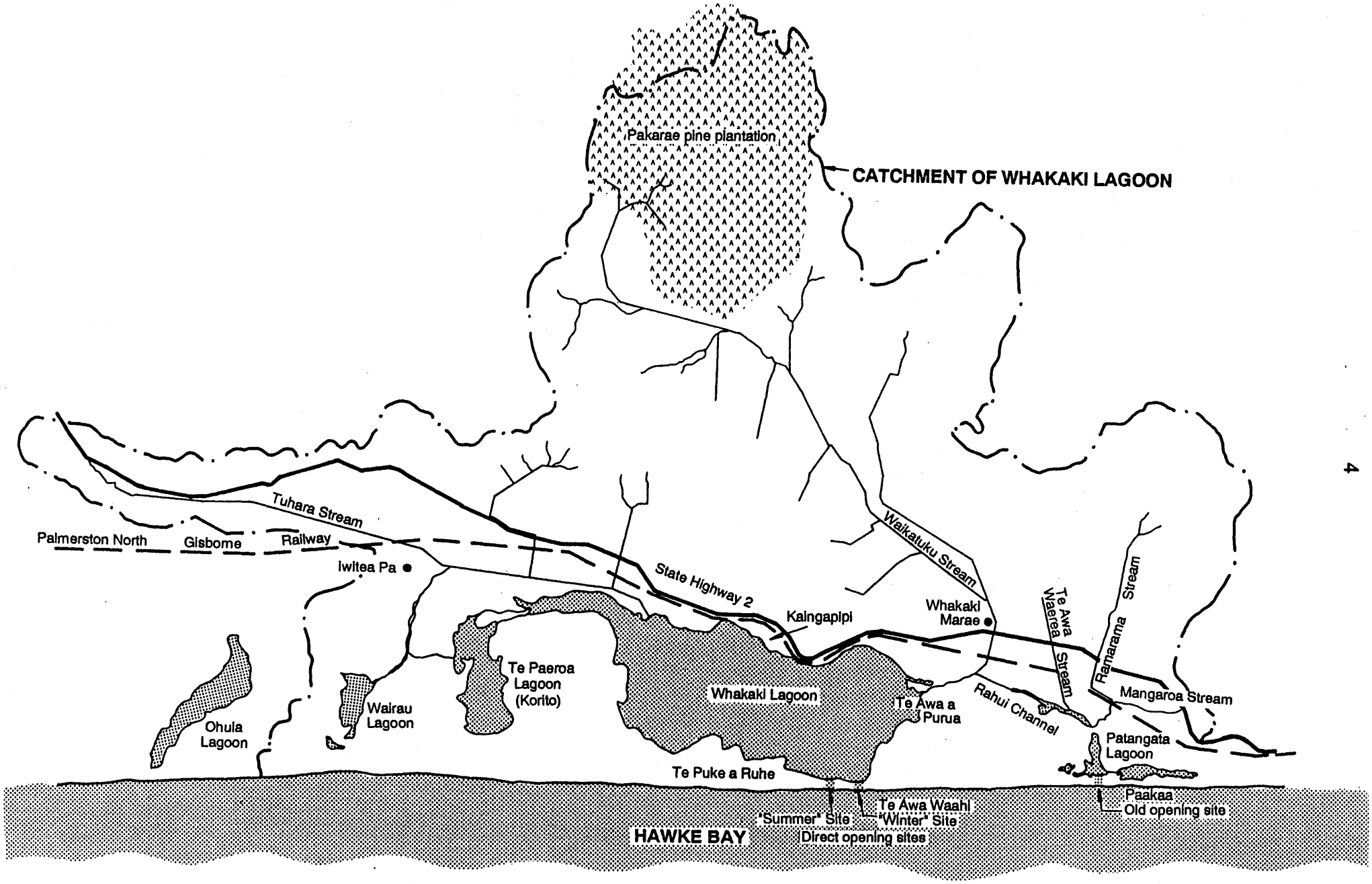


Figure 2: Map of Whakaki Lagoon, showing catchment boundary and major features.

1.1 TERMS OF REFERENCE

The original terms of reference used by the Commissioner to investigate this issue are as follows:

1. Determine whose responsibility it was for the original decision to bypass the Rahui Channel and whether there is still responsibility for its restoration by identifying:

   (a) which parties sought, opened and maintained the direct opening from Whakaki Lagoon to the sea, and when;

   (b) why was the direct opening sought and initiated;

   (c) what was the extent of consultation with affected parties prior to decisions being made.

2. Determine in so far as possible the principal reasons behind the loss of the eel fishery and bird habitat in Whakaki Lagoon by investigating:

   (a) the connection between the changed opening and changes in the physical and biological conditions in the lagoon;

   (b) other contributing factors such as land use changes, wetland drainage, hunting and fishing pressure, and authorisations which allowed these changes.

3. Determine:

   (a) what can be done to restore the old opening to the sea and maintain it as required over time;

   (b) whether and how an eel fishery can be enhanced for the people of Whakaki Marae;

   (c) whether and how habitat can be enhanced for preferred bird species of national significance;

   (d) where the responsibility for the costs should lie.

4. Provide advice to Ministers, agencies, local authorities and other parties as appropriate and report to the House of Representatives.

Information contained in this report was gathered using the original terms of reference. It should be read in conjunction with the Main Report, which uses the information to draw conclusions and make recommendations.

2.0 HISTORY OF LAGOON OPENINGS AND DEVELOPMENTS IN THE WHAKAKI CATCHMENT

This chapter provides information gathered under 1 (a), (b) and (c) of the original Terms of Reference developed for this investigation.

The tangata whenua

In this report "tangata whenua" is used to refer to the owners of the lagoon. The owners are now represented by Trustees established in 1967 under section 438 of the Maori Affairs Act. The Trustees appointed to represent the owners are chaired by Huki Solomon of Whakaki.

2.1 WHO SOUGHT OPENED AND MAINTAINED THE DIRECT OPENING TO THE SEA?

2.1.1 The first direct opening

On 15 August 1956, the *Wairoa Star* published an article entitled "New Outlet for Whakaki Lagoon".

> *"During the week ended July 21, it became necessary to open up the Whakaki Lagoon owing to the high level of the water impounded after the heavy rains which occurred during the previous weekend," said Mr Hawthorne, engineer, when speaking at the monthly meeting of the Wairoa County Council yesterday.*

The article describes a visit made to the lagoon by members of the Ministry of Works, the Soil Conservation and Rivers Control Council, and Hawke's Bay Catchment Board, in conjunction with "several of the settlers".

> *"... it was suggested that an opening of the lagoon in a new location might be more effective and beneficial than the old opening employed during the last year," went on Mr Hawthorne ...*
>
> *It was suggested that the new opening should be made at the narrowest part of the beach from the lagoon and this was subsequently done.*

The article continues to outline the attempts made to achieve an effective opening:

> *"The District Commissioner[6] and myself inspected the opening at this stage and it was agreed that an endeavour should be made to remove the ledge of sand and silt and concentrate the flow of water into a more defined channel and further lower the level of the lagoon. An effort was made by using gelignite to loosen the material and the bulldozers then tried to open the channel. The success of the experiment cannot be seen until the lagoon is again opened."*

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[6] Quoted earlier as being the Resident Engineer of the Ministry of Works.

TABLE 2.1: Contributions to the cost of opening Whakaki Lagoon

DATE	Tangata whenua	Settlers/ Whakaki Drainage Board	Wairoa County Council	Central Gov't: National Roads Board	Central Gov't: SC&RCC ,NWASCA	Hawke's Bay Catchment Board /Regional Council
until 1907	**Full cost**					
1907		2/3[1]	1/3			
1932		2/3[2]	1/3			
1946		1/3	1/3	1/3		
1956 direct opening		1/6	1/6		2/3	
1958-63		1/4	1/4		1/2[3]	
1963-87					1/2	1/2[4]
1987 to present						Full cost[5]

Bold line indicates change from traditional openings via the Rahui Channel to direct openings through the bar.

Notes:

1 Contributions made by tangata whenua after 1907 would have been through rates.

2 Wairoa County Council agrees with proposals from "settlers" to fund more openings. Agree to fund 1:1:1 between settlers, Whakaki Drainage Board and the Council

3 It has been suggested that the National Roads Board made contributions from the late 1950s rather than SC&RCC, but this is not clearly documented in the files.

4 Openings were paid from "shingle royalties".

5 Since the advent of the Resource Management Act 1991, "shingle royalties" were replaced by a resource rental fund. Funding of Whakaki Lagoon opening costs is met by a general fund which includes but is not limited to revenue from resource rentals.

Abbreviations: NWASCA National Water and Soil Conservation Authority
SC&RCC Soil Conservation and Rivers Control Council

A memorandum from the District Commissioner of Works to the Commissioner of Works, dated 14 September 1956, confirms the action that was taken.

> *During the recent visit by the Chief Soil Conservation Engineer an inspection was made of this area and he was shown a possible outlet through a narrow part of the shingle dune where the Lagoon itself could be opened directly to the sea. An opening was excavated at this point shortly after his visit when conditions were favourable and the success of this opening and the rapidity of drainage in the vicinity of the Lagoon has proved to be much better than expected.*

The Whakaki Drainage Board was normally involved in excavation of lagoon openings. However, according to the minutes of the Whakaki Drainage Board, the Board was not aware that excavation was proposed. Members were concerned about the increase in costs likely to be faced by the Board with the new opening regime:

> *Mr Pryde referred to the opening of the Whakaki Lagoon in a new place without reference to the Board, saying that it would be a very costly job.*[7]

Minutes of a later meeting indicate that the new arrangement was made between the Ministry of Works and the Wairoa County Council.[8]

Table 2.1 summarises funding contributions for lagoon openings.

2.1.2 Continuation of openings

The Wairoa County Council and the Whakaki Drainage Board continued to maintain openings at the new site until 1962-63, when the Hawke's Bay Catchment Board took over. (Until 1962, the Wairoa County Council had undertaken the functions of a Catchment Board under the supervision of the Ministry of Works.[9]) The Hawke's Bay Regional Council took over responsibilities from the Catchment Board in 1989.

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7 Whakaki Drainage Board minutes, 26 July 1956.

8 ibid; 29 November 1956.

9 The District Commissioner of Works had tried unsuccessfully for many years to persuade the County Council to join an existing Catchment Board. These proposals were met with opposition because the County perceived that the rates payable to the Board would not be returned to the area. It seems that the District Commissioner felt that the Council was receiving SC&RCC service without the rating normally undertaken by a Catchment Authority:

"The work required in Wairoa County is increasing. We cannot cope with it. The County are doing a job here and there but even those jobs are more or less organised by us.

"If it were possible, I would suggest that we just wipe the place and forget its problems until some satisfactory set-up is developed to handle the situation on an organised basis." District MOW file, 10/12/57.

2.2 WHY WAS THE DIRECT OPENING SOUGHT AND INITIATED?

Although there are written records of planning for a "Whakaki Flood Control Scheme", which involved work on the Waikatuku Stream and the enlarging of culverts under the road and railway line, there is no written record on files located for this investigation of any planning for the excavation of the direct opening site prior to the day it occurred.

Tangata whenua living in the area at the time recall that the Rahui Channel was operating satisfactorily in 1956. However, comments made by other parties indicate that, in their view, the channel was no longer able to provide the kind of drainage they considered appropriate.

During the visit referred to in 2.1:

> *It was mentioned by the settlers that the gradual depositing of silt in the bed of the lagoon near the Patangata inlet has been occurring through successive floods over a long period, had [sic] formed a bar consequently slowing down the runout of the impounded water.*[10]

In a memo to the Commissioner of Works written after the excavation had taken place, the District Commissioner of Works alluded to the inability of the Rahui Channel to remain open long enough to provide the desired amount of drainage:

> *Until recently the Lagoon was opened only when flooding was actually occurring in the settlement of Whakaki. Now the Lagoon is opened whenever there is sufficient head above tide to do so ...*
>
> *In addition, it had been the custom to make the opening for the Lagoon a mile or so to the East of the Lagoon itself and at the seaward end of the outlet channel. The mouth at the end of this channel did give an effective opening when the level of the Lagoon was such as to flood the surrounding low lying country but when the water level was reduced to within the channel limits, the amount of outflow was controlled by the quantity of water that the channel would carry. The result was that at this stage there was not sufficient flow to maintain an opening except under the most favourable circumstances of tide, wind and sea.*[11]

Other information suggests that use of the direct opening site was far more effective that than that at Paakaa: the lowering of water from the Iwitea end of the lagoon could be achieved in only one day, as opposed to three or four days using the Rahui Channel.[12]

A number of factors influenced drainage and flooding in the Whakaki Catchment and the ability of the Rahui Channel to provide the drainage benefits desired by interested parties.

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10 *Wairoa Star*, 15 August 1956.

11 14 September 1956.

12 *Wairoa Star*, 15 August 1956.

2.2.1 Physical factors

Land drainage

The history of land drainage appears to have begun before 1900 and accelerated from about 1945 to 1975. Some of the earliest developments appear to have involved the isolation of various catchments along the coast into separate units. The Waiatai is referred to as having been separated.[13] Figure 1 illustrates the connection between the Waiatai and Whakaki Lagoon before 1900.

In the early 1900s the Maori people of Whakaki are said to have opened the lagoon through the Patangata Lagoon at a place known as Paakaa, though how far the openings were intended to manage fish stocks, actively drain areas of land or control flooding is not clear.

The Whakaki Drainage Board was established in 1911 for the purpose of the construction of drainage works.[14]

While drainage and development of the flat lands surrounding the lagoon took place from the 1920s, the lagoon itself did not seem to have been actively drained to create land for further development.

Aerial photographs taken by the Department of Lands and Survey in 1942 show that the hills in the catchment area of the lagoon were already deforested and developed by the 1940s.

Reports prepared by the Ministry of Works in the 1950s describe the changes that took place in catchments above the eastern end of the lagoon during the 1940s and 50s. When referring to the condition of drains and streams in the area, the point is made that:

> *All these streams were dealt with in a small way many years ago by the Whakaki Drainage Board. That Board's work was successful in that it confined the streams to defined channels and changed the valley bottoms from swampy areas to dry land. At this time the hills and gullies were well bush covered and runoff was moderate. Circumstances are now completely changed. Hillsides are bare of bush, surface slipping is increasing, gullies are eroding, runoff is very high and streams are heavily charged with silt.*[15]

It was at this time that various work was contemplated to address growing problems of flooding at Whakaki.

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[13] District Commissioner to Commissioner of Works, 31 August 1955.

[14] Establishment of the Board was authorised by the Wairoa County Council under Section 167 of the Counties Act.

[15] District Commissioner of Works to Commissioner of Works, 31 August 1955.

The main highway

The main highway was built before 1900. By the 1950s, the Ministry of Works became concerned over the effects of flooding on the road which had virtually sunk below the level of the surrounding lands. During the early 1950s, work was undertaken to raise it.

The effect of the raised road on Whakaki village was reported.

> *The Ministry of Works is now in the process of raising the road formation to the original ground surface. Ample culvert space has been provided for the three small streams, but these culverts are ineffective until the stream channels are cleared, as culvert inverts are much below stream bottoms. This tends to make flooding worse on the upper side of the highway as less water can now pass over the new formation. Moreover, it is not quite practicable to provide water area in these culverts for flood waters from the Hereheretau Stream. This may cause backing up and longer periods of flooding above the highway.*[16]

The Wairoa County Council minutes indicate that severe floods in Whakaki were caused "entirely by the raising of the State Highway through the village without the provision of sufficient culverts to allow the water to get away". [17]

By the mid 1950s, the problems of flooding in the Whakaki area led to the development by the Ministry of Works of a flood control programme, concentrating on improvements to the channels of the streams Te Awa Waerea, Te Mangaroa, Ramarama and Waikatuku (also known as Hereheretau). The work involved stopbanking, developing an increased waterway for the road bridge and the removal of buildings in the village. Funding was shared between the National Roads Board, the SC&RCC and locals (3:2:1). Local Maori raised £5000 towards the scheme through the Maori Trustee, and repayments were shared between the people of Ohuia, Iwitea and Whakaki. The Maori loan was to be collected by the County Council as if it were a rate. [18]

Railway

The Wairoa-Waikokopu line was opened in February 1923. It was built and managed by the Public Works Department until 1 July 1939, when it was handed over to the New Zealand Rail.

Little information on the railway is available. The references that have been found refer to the need for culverts to be enlarged and drains cleared to minimise flooding. In 1941, the Country Engineer reported:

> *I have been reliably informed by settlers in this district that flooding such as occurred on Thursday the 28 August was unheard of prior to the formation of the railway embankment. Flood conditions occur several times a year at Whakaki and the*

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[16] District Commissioner of Works to Commissioner of Works, 31 August 1955.

[17] WCC minute book, meeting of 5 June 1956.

[18] Report of Judge Smith of the Maori Land Court, 6/3/57.

position is very serious from the fact that many large families derive a living on the Whakaki flats and children often have to wade to and from school.[19]

The only other reference is made during the development of proposals for the Waikatuku works in the 1950s. New Zealand Rail refused to fund the extension of the railway bridge, and it appears that the work was funded from the National Roads Board contribution.

It seems that the railway, rather than requiring protection from flooding, contributed to flooding instead.

2.2.2 Aspirations of interested parties

Much of the information available, both on files and from anecdotal sources, indicates that as far as drainage and flood control in the 1950s is concerned, interested parties had different aspirations.

The Wairoa County Council

It is clear from records of County Council minutes that the Council was concerned about flooding in Whakaki. Minutes of a meeting held on 5 June 1956 refer to the serious flooding in Whakaki:

This was caused entirely by the raising of the State Highway through the village without the provision of sufficient culverts to allow the water to get away. In the past, and before the road was raised, flood waters used to flow over the road. This could not now happen with the result that houses on the inland side of the highway, never flooded in living memory, had suffered considerable loss through water getting into them. Council approved the resolution "that the Chairman communicate by telephone with the District Commissioner of Works, Napier, and request him to take immediate steps to alleviate the flooding at Whakaki caused by the raising of the State Highway, even if it necessitates lowering of the road."[20]

The Ministry of Works

The District Commissioner of Works recognised the need to address flooding problems at Whakaki. Plans had already been put in place to undertake minor works on the three streams (Ramarama, Mangaroa, Te Awa Waera) and to design a more major scheme for the Waikatuku.

Nevertheless, in the eyes of the District Commissioner, further land drainage and development should be the prime objective of the general works being undertaken. In a file note, he outlines progress on the "Whakaki Flood Control Scheme".

The final stage would also include some permanent arrangement for maintaining a

---

[19] County Engineer's report, 10 September 1941.

[20] Wairoa County Council Minute Book, 5 June 1956.

low level in Whakaki Lagoon.

... This would result in large areas of first class land on the verges of the lagoon coming into production. It should be the ultimate objective in the whole scheme.[21]

However, even at this stage, a new opening regime was not contemplated:

I believe that for the purposes of the scheme outlined above, that is, dealing with the four streams and preventing flooding in Whakaki, the present method of opening the lagoon mouth by tractor will give satisfactory results but it will require more frequent opening to maintain the lowest possible level. It would be advisable to have a suitable tractor reasonably available to clear the mouth at short notice to take advantage of weather and sea conditions.[22]

Nevertheless, by September 1956, the District Commissioner's comments about the ineffectiveness of the Rahui Channel indicate that in his view, the direct opening provided a more effective way of maintaining low lagoon levels.[23]

Contributions to the funding of openings at the direct site both before and after excavation provide some insight as to how the District Commissioner assessed the benefits of the bypass opening.

Documentation on the Works file indicates that from 1946 to 1956, the costs of openings were shared 1:1:1 between the National Roads Board, Wairoa County Council and the Whakaki Drainage Board. After the direct opening was made, costs rose. This was due to a number of factors including the cost of excavating the layer of fine mud and the increased frequency of openings. The increased frequency alone would have led to a rise in costs, regardless of the site.

In his memo to the Commissioner of Works,[24] the District Commissioner states:

At present the only subsidy received by the County Council and the Whakaki Drainage Board is 1:2 from the National Roads Board. I would recommend that this subsidy be increased to 2:1. Perhaps the National Roads Board might continue to contribute at the present rate and the S.C. Council might consider a similar amount, and the annual total might be increased from the present sum of £100 to, say, £300.

The District Commissioner's recommendation indicates that protection of the road, Whakaki village and surrounding farmland were all factors to be taken into account in the management of any opening regime. It also suggests that the National Roads Board was not a party to any discussions about the costs or practicalities of the new opening regime (involving both site and frequency) until after the direct opening had been made. Nevertheless, the District Commissioner represented the Roads Board at the District level.

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21 District Ministry of Works file, 21 May 1956.

22 ibid.

23 District Commissioner to the Commissioner of Works, 14 September 1956.

24 ibid.

In the view of the Secretary of the National Roads Board, the road received little benefit from the opening regime post July 1956:

> *So far as I am aware, high floods in the lagoon will not detrimentally affect the improved highway neither will they interfere with traffic. Therefore I cannot recommend any continuation of any subsidy from NRB. (Secretary of the NRB, unknown signature, 4/10/56).*[25]

The SC&RCC Engineer thus recommended to the SC&RCC:

> *In order to obtain full benefit from improvements to streams feeding into Whakaki Lagoon the Whakaki Drainage Board wish to artificially open the outlet to the sea more frequently than has been the practice in the past. This will maintain the lagoon at a lower level, improve drainage on several hundred acres of low flats, and will also benefit the State Highway.*
>
> *Previously the openings cost about £100 per annum and the Whakaki Drainage Board received a 1:2 subsidy from the National Roads Board, because of the benefit to the Highway. It is estimated that the more frequent openings will cost approximately £300 per annum.*
>
> *It is recommended that the Council approve a 2:1 subsidy on £300 each year towards the cost of opening the lagoon.*
>
> *It is not recommended that the National Roads Board be asked to continue contributing towards the cost of opening the lagoon as approving of funds for river and drainage works is primarily the function of the Council.*

The subsidy was granted on 16 October 1956.[26]

Other sources document the District Commissioner's views:

> *The Commissioner pointed out that water flooding farmland had to be controlled, and investigations were being made in this direction. With the new opening at the lagoon, water from the catchment area above Whakaki, and also water from the Tuhara drain and the Ohuia area, could be led into this outlet and out to the sea without delay.*[27]

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[25] Handwritten comment on memo from District Commissioner of Works to Commissioner of Works, 14 September 1956.

[26] It appears that the 2:1 subsidy granted by the SC&RCC in 1956 was more than that normally granted for the type of work involved.

In 1958, the Ministry of Works advised the Wairoa County Council that subsidies for lagoon openings would be reduced to 1:1. The County considered that a higher subsidy was justified as "a new opening had been made at the request of the Ministry of Works, and also to prevent the flooding of the State Highway the lagoon was opened more frequently involving the Council in considerably more expense." It was for the above reason that the 2:1 subsidy had been granted. The Ministry reported that if the repeated openings proved to be a burden, a case could be made for further funding.

[27] *Gisborne Herald*, 15 December 1956.

The tangata whenua

Attitudes to drainage and development

In the early 1900s, waters from the lagoon were let out periodically by Maori people from Whakaki. The purpose of doing so is not clear. It was not until 1907 that openings began to be undertaken and funded by the Whakaki Drainage Board and the Wairoa County Council.

It is understood that land at the eastern end of Whakaki, which was and still is predominantly Maori land, was farmed for barley in the 1920s, apparently resulting in "bumper crops" which won prizes.[28]

In the 1920s and 30s representations were made by local landowners to MPs, Ministers and Government departments to promote drainage and land development schemes. For example:

> *I believe it is the desire of yourself and the Government to increase production to the highest point possible and to this end intend to take in hand the development of areas of land which are not at present producing to full capacity. This policy is to be highly commended. I desire to draw your attention to an area in the Wairoa County known as the Whakaki Lagoon area. It is the considered opinion of all local Public Bodies and many capable farmers that an area of approximately 4,000 acres can be brought into production by proper drainage at a reasonable cost.*[29]

However, the attitude of the tangata whenua was commented upon in response to the above representations:

> *... it appears that strong opposition to the drainage of the lagoon will come from the Natives on the grounds that their food supply, in the way of eels, carp etc., will be lost to them.*[30]

It is not until the mid to late 1940s that references to active development and drainage of the lower lying Maori land can be found. In 1945, Turi [A.T.] Carroll agreed to arrange meetings with Maori owners to look again at the question of drainage.[31] In 1946, the Minister of Maori Affairs promoted a plan for the drainage of Whakaki. The scheme was included by the Native Department in a 10-year programme. It was recognised that the agreement of Maori owners would need to be sought as there was some debate amongst them as to whether fishing or farming should be the prime source of livelihood in the area:

> *... the general question of drainage has been discussed with the Native Department ... They agree that there is some conflict of opinion among the natives as to use of the lagoon for farming or fishing purposes, but the Department informs me that the natives are of majority opinion in favour of drainage of the lagoon and development as farm land. That Department will accept the responsibility of obtaining agreement*

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28 J. Jardine, pers. comm., 14/10/92.

29 Mr P. J. O'Kane to the Minister of Lands, the Hon F. Langstone, 2 October 1939.

30 Under-Secretary of Lands and Survey to the Permanent Head, Public Works Department (12 October 1939).

31 *Wairoa Star*, 1945.

with the owners ... the Prime Minister is interested in this proposal and the examination and survey should proceed on the assumption that owners are agreeable to drainage and with the question of finance still to be determined.[32]

Information obtained from tangata whenua indicates that the issue was never clear. Although there was debate amongst tangata whenua, total drainage of the lagoon was never contemplated.

In 1952, the Ministry of Works reactivated proposals for the survey of a major drainage scheme for Whakaki. The Department of Maori Affairs was asked if it wished to proceed; however, it advised that it would not be able to fund work for a major scheme.[33]

Around this time, the owners of the lagoon prepared submissions stating their strong opposition to the Department's proposals to drain and develop the area. In 1951, a "Memorial of Dissent" addressed to the Department of Maori Affairs had been prepared. The concerns expressed were:

1. the likely cost to the owners of increased rates which would result from the cost of a scheme, the success of which, in their view, could not be assured;

2. the potential loss to the owners of their traditional food supplies;

3. the likelihood that due to the large catchment area, the land would still flood with more water than any proposed pumping scheme could cope with.[34]

Attitudes to flooding

Tangata whenua recall that in the 1950s, those living at Whakaki recognised the need to address the flooding problems created by the raised road and catchment changes. At that time, Whakaki was the first area to flood.[35]

The houses of some residents were flooded, so that immediate relief was sought. For example, the week before the direct opening was made, Sam Smith, a Whakaki resident, wrote to the District Commissioner of Works requesting assistance following severe flooding in Whakaki.[36] The Commissioner acknowledged that relevant culverts should be cleared to enable water to escape more quickly.[37]

On 27 April 1955, a meeting was held in Whakaki to discuss flooding and drainage problems. It was chaired by the Chairman of the Wairoa County Council, Mr A.T. Carroll.

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[32] Engineer in Chief to the District Engineer, Public Works Dept. Napier.

[33] The Department of Maori Affairs could only provide finances for developments proposed under Part I of the Maori Land Amendment Act 1936.

[34] Copy of submission addressed to the Department of Maori Affairs, 1951. Provided by Lake Trustees.

[35] H. Solomon, J. Smith, pers. comm., 13/10/92.

[36] Ministry of Works, District Office file. The solution suggested by the District Commissioner involved the possible raising of his house by at least a foot.

[37] Ministry of Works, District Office file, 27 July 1956.

This was at about the same time that proposals for the Whakaki Flood Control Scheme, to which tangata whenua contributed, were being developed.

> *Mr Purua Solomon explained the purpose of the meeting saying that at least three meetings had been held to his knowledge in connection with the drainage of the Whakaki area in 1926, 1945 and 1954. At first the older people had objected to a major drainage scheme being embarked upon. Now, however, there was no such objection as was shown by the meeting last year when an undertaking to that effect was given, the Maori people agreeing to find their share of the cost. It now remained for the survey to be carried out and as (sic) estimate of the cost prepared. In view of the recent flooding, this has become a matter of extreme urgency.*
>
> *Several other people spoke and it was eventually agreed unanimously that the only final solution of the drainage problem was the major scheme to keep the lagoon at summer level all the year. At the same time no overlooking the fact that there were insufficient culverts under the highway and railway.* [38]

It is not clear which scheme is being referred to.

At the close of the meeting, it was proposed that:

> *"... this meeting authorises the County Council to ask various interested Ministers of the Crown, Members of Parliament and others to visit Wairoa in order to go into the question of the flooding of the coastal areas of the Wairoa County from Ohuia to Mahia."*

In a note to C. G. E. Harker, the local MP, the County Clerk suggested that "the possibility of immediate relief being given to the people whose properties are being flooded should be given every consideration". The note accompanied a copy of minutes of the meeting held at Whakaki on 27 April 1955.

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[38] Copy of minutes on Ministry of Works file (Head Office).

2.3 THE EXTENT OF CONSULTATION WITH AFFECTED PARTIES

The sources referred to in 2.1 and 2.2 suggest that consultation between staff of the Ministry of Works, the Hawke's Bay Catchment Board and the Wairoa County Council and "settlers" took place during the visit of July 1956. The Whakaki Drainage Board did not appear to have been involved or consulted.[39] Prior to July 1956, there is no reference to a period of consideration in which advantages and disadvantages might have been weighed, or of consultation with the owners of the lagoon.

2.3.1 Consultation with tangata whenua

As information in the section 2.2 shows, consultation between the Ministry of Works, the Wairoa County Council and the tangata whenua took place to address flooding problems in Whakaki and to determine how a Whakaki Flood Control Scheme might be implemented. However, there is no written report of any consultation taking place over the opening site. The only written record of any discussions about the opening site is that contained in the *Wairoa Star*.[40]

On 1 March 1957, the District Commissioner indicated that, in his view, the tangata whenua could see the advantages of the post July 1956 opening regime, including efforts to continue to excavate below the mud layer:

> *In discussion of this proposal with Mr Acheson [Chief Engineer, SC&RCC] he was rather anxious about effective drainage of this lagoon in relation to fish food for Maoris. I would explain that the lagoon is now dry and not enough water remains to float the thousands of ducks which make their homes there but this is exceptional - it is about 2 feet lower than my proposed channel would be effective.*[41] *It is due to the low level before the dry spell and very high evaporation since. The Maori are quite happy. The question of possible loss of fish food was discussed with the Maori Tribal Chiefs, Elders and Tribal Committees and all are agreed that this is now unimportant, especially in view of the other advantages accruing to them from improved land drainage and this is recorded in the record of our meetings.*[42]

Nevertheless, tangata whenua recall that in discussions with Ministry of Works staff at meetings held at Whakaki before the direct opening was excavated, promises were made that summer lagoon levels would be maintained.[43]

While tangata whenua and other residents of the area were clearly affected by flooding, tangata whenua living in the area at that time recall that their pakeke were never happy with the idea of a direct opening to the sea. Purua Solomon, who at that time would give the final go-ahead to the Wairoa County Council regarding openings at Paakaa, was consulted about the new site prior to excavation. However, tangata whenua recall that no other options were

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39 Whakaki Drainage Board minutes, meeting of 26 July 1956.

40 15 August 1956.

41 The District Commissioner's proposal was to obtain extra subsidy to help meet the costs, of excavating a channel through the mud silt layer that formed a natural barrier in the sand bar.

42 Memo to the Commissioner of Works.

43 H. Solomon, pers. comm., Whakaki, 12 August 1992.

discussed and Purua Solomon felt he had no choice but to agree, at least on the understanding that Whakaki Lagoon would not ultimately be threatened.[44]

From the time the direct opening was made, Purua Solomon lost his role in decision-making regarding lagoon openings. Indeed, it is only recently that tangata whenua have been told of lagoon openings, and they have been notified rather than consulted.[45]

Assuming it was agreed between the tangata whenua, Wairoa County Council and the Ministry of Works that the lagoon was to be kept at summer levels all year round, and assuming that in summer the lagoon was not normally dry, then the District Commissioner's reference to a "dry" lagoon indicates that the opening regime had gone beyond what was originally envisaged and that a clear breach of promises, as understood by tangata whenua, was made.

Permissions that were required in 1956

The powers granted to the Wairoa County Council for drainage works under the Counties Act 1920, the Land Drainage Act 1908 and the Public Works Act 1928 all suggest that there was little required in the way of permissions from the lagoon owners.

2.4 THE NEW OPENING AS A PROBLEM

The following information helps to provide an understanding of the context in which difficulties with lagoon openings at the present site became apparent.

2.4.1 The 1960-70s environment

The Hawke's Bay Catchment Board took over the responsibility for lagoon openings from 1962-63. Material on files indicates that the Catchment Board, with the assistance of subsidies from the SC&RCC, took an active role in encouraging further development in the Whakaki Catchment area. For example, by 1966 it had became involved in proposals for further drainage and flood control works at Ohuia and other lands closer to the western end of Whakaki Lagoon. Approvals for subsidies were sought by the Board from the SC&RCC:[46]

> *Ohuia Block of 3428 acres is an incorporated Block and is being supervised by the Department of Maori Affairs.*

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[44] H. Solomon and J. Smith pers. comm., 13/10/92.

[45] pers. comm., H. Solomon and J. Smith, 13/10/92.

[46] 1:1 on drainage work and 2:1 on flood control.

> *The adjoining blocks (Te Wairau, Whakaki*[47] *etc) covering some 2000 acres are incorporated but as yet are not under Maori Affairs supervision.*
>
> *It is hoped that through the Department of Maori Affairs, suitable arrangements can be made to ensure the payment of rates, both for construction and future maintenance.*[48]

Approvals in principle were given by the SC&RCC in December 1966, and were dependent on more specific proposals.

The Hawke's Bay Catchment Board continued to encourage drainage works into the 1970s:

> *Any financial assistance which can be given by way of grant and/or subsidy towards the drainage scheme should be used in these developmental projects and this Board will do all it can through the Department of Maori Affairs to encourage such work".*[49]

No reference has been found on files to the siting of the direct opening of the lagoon as a problem until the 1970s. While parties who have asked for this investigation claim that the Ministry of Works blasted through the hard pan in the 1970s, there is no written reference to the use of explosives aside from those made in relation to the first direct opening in 1956.[50]

2.4.2 The assertion of non-farming interests

On 12 February 1975, a telegram was sent by H. Solomon (Lake Committee), R. Mayo (President, Rod and Gun), Sir Turi Carroll (Chairman, Tairawhiti Council) and R. Paku (Councillor) to Hon H. Watt, Parliament Buildings:

> RE WHAKAKI LAGOON CATCHMENT BOARD HAVE ACTED CONTRARY TO PREVIOUS AGREEMENTS AND HAVE OPENED WRONG OUTLET TO SEA CAUSING COMPLETE DRAINAGE. CONSERVATOR OF WILD LIFE AND OWNERS ARE VERY CONCERNED ABOUT FATE OF ABUNDANT YOUNG WILD FOWL CURRENTLY ON LAGOON AND FARMERS ARE ALSO CONCERNED AS THERE WILL BE NO WATER FOR STOCK. HAVE REQUESTED ENGINEER NAPIER TO BLOCK AT REASONABLE LEVEL WITHOUT SUCCESS. PLEASE INVESTIGATE URGENTLY.

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47 Most likely refers to lands owned by the Whakaki 2N Incorporation at the western end of Whakaki Lagoon.

48 Memo from Chief Engineer to Secretary, SC&RCC.

49 Chief Engineer of HBCB to Director, Water and Soil Division, MOW re works at Ohuia, 16 March 1973.

50 *Wairoa Star*, 15 August 1956; memos from the District Commissioner to the Commissioner of Works, 1956.

What was the nature of "previous agreements" and who were they with?

Tangata whenua advise that by the 1970s, they were becoming concerned about the effects on the lagoon of openings through the direct site.

Consequently, both they and other supporters, such as the Wildlife Service and the Wairoa Rod and Gun Club, made efforts to obtain the agreement of the Catchment Board to return lagoon openings to the former site at Paakaa.[51] Both were concerned at the low levels of water, which affected the plant communities fed upon by some bird species, particularly swans.

The earliest approach on record is a letter to the Catchment Board from the Conservator of Wildlife, expressing concern over the effects of low lagoon levels and salination on wildlife.[52]

From February 1974, meetings were held to discuss the issue. At a meeting held at Whakaki Hall on 17 April 1974 various problems were raised including siltation and low lagoon levels. It was noted that undertakings had been given to retain the lagoon at summer levels.[53] It was recognised that there were a range of interests affected by different lagoon levels, including farming and shooting. Representations were made by letter on behalf of the Whakaki 2 N Incorporation, which favoured the retention of the direct opening as it provided better drainage for farm land than the old site at Paakaa.[54] The issue of the rights of the tangata whenua is not a strong theme in the records of the time.

Two openings through the Paakaa outlet were attempted: the first on 4 February 1975, the second on 29 April 1976.[55] A works report from the Catchment Board, dated 21 February 1975, outlines the first attempt:

> *Following unseasonable rain in January the Whakaki Lagoon rose to a level of 5.1 ft on 31 January 1975. As part of the undertaking to the Wildlife Division of the Internal Affairs Department, the board excavated an opening through the beach at the old (eastern end) opening site in an attempt to overcome the problem to wildlife on the lagoon. This opening was made on the 4th February, and as a result, a good mouth developed. Mid-morning of the 5th February the lagoon had dropped to 3.75 ft. However at this stage there was very little outflow due to the channel siltation at the mouth of the Waituku Stream. The increase in sea activity during the following two days completely closed the opening (approximately 40m wide) to a height of 4ft. to 5ft. By this time inflow into the lagoon from tributary streams had raised the level to 4.1 ft.*
>
> *At this stage a decision had to be made on the locality of another opening and after*

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51 Conservator of Wildlife, Wildlife Service, to Chief Engineer, HBCB, 12 December 1973; President of Wairoa Rod and Gun Club to the HBCB, undated.

52 12 December 1973.

53 Minutes of meeting at Whakaki, 17 April 1974.

54 L. Robinson to the Chair of the meeting, 10 April 1974.

55 "Precis of Whakaki Lagoon", Wildlife Service (unknown author), 21 February 1978, papers provided by Lake Trustees.

> *full consideration it was decided to make a new opening at the normal site directly into the sea. However, due to sea conditions this was not completed until late afternoon of the 11th February and this resulted in a very good opening, completely emptying the lagoon.*

The telegram of 12 February 1975 protests at the effects of this particular opening.

The works report continues to point out that the Board

> *has fulfilled its obligation to the Internal Affairs Department and the local wildlife interests by opening the lagoon at the old (eastern) site. There was never any guarantee of success given to openings at this site, and the Board in its obligation to provide drainage to the area surrounding the lagoon and to facilitate the completion of the Tuhara Stream reconstruction reverted to the site that had proven successful for more than a decade.*

The report makes reference to a Ministerial inquiry into the wildlife aspects of the lagoon and states that until a report is received, the lagoon should be opened at the site directly into the sea as required.

Some information is unclear. It seems that at a public meeting held on 31 April 1974 it was agreed that the lagoon should be released from the direct site in the "wetter months" with openings taking place at the old site before summer.[56]

Letters on the Catchment Board files suggest that there was no clear understanding or process set in place to continue with lagoon openings at either site. It also seems that tangata whenua had little if any involvement in decisions to open the lagoon as the following extract shows:

> *This last time the opening was carried out while I was at Lake Waikaremoana and I was told that it had been opened two days prior by the local engineer ... I told him that this was contrary to what was decided at the meeting and I was concerned that this had been carried out. I said that the Maori people would not take this lightly etc. He said he could not worry about what they or anybody else thought his only concern was to empty the lagoon and as nobody had come up with a decision or any money he intended opening it at the usual [direct] outlet as long as he desired.*[57]

At this time, it is clear that the authority to make final decisions was firmly in the hands of the Catchment Board. Furthermore, there does not appear to have been any suggestion that the Whakaki Lagoon Trustees were regarded as anything other than one of a number of interest groups:

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[56] Commissioner of Works to Wildlife Service, 6 August 1975.

[57] Field Officer to the Conservator of Wildlife, Rotorua, 1 July 1975.

The Board must ascertain the requirements of all interested parties but it would then appear to be a technical matter for the board to design the best technical solution.[58]

In the view of tangata whenua, the Catchment Board went along with the idea of attempting openings at the old site, but was never serious about returning the openings to Paakaa permanent basis.[59]

By November 1975, the Board had clarified its approach to the matter by proposing to develop a catchment plan. The Chief Engineer pointed out that "the Board is most anxious to find a permanent solution to the many problems surrounding the Whakaki Lagoon." [60] He recommended that agreement by all parties to opening of the lagoon directly to the sea until December 1977 be obtained,[61] while the SC&RCC was asked to consider a catchment control scheme incorporating:

1. Whakaki Lagoon water level control;
2. soil conservation measures in the hill catchments;
3. a comprehensive channel reconstruction programme;
4. adequate provision for maintenance of all works including channels, lagoon openings and soil conservation;
5. a $3 for $1 subsidy plus a grant to cover half the local share for a suitably conceived and designed comprehensive scheme with good local support.

As proposals were developed by the Board, dissatisfaction continued to be expressed about the Board's consultation with interested parties:

I am not disputing the necessity for lowering during periods of excessive wet weather and bearing in mind the need to activate such an operation during the ideal marine conditions. I had hoped, however, that as a result of previous discussions between our respective organisations and other agencies, that some progress would be made in the overall situation on this lagoon, such as a change in the location of the cut [to Paakaa] and better consultation at a local level.[62]

Tangata whenua continued to push for a return of openings to the old site:

The deterioration of the lagoon as a wild life area is not the only problem which confronts the residents of Whakaki, the silting of the mouth of the river entering the lake is increasing rapidly year by year and we fear that if the opening is left where it is the flood waters which plagued us from time to time will not be sufficiently reduced to give relief ...

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58 Letter from Minister of Works to Minister of Lands (4 August 1975), minuted to the Chairman of the "Lake Trustees" by the Minister of Maori Affairs.

59 pers. comm., H. Solomon and J. Smith, 13/10/92.

60 Chief Engineer, HBCB to District Commissioner of Works, Napier, 7 November 1975.

61 In the view of the Board, it was necessary to ensure that the lagoon continued to be opened at the direct site, drains should be maintained and soil conservation encouraged on a farm basis. Anything less would result in a "rapid degeneration of the whole area".

62 Conservator of Wildlife to Chief Engineer, HBCB, 12 January 1976.

We believe that if notice had been taken of the warnings given by us earlier, this situation would not have arisen, the flow of water to the old bar would have scoured out the build-up of silt and flushed out the whole river system.

... we beg your Board to consider the proposal we have given your engineers and Board members, which is in essence to return the opening to the old bar. Considerable excavation will have to be undertaken to cut a channel through the silt bank and widening the river at the mouth of the Waituku Stream ...

We realise that the level of the water may have to be increased before opening and it could take from 24 to 48 hours longer to lower. This we feel is the price we have to pay, if we wish to retain at least part of our heritage.[63]

At about the time the above letter was written, the Lagoon Trustees offered to contribute a substantial proportion of the costs of excavating the delta which had formed at the entrance of the Rahui Stream into the lagoon.[64]

A catchment plan proposal was finally prepared and approval in principle given at a public meeting on 5 December 1979. It involved:

1. excavation of the old outlet through the Patangata Lagoon;
2. work on the two main catchments (Waituku and Tuhara);
3. soil conservation work.

The scheme was estimated to cost $400,000 which would be spread over a five-year period. It was hoped that a 3:1 grant would be obtained.[65] The Board was to report back on further cost implications.

On 6 August 1980, the scheme was rejected unanimously because of the high costs.[66] All interests including the tangata whenua were involved in the decision.

2.4.3 Recent attempts to address the problem

In the early 1980s the Catchment Board developed a plan to excavate the Rahui Channel and seek funds from both NWASCA (60% of half the total cost), and the Wildlife Service (Department of Internal Affairs: half the total cost)[67]. The proposal was intended to be implemented in conjunction with the application by the Trustees of Whakaki Lagoon for a right to discharge water through the Rahui Channel.[68]

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[63] Whakaki Lake Committee to the Secretary, HBCB, 26 June 1976.

[64] Noted in a summary of events, written by staff of the Wildlife Service, 21 February 1978 (paper provided by Lagoon Trustees).

[65] Minutes of meeting of interested parties, Wairoa, 5 December 1979.

[66] A similar proposal was rejected in June 1992.

[67] The estimated cost in 1984 was $426,000.

[68] Initially, the Catchment Board approached the Whakaki Drainage Board and later the Wildlife Service to apply for the water right. Both declined. The Trustees were considered the most appropriate and affected party to apply for the right. In his submission on the hearing, the Conservator of Wildlife pointed out that "*the grant of a right to the applicant would, in effect, formally authorise the Catchment*

The Trustees were granted a water right in 1982.[69] One of the conditions of the right was that the Hawke's Bay Catchment Board (now the Regional Council) have the right to continue discharging through the direct opening until funding to excavate the Rahui Channel could be found. This continues to be the case under the current water right, which expires in May 1995.

A practical problem with the direct opening has been the difficulty of controlling the minimum level set by the water right. The Catchment Board and the present Regional Council appear to have paid more attention to maximum rather than minimum levels. However, in the last year, in an attempt to ensure that minimum levels are maintained, the Council is using only one of two direct openings. The "winter site" (Te Awa Waahi - see map in main report) is no longer used because the sill has been blasted and eroded to the extent that the lagoon drains completely when opened. While a sill exists on the "summer site", it too is in danger of scouring.

The proposal to excavate the Rahui Channel did not proceed because the contribution from the Wildlife Service of the Department of Internal Affairs did not eventuate before the Wildlife Service was disestablished.

An application for funding was made to the Minister for the Environment by the Whakaki Lagoon Working Party in December 1991. The proposal was declined in March 1992 by the Minister, who suggested that a regional plan be developed by all interested parties, setting out objectives for the catchment. The Minister indicated that he would be prepared to consider a further proposal providing there is sufficient national interest.

Board to exercise its existing power to control levels and discharges, but within mutually acceptable limits to be established as conditions of the right. " He also pointed out that one of the uses for which the application was made was the "*production of waterfowl and eels. While a right was not needed for this use, the granting of a formal right would validate the use of waters and establish its importance relative to other uses*" (28/9/82).

[69] Levels were set separately by NWASCA on 1/9/86 - max. = R.L. 11.8 and min. = 10.5, set by NWASCA on 1/9/86. The water right to discharge through the Rahui Channel was first approved in November 1982. It expires in May 1995.

TABLE 2.2 SUMMARY OF EVENTS RELATING TO MANAGEMENT OF WHAKAKI LAGOON EARLY 1900s TO 1980s

Time	Public Works/ Ministry of Works	Catchment Board/ Regional Council	Wairoa County Council/Whakaki Drainage Board	Tangata whenua	Other
Early 1900 - 1930s	1920-30s: Proposals to drain and develop Whakaki area.		1906: County Council declines to fund openings as they "affect natives only". 1908: Arrangements made for the County to fund 1/3 share of costs of opening. Engineer to make arrangements to let waters out when necessary. 1911: WDB established. 1932: WCC agrees with proposals from settlers (Taylor, Pryde, Te Rito) to fund more frequent openings. Normally WCC and WDB share costs (1:1) but openings not frequent enough to prevent flooding. Agree to share costs settlers/WCC/WDB (1:1:1).	Openings of lagoon with horse and scoop. 1920s - 30s: Opposition from tangata whenua to proposals for drainage and development. Concern for food supplies.	1930s: Proposals through the Dept. of Lands and Survey/Public Works for drainage and land development.

Time	Public Works/ Ministry of Works	Catchment Board/ Regional Council	Wairoa County Council/ Whakaki Drainage Board	Tangata whenua	Other
1940s	1946: Minister of Works includes drainage project in 10-year section of National Programme of Works. To be investigated further in conjunction with the Native Department. Ministry expresses doubts about success unless Native Dept. can persuade Maori owners to participate. 1946: Proposal from WCC re. cost of openings passed to Main Highway's Board. Approval of 1/3 share. District Office lack resources to do major survey for scheme. 1949: Cabinet approves finance for Ohuia: 1:1 (drainage), 2:1 (flood and river control).		August 1940: WCC (through Chairman T. Carroll) encourages local Maori to contribute to funding of openings. Assurance given that rates collected would be spent in the area (reported in Wairoa Star). 1946: WCC request Works to contribute to cost of openings because of benefits to highway. Suggested 1:1:1 (Works/WCC/WDB). 1949-50: proposals from WDB to SC&RCC for grants for drainage works (Tuhara Drain). Board states it is in a bad financial position because of non-payment of rates by Maori.	August 1940: Local Maori form a committee to arrange and manage work (reported in Wairoa Star). Turi Carroll makes representations to push on with work at Ohuia.	October 1945, meeting of Federated Farmers: proposals by Mr T Carroll to arrange meetings with Maori owners to look again at drainage question (Wairoa Star, 1945). 1946: Minister of Maori Affairs promotes plan for drainage of Whakaki. Scheme included by Native Dept. in 10 year programme. Dept. to obtain agreement of Maori owners in recognition of conflict fishing vs farming. Prime Minister interested in scheme. Maori Affairs requests Works to do survey work for major scheme. Works at Ohuia strongly promoted.

Time	Public Works/ Ministry of Works	Catchment Board/ Regional Council	Wairoa County Council/ Whakaki Drainage Board	Tangata whenua	Other
1950's (Bad floods: Houses flooded. Road acting as a dam/ inadequate culverts; "worst floods in living memory.)	1952: Reactivate proposals for survey of major drainage scheme Works asks DMA if they wish to proceed. Proposals to SC&RCC for survey work for drainage and flood control work. (References to bare hills and high run off helping to create problem). Approval of grant (£200). Work to be handed to WCC to do. 1955: Requests to WCC to open lagoon more regularly. 1956: Proposals developed for works on Waikatuku (stopbanking, new road bridge and removal of houses, check on other streams). Benefit first to highway and second to locals. Funding 3:2:1 NRB/ SC&RCC/locals (Maori to raise £5000).		Railway culverts (on Tuhara) too small for floodwaters. WCC makes approaches to NZR. No progress. April 1955: WCC initiates meeting at Whakaki. Unanimous agreement to keep lagoon at summer levels all year. WCC to ask Ministers and MPs to assist. 1955: WCC opens lagoon more frequently. 1956: WCC Chairman to approach Works (Napier) to have immediate steps taken to alleviate flooding (Wilson 1978).	1951: Lake Trustees prepare a Memorial of Dissent, objecting to proposals to drain the lagoon. Supported resolutions to keep lagoon at summer levels all year round. 1956: P. Solomon, J.Raureti and R. Pomana approach WCC for assistance with raising their share of funds for flood control scheme. Council to assist as far as possible.	1952: DMA not able to fund any work. [can only provide finances under Part 1 of the Maori Land Amendment Act 1936].

Time	Public Works/ Ministry of Works	Catchment Board/ Regional Council	Wairoa County Council/ Whakaki Drainage Board	Tangata whenua	Other
1950s cont'd	Visit to area by Works/SC&RCC staff. Direct openings "suggested" (Wairoa Star). Proposal to SC&RCC for 2:1 subsidy for new opening. NRB now fund 1:2 with WCC and WDB. Appr'vd Oct 56. 1957: over-expenditure on openings. Request to SC&RCC for subsidy on extra needed for excavation of clay layer. Approved. 1958: Works advise WCC that subsidy for openings to be reduced to 1:1. If WCC faces difficulties, make a case (Wilson 1978). November 1959: Visit to area by Chair of SC&RCC. Proposals for further works at Kihitu and Iwitea. Use of Maori share of Waikatuku works which were cheaper than expected.		July 1956: WCC opens lagoon directly to sea (Wairoa Star). WCC resp. for handling Waikatuku works and collecting local contribution. 1958: In response to advice that subsidies for openings reduced, Carroll advises that site and increased frequency of opening made at the request of Works because of road.	1957: Funding for Waikatuku works raised through Maori Trustee. Contributors: Ohuia/Iwitea/Whakaki. Whakaki people agree not to move marae and other buildings as part of Waikatuku works. Plan to build a new one in future. Accept some flooding of buildings meanwhile. Total share of Maori funds not spent. November 1959: Iwitea and Kihitu people propose further drainage works (report of visit by Chief Engineer of SC&RCC).	NZR unwilling to fund lengthening of rail bridge over Waikatuku.

Time	Public Works/ Ministry of Works	Catchment Board/ Regional Council	Wairoa County Council/ Whakaki Drainage Board	Tangata whenua	Other
1960s	1960: Proposals to build bridge across Patangata. To be charged to the "scheme". 1960: Works (D.Comm) not happy about control of lagoon levels. WCC/WDB not seen to be doing job properly. WDB lacks funds.	1961: Hawke's Bay Catchment Board levies first rate. Proposals for further work at Ohuia. Land development to be used to pay for scheme. 1966: approved 1:1 on drainage, 2:1 on flood control (NWASCA).	WDB applies for further subsidy of 2:1 for openings.(Normal subsidy 1:2).	1967: Ohuia and Whakaki 2N Inc. interested in raising loan for further drainage works. 1969: Owners of Whakaki Lagoon form Trust through Maori Land Court.	1967: DMA to facilitate Ohuia proposals as far as possible. 1968: DMA - took over management of Ohuia. 10-year development plan: to include drainage.
1970's	Minister of Works to Lands re proposal to excavate Rahui Channel: HBCB to assess if non-subsidised contribution forthcoming (including wildlife interests). Proposals to be drawn up including all options. Maximum and minimum levels to be set by way of water right.	1973: proposals for subsidies for Ohuia - pump modifications. "Board doing all it can to encourage land development". Propose to assess all options including continued use of direct opening.		12 February 1975: H Solomon, T Carroll, R Paku and R Mayo (Rod and Gun) send telegram to local MP re action of HBCB in opening lagoon "contrary to previous agreements". Concern over fate of wild fowl and lack of water for stock.	17 Feb 75: NCC inspected lagoon following opening to the sea. April 75: NCC initiates meeting of interested parties, Whakaki Marae. Meeting resolved to: maintain fixed minimum level, return outflow to old channel, ensure that maximum level such that farm land not endangered from flooding.
1970's cont'd		1975/1976: attempts to open via old outlet. Minimal flow. Promote development of Catchment scheme. (NB: subsidies normally 1:1 for on farm works, former 2:1 works now 3:1 if part of a catchment scheme). December 1979: Public meeting in Wairoa; resolution to support a catchment scheme.			Wildlife Service makes verbal agreement to make financial contribution to local share (providing water can be brought under some form of tenure e.g. wildlife reserve). DMA can provide no financial contribution as no jurisdiction over the lands.

Time	Public Works/ Ministry of Works	Catchment Board/ Regional Council	Wairoa County Council/ Whakaki Drainage Board	Tangata whenua	Other
1980s	1984: District Comm. Works evaluates capital costs of reinstating old opening. To seek 60% subsidy from NWASCA. March 1985: NWASCA approves 60% of 1/2 total cost. Locals to contribute 40% of 1/2 total, and Internal Affairs to contribute 50 % of total cost. HBCB to approach Internal Affairs. 12 March 1987: project lapses.	Regional Water Board Tribunal grants right (1-11-82 to 31-5-87) but does not set levels. (NB right extended on 1-6-86 to 31-5-95.) Catchment Board to continue direct opening until work can be done. NWASCA sets levels between RL 10.50 - 11.80.		September 1982: Lake Trustees apply for water right to discharge via old opening.	16 Oct 85: Minister of Internal Affairs (Tapsell) declines to make contribution. Maori rights under the Treaty stressed. Wildlife interests not to blame for the problem.

Abbreviations:

DMA	Department of Maori Affairs
HBCB	Hawke's Bay Catchment Board
NCC	Nature Conservation Council
NWASCA	National Water and Soil Conservation Council
SC&RCC	Soil Conservation and Rivers Control Council
WCC	Wairoa County Council
WDB	Whakaki Drainage Board

3.0 WILDLIFE HABITATS

3.1 OVERVIEW

Before European settlement, the coastal plain which includes Whakaki Lagoon was naturally susceptible to floods, and all of the lagoons between Wairoa and Whakaki were linked in an extensive wetland system (see Figure 1). The previously abundant fish and bird population, and the tangata whenua who relied on them, were sustained by this large wetland system.

Over the last hundred years, this wetland was drained and converted to farmland, causing dramatic reduction of the seasonally flooded wetland. The traditional food production provided by the wetland (eels, other fish, birds, shellfish) was replaced by the produce that could be gained from pasture and cropland.

Direct openings of Whakaki Lagoon to the sea dating from 1956 are only the most recent phase of wildlife habitat alteration that has gone on for over a hundred years. When looking at the historic causes of decline in bird and fish species in the Whakaki Lagoon area and possible remedies, one must take account of contributing factors.

3.2 WATER QUALITY

This section will summarise what is known about some basic parameters of water quality in Whakaki Lagoon (salinity, water levels, nutrient loading, siltation, turbidity).

3.2.1 Salinity

At the present time the lagoon generally contains brackish water, and extremes of fresh and salt water occur in times of flood or tidal flow after direct openings. Other factors which can increase or decrease salinity include wave splash during storms, salt spray, evaporation, and rain. Fluctuations in salinity caused by floods and droughts are a natural feature of coastal lagoons.[70]

Anecdotal evidence of wildlife change indicates that the direct opening regime has not so much caused an influx of salt water, but a shift of location in the lagoon and connecting waterways where predominately fresh, brackish, or saline waters could be found. Tangata whenua report that salt/brackish water species such as flounder and mullet used to live year-round in the Patangata Lagoon area near here the old exits used to be made, but now they can be found only seasonally in Whakaki lagoon near the new exits. Similarly, freshwater carp used to be found throughout Whakaki Lagoon, but now are found only in the western tributaries to the lagoon and in the Patangata Lagoon area.

Both the currently used direct outlet and restoration of the old Paakaa outlet have the potential to allow direct human-induced intrusion of salt water to the lagoon ecosystem, particularly if the cut violates the hardpan layer in the shingle bar. The difference is that salt entering the Paakaa outlet can be diluted over the length of the Rahui Channel, whereas at the direct outlet salt enters directly into Whakaki Lagoon.

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[70] de Winton et.al. 1992, p. 8.

Records of salinity in Whakaki Lagoon were taken regularly from 1984 -88 and have been taken intermittently since that time. Unfortunately the taking of these samples was not related to the opening of the bar, and insufficient data is available to show whether there is any significant statistical relationship between bar openings and increased salinity. The smaller number of recording days in recent years also means that any apparent trends have to be treated with caution.

Table 3.1: Hawkes Bay Regional Council salinity readings, Whakaki Lagoon, 1984-1990

YEAR	Days records taken	No. of readings	Range of salinity (ppt)	Average salinity (ppt)
1984	11	31	1.0 - 31.0	7.5
1985	5	15	2.4 - 22.0	8.4
1986	4	12	1.5 - 11.0	4.6
1987	4	12	4.0 - 12.0	7.6
1988	1	3	9.2 - 10.3	9.6
1989	3	9	2.5 - 5.8	4.6
1990	1	3	0.0 - 5.0	2.0

Salinity levels (ppt)	common description of water
0 - 0.8	fresh
0.8 - 20	brackish
20 ->	saline
35	sea water
40 ->	highly saline

Source of data : Porter 1991, Appendices. Three test sites; eastern, western, and staff gauge.
Source of salinity ranges: Dr. C. Howard-Williams, pers. comm.

However, there is clear evidence of wide variation in levels of salinity; average readings were between 5.9 to 7.3 ppt (brackish water), but extremes of 0 (fresh water) to 31 ppt (nearly salt water) have occurred.[71] The higher reading approaching the salinity of salt water has not been recorded since 1985 (Table 3.1), but this does not mean this level has not occurred on days when recordings were not taken.

In 1992, salinity records were taken in connection with a vegetation survey of the lagoon. Salinity was relatively constant between 4.0 to 5.5 ppt (brackish water), and records taken along the sand bar did not indicate peaks in salinity that would suggest particular areas of saline intrusion (such as if the "hardpan" remained shattered at the old direct opening site at Te Awa Waahi).[72]

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[71] Porter 1991, Appendices.

[72] de Winton et.al. 1992, p. 4.

At high tide the sea can come into the lagoon once the sand bar has been opened and the lagoon drained. The length of time this occurs depends on how long the cut stays open; in a southerly this may only be a matter of days, but when there is a westerly the tide can flow in and out of the lagoon for as long as 2-3 weeks.[73]

3.2.2 Water levels

The openings directly through the sand bar to the sea for flood control have reversed the natural water level patterns in the lagoon; the normal pattern would have been high water in winter, draining gradually to lower level in summer.[74] Levels are now allowed to drop at any time of the year that R.L. 11.8 is reached.

There were a number of times in the past when the opening of the direct outlet has dramatically dewatered the lagoon, on occasions so much so that a person could walk across it. Observations have been made in recent years of times when the aquatic plants were exposed, and seabirds came in to feed on stranded fish.[75] This has *not* been solely on account of the alleged of the "hardpan" in the 1970s; written accounts of complete dewatering after opening the sand bar date from 1957.[76]

Development of farmland closer to Whakaki Lagoon contributed to the demand for frequent openings, and the lake was drained to lower levels as a consequence.[77] In addition, the draining of wetland lowered the water table and reduced the ponding area, so that the severity of dewatering events caused by direct opening to the sea has been increased as a side effect of the farming practices of the local community.

Dewatering creates a serious disruption to the lagoon ecosystem and puts stress on aquatic species. The danger of desiccation would increase with the length of time the bar remained open, especially in hot dry weather. It has been suggested that dewatering events longer than about 10 days would be of concern[78] and, although most bar openings close after a few days with the impact of southerly winds, there have been occasions of openings lasting 2 weeks, and once for 3 weeks.[79]

A recent vegetation survey of the lagoon found a healthy population of typical brackish water species despite dewatering events.[80] However, as discussed in section 2.4, "premature harvesting" from wave action during refilling of the drained lagoon is considered a significant negative impact on the aquatic vegetation. Maintaining a minimum water level which lies above the aquatic weed beds would prevent this large-scale reduction of biomass which could

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[73] H. Solomon, J. Smith, and J. Jardine, pers.comm., 1992.

[74] K. Hawkins, pers. comm., 1992

[75] G. Willoughby, K. Hawkins, pers. comm., 1992.

[76] Memorandum from District Commissioner of Works Napier to Commissioner of Works Wellington, 1 March 1957, file PW 81/16, Wellington Archives.

[77] Porter, 1991, p. 1.

[78] S. Porter HBRC, pers. comm., 1992.

[79] H. Solomon, J. Smith, and J. Jardine, pers. comm., 1992.

[80] de Winton et. al., 1992

otherwise provide food and shelter for other aquatic species.

Table 3.2 shows when openings have occurred between November 1976 to August 1992, ranging in frequency from one to six per year. However, data are not available on the extent and duration of dewatering, as water level records are only kept to determine when floods are occurring and the sand bar may need to be opened. In dewatering periods the water level retreats below the staff gauge used to record flood levels and accurate low level readings cannot be made.[81]

It appears that the natural summer level prior to the 1920s was R.L. 10.7 (0.7 metres above sea level).[82] The current water right sets a minimum (to date not enforced) of R.L. 10.8. After a recent dewatering event levels were estimated at R.L. 10.6, but by the time readings were taken the bar had closed and the water level may have begun to rise again.[83] It has been estimated that the first cut below the hardpan was at R.L. 10.3, and that natural scour could take this down to R.L. 10.0 or 9.6.[84]

3.2.3 Eutrophication

Development of lands for agriculture leads to an increase in nutrients entering waterways (eutrophication). Topdressing with fertilisers, droppings from livestock, and eroding soil all can add nutrients, and loss of stream and lakeside vegetation removes effective "sinks" or filters for nutrients and silt. This process has been going on in the catchment of Whakaki Lagoon for many decades.

An additional source of nutrients in the lagoon and that has been commented on is droppings from large populations of Canada geese. Although the lagoon previously supported large populations of waterfowl, these species would have cycled nutrients within the lagoon system. Canada geese, however, feed outside the lake and roost on the lake, thereby potentially transferring nutrients into the lake from the surrounding pastures.

To a certain extent, increased nutrients can improve habitat for waterfowl and eels. Although die-off of algae and phytoplankton growth following excess nutrient inputs can lead to seriously depleted dissolved oxygen in the water and death of fish and other aquatic species, in shallow water such as Whakaki Lagoon this would be a potential problem only in hot still weather when no wind-induced mixing of lagoon waters can occur.[85]

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[81] G. Willoughby pers. comm., 1992.

[82] Works map PW NA 214/5 (railway not yet built), level at 4.7 feet, converted to R.L. by Williams (1982).

[83] T. Koutsos and G. Willoughby HBRC, pers.comm. The opening was made on 2 June 1992, the bar had stayed open 3 days, and the measurements were taken on 9 June 1992.

[84] T. Koutsos, pers. comm., 1992.

[85] J. Adams (DOC Napier), D. Jellyman, and C. Mitchell, pers. comm.

TABLE 3.2: OPENINGS MADE FROM WHAKAKI LAGOON TO THE SEA THROUGH THE SAND BAR, DECEMBER 1976 - OCTOBER 1992

1976

12 December

1977

24 April
14 June
17 July
29 August
15 September *
16 October

1978

29 June
8 August
3 October
26 October
7 December

1979

5 January
29 May
16 July
22 August
12 December

1980

19 June
(at "controlled" site)
13 July
1 September

1981

25 May
9 June (re-opened by itself)
17 July
1 September *

1982

30 April
11 May *
21 June
5 October (unsuccessful) *

1983

17 July

1984

25 February
13 June (unsuccessful)
28 June
31 July *
25 September

1985

30 May
30 July (sea coming over bar)

1986

11 July
20 August *
24 September
(stayed open several days)

1987

12 April
30 June *
18 July *

1988

10 March
(stayed open several days)
11 May *
23 June *
20 July

1989

27 May
1 June
4 July *
19 August
14 September
(still open after 6 days)

1990

27 March (unsuccessful)
28 March
(tide coming through cut)
15 June
1 August
25 August *

1991

12 April
8 May
25 June
1 August *
19 November * (closed by HBRC 21 November)

1992

12 May
2 June *
(still open 3 days later)
--"controlled" site after this--
30 July *
2 October (not successful)
18 October (open 1 week)

Source: Whakaki level book, Wairoa Depot, Hawkes Bay Regional Council.

NOTE: This is not a complete record with regard to the length of time the bar has remained open after a cut is made (such data were not always collected).
*Openings are generally made when the lagoon level is at or above R.L. 11.8, but on some occasions (marked *) it has been opened at levels between R.L. 11.5 and 11.8.*
Data on minimum water levels are not recorded (the staff gauge is not calibrated low enough).

Accelerated eutrophication favours algal rather than submerged plant communities, and blooms of blue green algae can be toxic to the aquatic ecosystem. Increased nutrients also favour increased populations of phytoplankton which can cloud the water. Both of these effects lead to increased turbidity (lack of water clarity), which in turn leads to decreased light reaching the bottom, and decreased underwater plant growth. Vegetation can trap and bind sediments, remove nutrients and buffer waves that would otherwise stir up sediments; a decline in plants attached to the bottom can therefore further increase turbidity and compound the problem.

Occasional algal blooms have been reported in Whakaki Lagoon, indicating periods of eutrophication.[86] The 1992 vegetation survey found some localised patches of filamentous green algae, but these were considered seasonal and a normal component of brackish communities rather than a sign of eutrophication.

3.2.4 Siltation

Smothering by silt does not appear to be a problem for the aquatic plants in the lagoon.[87] However, silt may have contributed to the decline in some fish populations (see section 3.6), and has reduced the amount of wildlife habitat available in both the Rahui Channel and Whakaki Lagoon. Silt has nearly filled in the Rahui Channel over time, and has reduced the area of the lagoon by an estimated 40 acres.

This siltation is a result of clearing and giant discing of the land in the lagoon catchment, and the reversal of the flow pattern for water through the Rahui Channel after the direct openings replaced openings at Paakaa. A large stand of raupo now grows where the Rahui Channel once ran deep and clear; this has created a habitat which may be preferred by some bird species, but the original habitat is preferred by tangata whenua.

3.2.5 Turbidity

Turbidity, or lack of clarity in the water, has been shown in some water bodies to be a significant factor in blocking light to aquatic plants and reducing their extent and vigour. Turbidity can be caused by siltation, by an abundance of plankton caused by eutrophication, and by wave action which re-suspends sediments.

These factors are present in Whakaki Lagoon, but the lagoon is shallow and it has been suggested that light reaches the bottom despite high turbidity at times.[88] There are areas of 0.6 to 1.0 metres deep with limited or no aquatic weed growth, and the 1992 aquatic plant survey also found large areas of turbidity associated with low plant cover contrasting with areas of high water clarity above dense plant cover.[89] Aquatic vegetation helps to stabilise sediments, and lack of water clarity may be a result of loss of vegetation from other causes rather than the cause of poor vegetation establishment.

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[86] Stack, 1991.

[87] G. Willoughby HBRC, pers. comm., 1992.

[88] Ibid.

[89] de Winton et. al. 1992, p. 5, and Transect 2.

3.3 WATER VOLUME AND FLOW

The proposal to reinstate the Rahui Channel and the Paakaa exit rests on the assumption that the Channel will be largely or wholly self-flushing, and the created exits will provide the required amount of drainage. As these assumptions are central to the proposal, they require some explicit scrutiny.

Prior to 1956 the Rahui Channel was deep, wide, and hard-bottomed, and after openings were made at Paakaa it carried waters to sea at such a velocity that it could be heard roaring from some distance.[90] This channel had developed over a period when there was a larger catchment of water (before the Waiatai and Ohuia waters were diverted away to the west) and before intensive land development brought a huge silt load into the Channel.

In the 1930s, the Paakaa opening was often not made until the flood waters were lapping the highway,[91] which is significantly higher than the R.L. 11.8 currently enforced.

In addition the water table has been lowered through decades of wetland drainage to create farmland, so that the lagoon has become shallower (at least at the Rahui delta) and therefore holds less water. The previously self-flushing nature of the Rahui existed when there was a significantly higher "head" of water to do the work. This situation cannot realistically be recreated.

Before the direct opening to the sea was made, waters from the Waikatuku and Ramarama Streams would naturally flow into the Rahui Channel, and as that area filled would also flow into Whakaki Lagoon, until an opening at Paakaa caused water to flow eastward. Silt carried by those streams would settle out onto the channel or lagoon bottom, and the degree of resuspension and clearance to the sea would depend on depth and velocity of the water flow.

The extensive land clearance and giant-discing of the catchment in the 1950s-70s brought a massive load of silt down into the Rahui Channel and its delta into Whakaki Lagoon just as the Rahui Channel was bypassed by the direct outlet, and naturally that silt settled and did not clear. The catchment is not as unstable as it once was and silt loadings should therefore be considerably lower, but so too is the "head" of water available to flush out sediments.

Should the Rahui Channel be dredged and reinstated as the exit of Whakaki Lagoon, its ability to be self-flushing is not assured, and between openings silt may well continue to settle into the lagoon delta. Silt carried into the Lagoon by the Tuhara Stream would be likely to settle out between openings and further add to the continued shallowing of the lagoon.

At present, the average drainage time for the lagoon after an opening is about 2 days. Estimated drainage time for the lagoon using the Rahui/Paakaa exit is 2.5 to 15 days, depending on how deep and wide the Rahui Channel is opened.[92] A faster drainage time would not only benefit farmers on low-lying land by reducing the time that fields are under

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[90] H. Solomon & J. Smith, pers. comm., 13/10/92.

[91] D. McKinnon, pers. comm., 1992.

[92] Williams 1982, p. 7.

water, but increase the velocity of the water through the Channel and assist in flushing out sediment and holding the cut open in the face of southerly swells against the bar. Although it would initially be more expensive, for long-term practical benefit a deeper and wider opening of the Channel is to be preferred.

It has been argued that with the extra distance the water would need to travel down the Rahui and the consequent loss in velocity, the cuts through the bar will naturally close sooner in the face of southerly swells, and therefore more cuts will need to be made per year, thus raising costs. A decade ago it was estimated that on average only one extra cut would be required per year.[93] However, it must also be noted that since 1976 some 16 openings were made before the water level had reached R.L. 11.8 (Table 3.2) when a lesser "head" of water was available and natural closure of the opening before full drainage was more likely. Thus the need for "extra" openings may already have been created from time to time under the "status quo".

3.4 VEGETATION

All of the wildlife species in and around the lagoon depend on aquatic and/or marginal vegetation, either using it directly for food and shelter, or feeding on other organisms which do.

3.4.1 Aquatic macrophytes

Aquatic plants currently living in the lagoon are typical of brackish water environments, and well adapted to changes in salinity. Two of the common species are *Lamprothamnium papulosum* (brackish water stonewort) and *Ruppia polycarpa* (watergrass), both of which can grow in extremely saline waters. However, the plants grow best between 5 and 10 ppt salinity. In 1992, the vegetation in Whakaki Lagoon was assessed by the survey team as "well developed and in a healthy condition".[94] As vegetation surveys were not done prior to 1956, it is not known whether these species have always been the main aquatic macrophytes in the lagoon, or whether they have come to dominate because they are adapted to fluctuations in water levels and salinity.

Aquatic macrophytes are important not just for direct sources of food and shelter. Aquatic weed beds trap fine silt and organic debris creating a productive area for molluscs, invertebrates and fish, act as a buffer to fluctuations in nutrient levels, provide habitat diversification, and buffer wave action.[95]

The effects on vegetation of dewatering through the direct opening are several:

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[93] Ibid, p. 9.

[94] Ibid, pp. 6, 10.

[95] Chisnall 1987, p. 12, Gerbeaux 1989, pp. 7-9.

Excessively low water levels can impact on aquatic plants through desiccation, increased turbidity by wave re-suspension of bottom sediments, direct wave disturbance of plants, and increased access for grazing waterfowl. However, low water levels may also result in higher light levels available to submerged plants. [96]

Observations by Regional Council staff suggest that rather than desiccation, a much more frequent and significant result from dewatering is the "premature harvesting" of aquatic plants as the lagoon levels rise again. As the water rises from below the weed bed levels, waves strike against the roots of plants which would normally be under water. This dislodges the plants, and large rafts of them can be found washed up on the downwind shores of the lagoon.[97]

Investigation of aquatic macrophyte establishment and growth in Lake Ellesmere, which has many similarities to Whakaki Lagoon, determined that the most important time to manage salinity, water level fluctuations and turbidity was during the establishment and growing season for the plants, which is September to March. An analysis of the bar opening records (see Table 3.2) shows that over 16 years, during only 4 were there no dewatering events during the plant growing season, and in 3 years there was more than one dewatering event.

Maintaining the minimum water level in the water right would reduce stresses from dewatering and improve the habitat for aquatic plants and the species that rely on them.

It should be noted that if the Rahui Channel were re-excavated and Whakaki Lagoon converted to a principally fresh water ecosystem, a new potential for lakeweed infestation could exist. This could enhance wildlife habitat to some extent, but could also add to the cost of channel maintenance, and inconvenience recreational users of the lagoon.

3.4.2 Marginal vegetation

The terrestrial seasonally flooded ponding areas between aquatic macrophytes and adjacent pasture are very important for foraging and nesting by bird species, shelter and food sources for some fish species, and egg-laying by inanga.[98] Apart from the southern margin retired from grazing by the Lake Trustees, these areas have been opened to livestock by adjacent landholders (whether for grazing or for access to water), and burning, mowing and herbicides are used in some areas to keep the vegetation down. Low water levels give stock access to marginal vegetation, allowing greater damage from grazing and trampling.

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[96] de Winton et. al., 1992, p. 8.

[97] G. Willoughby HBRC, pers. comm., 1992.

[98] S. Porter, HBRC, pers. comm., 12/10/92.

3.5 BIRD HABITATS

Traditionally, the lagoon wetland complex from Wairoa to Whakaki provided a rich habitat for birds. Tangata whenua report that the birds harvested for food included parere (ducks), wana (swans), pukeko, and matuku (bittern).[99]

Over time the original bird habitat has been greatly diminished in size and quality through a combination of land clearance, draining, and flood control. Additional damage to bird habitat is caused by livestock grazing and trampling vegetation along the margins of the lagoon. Of most importance for bird habitats are the swampy transition zones between the deeper water and dry land, which suffer the most damage when wetland is converted to farmland.[100]

Not all waterfowl species rely on the lagoon for feeding; some use the lagoon for resting and fly out to feed in inland wetlands. As these other wetlands are a mere 10% of their extent in the 1930s, the reduction of waterfowl in Whakaki Lagoon is related to land clearance and drainage in other catchments as well.[101] Habitat restoration at Whakaki cannot bring back lost wetlands elsewhere.

The Korito and Wairau Lagoons to the west are part of the Whakaki Lagoon catchment and are an important part of the bird habitat, particularly at higher water levels. Extensive drainage of these areas by the Iwitea people has reduced wildlife habitat. A proposal in 1983 by local landholders to isolate these lagoons from Whakaki Lagoon with a stopbank was opposed by wildlife officers as a threat to wildlife habitat (in the end it did not proceed on economic rather than ecological grounds). However, recent initiatives by the landholders, together with the Fish and Game Council, the Regional Council and the QE II National Trust to maintain minimum water levels and establish riparian planting have begun to reverse that trend immediately around those small lagoons.[102]

Despite major habitat change, the large size and shallow water of the Whakaki Lagoon network still combine to create a habitat attractive to waterfowl. The lagoon supports a healthy, although much diminished since the 1950s, population of game species tolerant of human-altered environments (introduced species such as mallard ducks, swans, Canada geese; indigenous species such as grey ducks, paradise shelducks). Waterfowl numbers, monitored annually, show most species in recent decades maintaining static population, except for Canada geese which continue to increase.[103]

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[99] Solomon 1992, p. 1.

[100] The emergent vegetation in this zone is also extremely important for the inanga (whitebait), as this is where eggs are laid during high water events.

[101] K. Hawkins, pers. comm., 4/11/92.

[102] J. Robinson, C. J. Owen, K. Hawkins, pers. comm., 1992, also *Daily Telegraph*, 13/12/83.

[103] Stack 1991, p. 4.

Most available estimates of changes in the waterfowl population focus on swans. It has been estimated that their population is down perhaps 80-90% since the 1950s, when there were 5,000-10,000 swans. There are several hundred to a thousand now.[104]

About a hundred hunters use the Whakaki Lagoon area, harvesting up to 1,000 birds annually (swan, mallard and grey ducks). The lagoon also provides a feeding and moulting area for birds which are harvested elsewhere (paradise and shoveller ducks).[105] About 60% of the hunters are local people, and hunters also come regularly from the wider region. The lagoon is considered the most important waterfowl shooting area in the Wairoa District.[106]

Gamebird hunting in most of the lagoon is managed by the Lake Trustees, whose members are rangers. In addition to the Fish and Game Council licence, hunters must obtain permission from the Lake Trustees to hunt on their area of the lagoon. Maimais are also controlled by the Lake Trustees, and in the early 1970s some were removed by the Trustees to reduce hunting pressure on birds.[107] In the early 1950s, revenue from access right fees boosted the Whakaki Marae maintenance fund by some £50-£60 a year.[108]

Information on the population of non-game, endangered and protected species at Whakaki Lagoon is more limited. Of principal interest is the bittern, which was once very numerous,[109] but is now present in quite small numbers, and the grey teal which was a year-round resident in large flocks but since the 1970s has been an infrequent visitor and the flocks have been smaller.[110] Both species require healthy stands of marginal vegetation for shelter and nesting, and shallow waters near this vegetation for feeding. Marginal vegetation has been significantly reduced by farmers in many areas around the lagoon and dewatering would distance feeding areas from sheltering vegetation. In addition, the grey teal was often a "mistake" bird in the hunter's bag and the bittern was harvested by tangata whenua in earlier years, so that harvesting may also have significantly contributed to the decline in their numbers.

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104 H. Solomon, J. Smith, and J. Jardine, pers. comm.

105 Adams 1982, p. 8.

106 H. Solomon and J. Smith pers.comm., 1992, and J. Jardine, speaking for the Central North Island Wildlife Conservancy Council at water right hearings in 1982.

107 H. Solomon and J. Smith, pers. comm., 13/10/92.

108 Submission to the Minister of Maori Affairs from the people of Whakaki, 1951 (from Whakaki Marae files, c/- H. Solomon). Sale of shooting rights is illegal under the Wildlife Act 1953, and these funds were "grant monies in the form of a donation" for access (D. Stack, pers. comm.).

109 H. Solomon & J. Smith, 13/10/92.

110 D. Stack, pers comm., 7/10/92.

Loss of rushes for cover not only impacts on bitterns, but on species which nest in the reeds. Failure to allow the water to rise in spring to encompass the rushes also means that seedfall from the rushes is not as available to waterfowl such as the shoveller duck.[111]

A summary of habitat requirements of the major species present in the lagoon area is presented in Table 3.3.

[111] K. Hawkins, pers. comm., 4/11/92.

Table 3.3: Habitat requirements for bird species at Whakaki Lagoon

	Population and Lagoon usage	Water levels	Salinity	Lagoon extent, vegetated margins
GAME SPECIES[2]				
Black Swan	200 to 2,000 use year-round, peaks early and late summer. Moderately important breeding area (100 - 200 birds produced/yr.).	Eat submerged veg., moist pasture. Rapid lowering of lagoon water level followed by 50% leaving area. High levels can flood nests.	Eat fresh or salt water species, but sharp salinity changes might disrupt food supply.	Well vegetated margins important for nesting and feeding. Wetland drainage reduces habitat.
Mallard, Grey Duck	500 to 2800 use lagoon, mostly in summer. In late 1980s, 3,000 - 8,000 were present.	Feed in shallow water, on land. High levels reduce rest areas, shelter, floods nests. 50% have left area after rapid lowering or rising.	Eat fresh or salt water species, but sharp salinity changes can destroy food supply.	Well vegetated margins important for shelter during moulting, nesting, feeding. Wetland drainage reduces habitat.
Shoveller Duck *Kuruwhengi*	300 to 800 use lagoon in winter, to feed before breeding. Nesting occurs elsewhere.	Feed on insects and vegetation in shallow water; dewatering and high water disrupt access to food.	No information.	Vegetated margins provide shelter and improved food supply. Wetland drainage reduces habitat.
Paradise Shelduck *Putangi-tangi*	Up to 1,800 use lagoon, mostly for moulting (summer) and feeding (winter). Majority of time spent upcountry.	Prefer higher lagoon levels in summer (offers escape areas). Dewatering does not affect food; feed on pasture.	No information.	No information.
Canada Goose	500 to 12,000 use lagoon, autumn/ winter. Open water offers escape area, sand spit provides good nesting area.	Primarily feed on land; dewatering would only affect area available for escape, resting, and moulting.	Not important; feed on land.	Vegetated sand bar provides shelter for nesting, otherwise prefer open water or open pasture.

PROTECTED SPECIES				
Waders[1]	Up to 1800 counted at low water periods in warmer months, usually 100 - 300.	Prefer moderate to low water periods, when move from coast to feed.	Prefer saline or brackish tidal environment.	No information.
Gulls and Terns	100 - 500 present, up to 1550 at low water periods.	Benefit from stranded fish and invertebrates during dewatering.	Prefer saline but can thrive inland.	No information.
Shags[2] *Kawau*	Up to 300 present in lagoon, especially at low water.	Benefit from stranded fish and invertebrates during dewatering.	Prefer saline but can thrive inland.	No information.
Grey Teal *Tete*	230 sighted 1992; ranged from 0-730 last 20 years. Was a permanent flock, but now intermittent.	Feed in shallow water. Dewatering could reduce food supply.	Freshwater species.	Vegetated margins required for shelter, nesting. Wetland drainage seriously reduces habitat.
N.Z. Dabchick *Weweia*	1 - 5 sighted in lagoon on occasion, was up to 29 in 1989.	Feed underwater. Dewatering could reduce food supply.	Fresh/brackish water species. Rapid changes could disrupt food supply.	Vegetated margins essential. Wetland drainage seriously reduces habitat.
Bitterns, Crakes and Rails [3]	2 bitterns sighted in 1984, 1 in 1992.	Dewatering would distance foraging area from sheltering vegetation.	Fresh/brackish water species. Rapid changes could disrupt food supply.	Vegetated margins essential. Wetland drainage seriously reduces habitat.

Bird count data 1972-91 courtesy of the Eastern Region Fish and Game Council.
Other species occasionally sighted around lagoon include pukeko, kingfisher, harrier hawk, and barn swallow.
Nutrient levels and siltation not critical factors according to information available.

1 Includes Pied Stilt (up to 1500), White-faced Heron, Dotterels, Spur-winged Plovers and Oystercatchers. Occasional sightings of species outside their usual habitat include White Heron, Royal Spoonbill, Glossy Ibis, Bar-tailed Godwit, Turnstone, Red-necked Stint, Sharp-tailed Sandpiper, Curlew Sandpiper, Golden Plover, and Asiatic Whimbrel.

2 Includes Black Shag, Little Shag, and Little Black Shag.

3 Sighted species include Bittern and Spotless Crake. It is thought that Banded Rail, Spotless Crake and Marsh Crake are probably also present. Bitterns, Crakes and Rails are very secretive and difficult to sight.

3.6 FISH HABITAT

The tangata whenua obtained a major part of their sustenance from fish in and around Whakaki Lagoon. In the early 1950s these included eels, carp, mullet, inanga, founders, herrings, and kokopu.[112] Shellfish utilised included pipi and ngupara.[113] As the tangata whenua argued in 1951, retention of these resources was important because the lagoons and swamps provided a large supply of fish which was *" ...free of cost, and is health-giving."* Since that time, the populations of these species have declined significantly.

3.6.1 Restoration of the eel population

One of the major concerns of tangata whenua in relation to Whakaki Lagoon is the dramatic decline in the eel population. Traditionally, the eels of Whakaki Lagoon were renowned. A major source of tribal sustenance, they were also used for trade with inland tribes. The nickname for the people of Whakaki is *kirituna* - "eel skin". Now, the eel population is estimated to be only about 25% of what it was in the early 1950s.[114]

Tangata whenua have attributed the decline of the eel population to the opening of the lagoon directly to the sea rather than maintaining the traditional opening at Patangata. However, it appears that land drainage, deforestation, and fishing with commercial eel nets have probably had as much, if not more, impact on the eels. While restoring the Paakaa opening might assist the eels to some degree, this alone would not be sufficient to restore the eel population, and additional measures would be required.

The Korito and Wairau Lagoons are part of the Whakaki Lagoon system, and eel populations have declined there too; they are an estimated 50% of what they were in the 1950s. Commercial fishing did occur in Wairau Lagoon for several years, and farm drainage led to the Wairau completely drying up in 1985 with an extensive kill of eels. A low earthern dam has since been built to prevent complete dewatering, and the Wairau again supplies eels to the tangata whenua of Iwitea.[115] These lagoons do not suffer dewatering and salinity intrusion, as does Whakaki Lagoon when bar openings are made, and thus demonstrate the loss of eel populations that can result from other factors.

The eel population has declined in the Hawke's Bay generally.[116] Possible factors contributing to this are:

* Inflow of saltwater to the lagoon;
* Extreme low water levels;
* Loss of an extensive flood plain;
* Loss of natural stream bed and vegetated margins;
* Use of fyke nets and commercial exploitation;

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[112] Submission to the Minister of Maori Affairs from the people of Whakaki, 1951, p. 2 (from Whakaki Marae files, c/o H. Solomon).

[113] Solomon 1992, p. 1.

[114] H. Solomon & J. Smith, pers. comm., 13/10/92.

[115] J. Robinson and K. Hawkins, pers. comm.

[116] S. Porter, HBRC, pers. comm., 1992.

* Excessive siltation;
* Excessive nutrients (eutrophication);
* Interference with eel migration.

Suggested management strategies to enhance the Whakaki eel population, as well as the prospect for tribally controlled eel farming, are discussed below.

Inflow of saltwater to Whakaki Lagoon

Both the short-finned and long-finned eels have a high tolerance of brackish and salt water, and some short-finned eel populations are known to live out their lives (prior to sea migration) in the salt water zones of estuaries.[117] However, even though these eels can inhabit fresh, brackish, or salt ecosystems, sharp *changes* in salt levels might disrupt the species the eel relies on for food.

Traditionally Whakaki Lagoon has had a fresh/brackish water ecosystem typical of coastal lagoons, rather than the salt/brackish water ecosystem typical of estuaries. In fresh/brackish water a typical food species for the eel would be Chironomid midge larvae ("bloodworms"), and if the lagoon changed to a salt/brackish ecosystem, Mysid shrimps could provide food for the eels.[118] Either regime is a productive source of food, but a large and sustained shift from fresh to salt water or vice versa could disrupt the species present. However, there is no evidence to support or refute the suggestion that salinity changes have reduced the food supply for eels. Brackish water tolerant aquatic plant species presently thrive in the Lagoon[119], and there is no reason to think that brackish water tolerant invertebrates are not also present for eels to feed on.

Should still weather and high salt levels combine to form a deoxygenated lower level in the lagoon, the eels could probably flee to areas where oxygen is available, but in the meantime food sources would be disrupted.[120]

As natural saltwater intrusion will always continue it is only the human-induced changes in salt levels that can be prevented. The options to achieve this are:

(a) re-establish the Rahui Channel and periodic opening to the sea at the Paakaa outlet to release flood waters, with the potential for buffering of salinity over the distance of the Rahui Channel;

(b) establish a weir at the direct opening site to hold the lagoon level above the high tide level; or,

(c) cease the practice of artificial outlets altogether and allow flood waters to disperse naturally.

Another method of stabilising salinity levels would be to open the lagoon to the sea permanently to allow a salt/ brackish estuarine-type ecosystem to establish and stabilise

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[117] C. Mitchell, pers. comm., 1992; McDowall 1990a, p. 61.

[118] C. Mitchell, pers. comm., 1992

[119] de Winton et.al. 1992

[120] C. Mitchell, pers. comm., 1992.

instead. However, given the relentless tendency of the sea to fill in any openings in the shingle bar, creation of an estuary would be neither practical nor affordable.

Extreme low water levels

During earlier times the eels would have had access to the Rahui Channel to wait out dewatering events, as reported in 1957:

> *many fish have died but countless thousands have transferred themselves to the long channel between the lagoon and the old outlet in which ample water remains as it is fairly deep.*[121]

However, following disuse of the Paakaa outlet and decades of heavy siltation from land clearance and development, the channel has filled in significantly and offers limited escape.

Unlike some other fish species, eels can bury themselves in mud to survive low water periods.[122] Nonetheless, dewatering events would cause major disruption to the food supply for the eels and force them to deplete stored fat reserves. The extent of this disruption would depend on the length of time at extreme low water, and whether hot and dry weather speeded up the drying process. Chironomid midge larvae would survive only until the mud started to dry out, and other invertebrates and small fish might be killed immediately. Extended dewatering periods (more than several days) seem to occur about once a year.

There are three main options by which these dewatering events would be avoided:

(a) maintain the direct outlet only at higher levels through use of a weir;

(b) re-establish the Rahui Channel and Paakaa outlet, with a buried weir at the exit of Whakaki Lagoon to prevent dewatering;

(c) cease the practice of artificial outlets altogether and allow flood waters to disperse naturally; or,

(d) dredge and maintain the Rahui Channel as a sanctuary for fish during dewatering events.

Loss of an extensive flood plain

During floods, short-finned eels move out onto flooded lands and feast on drowned terrestrial species such as earthworms, grass grubs, and insects, which are both plentiful and readily digestible. Research in the Waikato has shown that eels captured during times of flood have significantly fuller stomachs, especially in the winter when the usual food supply is scarce

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[121] Memorandum from District Commissioner of Works, Napier, to Commissioner of Works, Wellington, 1 March 1957, file PW 81/16, Wellington Archives.

[122] S. Porter, Hawke's Bay Regional Council, pers. comm., 1992.

and eels use fat stored in summer.[123] It follows that draining and flood protection work on previously flooded lands removes an important food source for eels and reduces the number and size of eels that can be supported.

This strongly suggests that the historical decline in the eel population of Whakaki Lagoon directly relates to the extensive land drainage and flood control works undertaken by both Pakeha and Maori in the area from Wairoa to Whakaki.

If it is assumed that landholders on these drained lands want to continue farming them, options are limited for restoring some of the flood plain and enhancing the eel habitat. Possible options include:

(a) restore the Rahui Channel and the Paakaa outlet, providing slower drainage of flood waters and a longer time period for eels to feed on flooded pastures;

(b) delay the opening of the bar for a period of days to allow eels to feed (regardless of which outlet is used);

(c) fence off and retire the margins of the lagoon, plant native wetland species (e.g. flax, kahikatea), and allow natural flooding of these areas;

(d) replace natural flood food for eels with feed supplements, such as earthworms produced from composted agricultural wastes.

Option (a) has an additional advantage for eels in that the potentially flooded area accessible to eels from Whakaki Lagoon is enlarged (area surrounding Rahui Channel). However, this would probably be seen as a disadvantage by flooded farmers.

Option (c) has been proposed to enhance the Lake Poukawa eel fishery,[124] and would probably be supported in principle by the regional conservancy of the Department of Conservation. It would also remove the most flood-prone lands from the areas that farmers expect to be drained promptly, and enhance bird habitat.

Option (d) requires further investigation. Eel farming and the technology for producing earthworms are both well established overseas, but no information has been found to suggest that this combination has been tried in New Zealand.

Loss of natural stream beds and vegetated margins

The process of converting streams into straight stopbanked channels and cutting drains through wetland removes habitat ideal for eels and other freshwater fish.

> *Creeks and drains that are "properly maintained" are usually kept in a condition unsuitable for fish, because they are largely vegetation free, with open mud, sand, or loose gravelly beds to allow free flow of water through the channel. Drag lining*

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[123] D. Jellyman pers. comm., 17/12/92, and Chignall 1987, pp. 73-79, 111, 115-16, 125.

[124] Mitchell 1984, p. 8.

drastically disturbs the environment and causes complete depopulation of fishes, as there is little food left for the fish. [125]

Measurements of fish populations in drains has shown that where drains are allowed to grow rank vegetation along the margins, ten times the amount of fish (in kg/ha) can be supported.[126] However, if drains are allowed to be silted in too much they may become blocked, and their suitability for fish habitat would decline.

Eels prefer some form of shelter, such as overhanging vegetation or even high turbidity, to protect from from direct sunlight.[127] Vegetation on the margins of waterways also helps slow the current, encourage deposition of fine particles of soil and organic detritus, and fuel a rich feeding ground for eels.[128] Removal of this growth therefore reduces the size of the eel population that can be supported in the waterway.

Vegetated margins also help stop excess sediment and nutrient runoff from farmland entering the waterway. The vegetation that extracts these nutrients in turn supports a rich insect and earthworm population, and if the margins are allowed to flood this food becomes available to the eels.

Re-establishment of the Rahui Channel and Paakaa outlet would open the potential to recreate in the Rahui Channel suitable vegetation to support eels and other fish. Ideally the margins of both Whakaki Lagoon and Rahui Channel should be fenced and retired from grazing, planted with native wetland species and/or allowed to naturally revegetate, and allowed to flood.

Compromise options would involve smaller areas being retired for this purpose if landowner consent or adequate compensation could not be arranged. Piped water supply would need to be arranged for those farmers who rely on the channel and lagoon to water stock.

Use of fyke nets and commercial exploitation

Commercial exploitation of eels in New Zealand increased during the 1930s and 1940s, but began in earnest in the late 1960s.[129] However, the peak harvests and exports in early to mid-1970s were not sustainable (Figure 2.3). The Lake Ellesmere eel fishery was restricted in 1978 as the rate of exploitation was such that the eels were not replenishing themselves fast enough to sustain the fishery, but nonetheless catches have still continued to decline.[130]

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[125] McDowall 1975, pp. 11-12.

[126] Ibid, p. 10.

[127] Jellyman and Todd 1982, p. 13, D. Jellyman pers. comm., 17/12/92.

[128] Chisnall 1987, pp. 4, 12.

[129] McDowall 1990a, pp. 424-426.

[130] Town 1985, pp. 11-13.

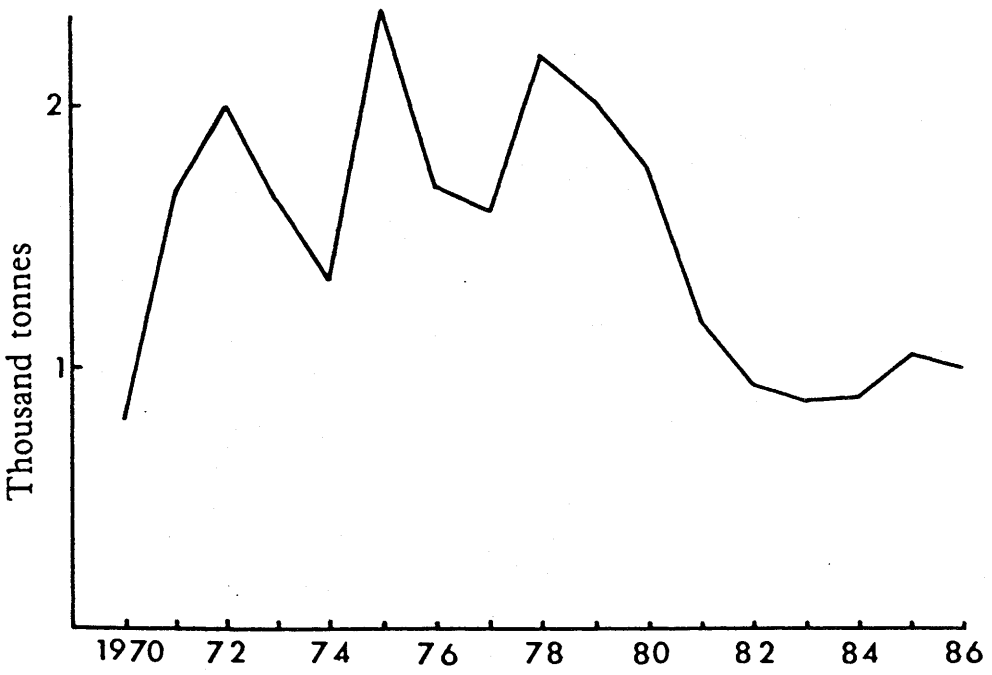

Figure 3: Eel exports from New Zealand, 1970-85

Source: McDowall 1990a, p. 426.

All waters of New Zealand are open to commercial eeling unless they are in gazetted non-commercial Maori fishing areas (Lake Forsyth, Lake Horowhenua), in National Parks, or in other Reserves.[131] Whakaki Lagoon has therefore been legally open to commercial exploitation of eels for over 20 years.

The policy of the Lake Trustees is not to allow capture of eels for commercial resale, and they have turned down offers from commercial eel buyers. They have on occasion evicted commercial eel fishers who were poaching in their lagoon and believe that they have managed to stop most of them. They have also confiscated some of the commercial fyke nets used by poachers, and now use these nets themselves. The "unwritten rule" is that the local people may take any number of eels they like as long as they are not for sale, except for charitable fund-raising.[132]

It is clear that the Trustees strongly oppose commercial exploitation of their eel resource, but it seems that their policy nonetheless leaves open the possibility of occasional large catches of eels using fyke nets for hui or community fund-raising purposes. Fyke nets are exceedingly efficient in capturing eels, and their use may contribute significant harvest pressure on the eel population. The Trustees may want to consider exerting additional controls on eel harvest, as well as working to enhance recruitment of young eels into the lagoon.

Commercial harvest of eels from Wairau Lagoon, a tributary of Whakaki Lagoon under control of the Iwitea tangata whenua, did occur for several years.[133] Data on any

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[131] McDowall 1990a, p. 426; Town 1985, p. 15.

[132] H. Solomon & J. Smith, pers. comm., 13/10/92.

[133] L. Robinson, pers. comm., 14/10/92.

commercial eel catch from Whakaki, Korito or Wairau Lagoons not available, as data are collected for Hawke's Bay as a whole, not for smaller areas.

Eels are a very slow-growing and long-lived species. For the short-finned eel, the average age of an eel which has reached the legal minimum size of 150 grams is 9-17 years.[134] Short-finned eels do not migrate to the sea to breed until they are on average 14 years old (for males) to 22 years old (for females)[135], and very large eels can be 30 years old or more.[136] Following the initial boom in eel fishing in the 1970s there was a marked decline in the average size of eels caught,[137] a sign that the larger eels have been removed and are not being replenished in the population (whether through over-harvesting or lack of food through loss of habitat or both).

In shallow waterways nets may be set easily and eels may be plentifully caught especially around waterway margins in times of flood.[138] Thus harvest pressure may be relatively high in Whakaki and its tributaries by virtue of their easier accessability.

As eels must grow to a certain size to migrate and breed successfully,[139] overfishing can endanger recruitment of young into the population. There is a legal minimum of 150g for commercial eel harvest, but this does nothing to ensure that the breeding stock grows to sufficient size to migrate and successfully spawn. It has been suggested that there be a *maximum* size as well, to protect breeding stock.[140] However, in the face of inadequate scientific data on eel recruitment, it has been assumed by Government that there are no problems, and the change currently being considered is to increase the legal minimum to 200g, despite some Ministerial advisers advocating a maximum size limit as part of a more conservative approach to eel manangement.[141]

In coastal lagoons Maori concentrated their eel fishing effort when the migrating eels (tuna heke) crowded in great numbers seeking exit to the sea[142]. At Lake Ellesmere, Maori had a tradition of releasing the larger eels (poutuna), to assist replenishment of the species;[143] as these larger eels were likely to be females, which were most fecund and had greater fat reserves to survive their migration, this was a wise management

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134 For the Lake Ellesmere fishery, 9-11 years to harvest size (McDowall 1990, p. 428); Lake Ellesmere, Lake Waikare and Waikato River, 16-17 years to legal minimum of 150 g (Chisnall 1987, p. 97).

135 Jellyman and Todd 1982, p. 10.

136 McDowall 1990b, p. 12.

137 Jellyman and Todd 1982, p. 19.

138 D. Jellyman, pers.comm., 17/12/92.

139 The average weight of migrating shortfinned eels is 200g for males and 800g for females (Jellyman and Todd 1982, p. 10).

140 Dr. D Jellyman, pers. comm., 1992.

141 S. Barclay, (MAF Operational Policy Group) and D. Jellyman (NIWAR), pers. comm., 1992.

142 McDowall 1990a, pp. 412 for Lake Ellesmere. At Whakaki Lagoon, the main harvest time was also February to May (Solomon 1992, p. 1) which covers the migration period.

143 C. Mitchell, pers. comm., 1992.

method.[144] The concentration of eel fishing at migration time remains the tradition at Whakaki, but a poutuna release policy is not practised.[145]

Local establishment of a *poutuna* release policy could be done informally, or formally through gazetting local tribal control of the eel fishery; but as the return of young eels is not related geographically to the departure point of their parents, national regulation for maximum harvest size and protection of eel habitat also needs to be pursued to enhance production of young eels to replenish the population.

Excessive siltation

Eels can tolerate high silt loadings,[146] but siltation has still had a negative impact on eel habitat. The people of Whakaki Marae used to capture eels in the muddy delta of the Rahui Channel, where it joins Whakaki Lagoon. The changed drainage patterns enforced on the lagoon have meant that silt from the upper catchment is deposited here, but can no longer be flushed through the Rahui Channel to the sea. The area that used to be a productive fishing site for eels is now solid land.[147]

A channel can be dug through this delta and the Rahui Channel re-opened, which would regain some potential eel habitat. Should a new channel and a return to the old opening not prove to be a self-flushing system, maintenance dredging would be required.

Excessive nutrients (eutrophication)

Eels are relatively tolerant of high nutrient levels in the waters they inhabit, often being the only native species left in eutrophic waters.[148] Initially eels benefit from increased nutrient levels, if that leads to increased food supply. However, at a certain point algal blooms can occur and deoxygenate the water. Eels themselves can tolerate low oxygen levels (down to 1-2 ppm),[149] but the species they feed on may be killed. Usually eels will leave areas if dissolved oxygen levels drop too low, and only if escape is prevented will they be killed.[150]

Lake Ellesmere is similar in many respects to Whakaki Lagoon. The decline in the Lake Ellesmere eel fishery has been attributed to both commercial over-exploitation and eutrophication.[151]

Given the assumption that landholders do not wish to make major changes in their existing land use, the options to reduce the incidence of nutrient inflow to the lagoon involve recreating filters for nutrients through retirement and planting:

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144 McDowall 1990a, p. 49.

145 H. Solomon & J. Smith, pers. comm., 13/10/92.

146 C. Mitchell. pers. comm., 1992.

147 H. Solomon & J. Smith, pers. comm., 13/10/92.

148 C. Mitchell. pers. comm., 1992.

149 Jellyman and Todd 1982, p. 13.

150 D. Jellyman, pers. comm., 17/12/92.

151 McDowall 1990, p. 428.

(a) fencing off and retiring the margins of the lagoon, planting native wetland species (e.g. flax, kahikatea); and

(b) fencing off and retiring the margins of all streams and drains entering the lagoon, planting and allowing existing vegetation to grow more densely.

Interference with eel migration

To complete its life cycle, the eel must have access to the sea for migrating breeding age adults, and access from the sea for returning young ("glass eels"). In various parts of the country this access has been impeded by artificial structures (dams, weirs, culverts, flood gates), and by dewatering, industrial effluent, and deoxygenation of waterways.[152]

At Whakaki Lagoon, as with other coastal lagoons such as Lake Ellesmere, there is a natural barrier between the lagoon and the sea in the form of a sand bar. Previous to human interference the migrating eels would have obtained access in times of flood and storm overwashing the bar. Prior to large-scale drainage for farmland, flood waters from the whole coastal area from the Waiatai River to the Opoho Stream would have applied pressure to open the lagoon to the sea through the bar. Interference with the natural flooding regime of the lagoon complex through extensive land drainage may have reduced the incidence of good migration events for the eels into and out of the lagoon.

Eels are generally slow-growing, so that lack of recruitment of young to the population in any one year is not critical. However, over the longer term, duration and frequency of lagoon openings would be a significant factor in replenishing the population.

Tangata whenua have not observed how or when the "glass eels" may be gaining entrance to the lagoon system, but report that the adult eel migration occurs in mid to late summer largely at times of *taitipi* when the sea overwashes the bar.[153]

As eels do not appear to have a "homing instinct", the migrating adults that leave Whakaki may or may not produce young that return to replenish the local eel population. The entrance of young glass eels from the sea is essential to replenishing stock in the lagoon, and unlike the migration of adult eels (which can crawl over land some distance if it is wet enough) the eels at this early stage require water for swimming. The human-made breaches to the bar are only of use for eel migration if they occur when the adults migrate (February to May) or when the young glass eels return (August to October).[154] An analysis of openings made in the Whakaki bar over the last 15 years (Table 3.4) shows that there have been openings at the right time, but not every year, and not necessarily with the appropriate water flow and duration. The situation in Lake Ellesmere is similar, in that openings are made to suit flood control rather than eels, and the eel population is in decline through a variety of factors. However, the connection between loss of natural flooding, artificial bar openings, and recruitment of young eels into coastal lagoons has not been studied.

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[152] Jellyman and Todd 1982, p. 13, McDowall 1990a, pp. 54-55, Mitchell 1984, p. 6.

[153] H. Solomon & J. Smith, pers. comm., 13/10/92.

[154] Jellyman and Todd 1982, p. 12; McDowall 1990a, pp. 52-53; D Jellyman pers. comm., 1992.

Table 3.4 Relationship of bar openings at Whakaki Lagoon and migration times for shortfinned eels and inanga (whitebait), January 1977 to August 1992.

NUMBER OF TIMES THE WHAKAKI BAR WAS OPENED

YEAR	SHORT-FINNED EELS Adults to sea Feb - May	SHORT-FINNED EELS Young return Aug - Oct	INANGA Young return Sept - Oct	neither	opening periods of several days' duration
1977	1	3	2	2	
1978	0	3	2	2	
1979	1	1	0	3	
1980	0	1	1	2	
1981	1	1	1	2	
1982	2	0	0	1	
1983	0	0	0	1	
1984	1	1	1	2	
1985	1	0	0	1	
1986	0	2	1	1	24 Sept. - several days
1987	1	0	0	2	
1988	2	0	0	2	10 March - several days
1989	1	2	1	2	14 Sept. - over 6 days
1990	1	2	0	1	
1991	2	1	0	2	
1992	1	1	1	2	2 June - over 3 days

Bar opening data from Hawke's Bay Regional Council. Data on duration of openings incomplete (not always recorded). No data available on suitability of water flow for glass eels or young inanga to use.

Use of the direct opening with the addition of a weir, which has been proposed as an alternative option, would prevent glass eels from entering the lagoon and would probably cause a further decline in the already diminished population. Although it is suspected that glass eels can wriggle through porous gravel bars such as at Ellesmere, Forsyth and Onoke, particularly at high tide, the prudent approach would be to assume that eel recruitment will be impeded in some way by the sand bar.[155]

Eel ladders have been devised to assist elvers over physical barriers in inland waters such as dams and steep weirs,[156] but elvers are a more mature stage than glass eels just entering from the sea and are able to crawl up structures to a certain degree. No information has been found on artificial structures to assist glass eels over sand bar barriers, although theoretically one could be devised.

The process of maintaining drainage pumps in the area may also have interfered with eel migration. In the early 1970s, in the Whakaki-Ohuia area, eels were continually being caught up in the drainage pumps, and installing smaller screens meant merely that large accumulations of smaller eels still triggered overload switches.[157] While this interfered with the viability of the pumping scheme, it also meant that numerous eels were being killed and natural eel movement (whether for feeding or migration) was being impeded. Eel ladders have been designed for elvers elsewhere and theoretically this problem could be overcome with some structural changes.

As discussed in the section above on commercial exploitation, the easiest time for capturing eels in coastal lagoons is when the adults crowd the bar seeking the sea, and controls are required to ensure a reasonable number escape to breed. Tangata whenua do not exert any particular eel fishing controls at this time.[158]

Eel farming

It has been suggested that if it is not possible to restore a healthy eel population in the lagoon (particularly if the necessary lagoon margin retirement and fishing controls are not put in place as well as a return to the Paakaa openings), eel farming might be considered as an alternative to supply eels for the people of the Whakaki Marae.

Eel farming is well established overseas, and six eel farms were established in the early 1970s in New Zealand. The longest running of these was at Te Kaha, operated in connection with tangata whenua and experts from Japan, but this closed in 1975. Problems encountered by New Zealand eel farms included an uncertain supply of glass eels, slow growth, disease, high production costs, and fluctuating export prices. The Te Kaha farm was handed over to the Government for research after it was found to be uneconomic, and researchers solved most of the technical difficulties. The problem

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155 D. Jellyman, pers. comm., 17/12/92.

156 McDowell 1990a, pp. 54-55.

157 Letter from the Hawke's Bay Catchment Board to the Director of Water and Soil Conservation, Ministry of Works, 9 March 1973, Works file 12/212000, National Archives, Wellington.

158 H. Solomon & J. Smith, pers. comm., 13/10/92.

remained that the cost of production, at least at that time, exceeded the returns possible from the domestic and export market.[159]

If eel farming were introduced to Whakaki for tribal use, commercial costs might not be relevant. The raising of eels in captivity would still cost money, however, whereas the harvest of eels from the wild is "free". It has been suggested that, rather than use commercial feed, earthworms could be produced from composted organic wastes. There has also been interest shown elsewhere in New Zealand in capturing young market-size eels and feeding them to improve their quality. Various combinations are possible, but costings have not been done for the Whakaki situation.

Eel farming cannot be considered a *substitute* for maintaining good eel habitat in the wild. Eels have not been induced to breed successfully in captivity, and captures of wild stock are essential both for farming of young eels and fattening older stock.

3.6.2 Other fish and shellfish

Carp

This "traditional" Whakaki Lagoon species, also called *morihana* (for Constable Morrison who introduced it to the Central North Island in the 1880s), is also known as the goldfish, or *Carassius auratus*.[160] This species was an important food source for tangata whenua prior to the direct bar openings in 1956.[161]

Despite suggestions to the contrary, the carp of Whakaki Lagoon are unlikely to be the European or Koi carp (*Cyprinus carpio)*, which is considered unlikely to have been established in New Zealand in any numbers before the 1960s. In addition, the European carp is considered a noxious species which contributes to serious turbidity problems, so its presence would be of considerable concern.[162]

The people of Whakaki Marae report that carp were once abundant in the lagoon, particularly near Kaingapipi, but now can be found only in the much more restricted areas and numbers in Patangata Lagoon and the tributary waters on the Iwitea side. They are a fresh water species, and tangata whenua have watched them actually keel over after entering salt/brackish waters in the lagoon from fresh water on the Iwitea side.[163]

Dewatering has also significantly affected the carp population in the lagoon. Observations have been made of carp stranded in dewatered areas (where birds flocked to harvest them) and washed out to sea as the lagoon emptied (when kahawai came to feed on them).[164]

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159 Jellyman and Todd 1982 p. 18; Jones, Astill and Kerei 1983; McDowall 1990a pp. 447-48.

160 McDowall 1990, pp. 231-235, D. Jellyman, pers. comm., 17/12/92.

161 Letter of 12 October 1939 from Department of Lands and Survey to Ministry of Works, citing loss of eels and carp as reasons local Maori would oppose draining of the Lagoon (Head Office Works files); and 1951 submission from people of Whakaki to the Minister of Maori Affairs (H. Solomon's files).

162 D. Stack, pers comm; McDowall 1990, p. 237

163 H. Solomon & J. Smith, pers comm, 13/10/92.

164 K. Hawkins, pers comm, 1992.

Carp or goldfish are tolerant of fairly eutrophic and turbid waters, and there is no evidence to suggest that siltation or nutrient runoff has posed a serious threat to their habitat.

To restore a carp population in the lagoon, the influx of the salt water would need to be reduced and a minimum water level maintained. It would seem that carp would not have to be reintroduced, assuming that the Patangata or Iwitea stock could spread back into the lagoon if the habitat were again suitable.

Mullets, herrings, and flounders

Mullets or kanae (*Mugil cephalus*), yellow-eyed mullets or "herrings" (*Aldreichetta forsteri*), and flounders (*Rhombosolea spp*) are saltwater species which are commonly found in estuaries, upstream in large rivers, and in coastal lagoons. Tangata whenua report that before the direct opening through the bar these species were common in the Patangata Lagoon and the Rahui Channel year-round. Now, the Rahui Channel is virtually silted in, and these fish have become seasonal visitors to Whakaki Lagoon, coming in when there is a bar opening and going out again through the next opening. Tangata whenua say that flounders especially come in and get fat in the lagoon, but then go back out to sea before they are old enough to be harvested for food.[165] Earlier harvests occurred on sandy stretches of the Rahui Channel and Patangata Lagoon,[166] but erosion in the upper catchment has contributed to covering previously sandy areas with silt.

Changing the outlet back to Paakaa has the potential to reverse the residence pattern of these species, but if the channel does not prove to be self-flushing for silt, the flounder may be less likely to re-establish.

Kokopu, inanga, and bullies

Kokopu and inanga or whitebait (*Galaxias spp.)* reside in fresh water as adults and migrate from the sea as juveniles. Three generations ago tangata whenua got good harvests of whitebait in and around Whakaki, but now only small amounts are found in the tributaries on the Iwitea side. Bullies (locally called cockabullies but probably *Gobiomorphus* rather than *Tripterygion*) were once extremely abundant in the lower reaches of the Waikatuku Stream by the marae, but they have gradually declined since the 1950s and are no longer found there.[167]

Although adult inanga are usually found in fresh water, they can also be found in brackish tidal estuaries and are very tolerant of salinities approaching and even exceeding sea water,[168] so salt water influx from the direct openings cannot be argued to have been the cause of the whitebait decline. Much more likely is the loss of seasonally flooded intact marginal vegetation, which is required for egg-laying above the water level in autumn high spring tides, and limited openings of the bar when the young whitebait need to return from the sea (see Table 3.4). Marginal vegetation is also required by kokopu for shelter.

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[165] H. Solomon & J. Smith, pers comm, 13/10/92.

[166] Solomon 1992.

[167] H. Solomon, J. Smith, J. Pryde, pers. comm., 1992.

[168] MacDowall 1990, p. 120.

In addition, both the kokopu and bullies require a clear sandy or rocky bottom,[169] which would have been obliterated through heavy siltation which took place in the 1950s-70s following the influence of farm development subsidies.

Resiting of the bar opening at Paakaa will not assist with the return of these species to the lagoon network unless more marginal vegetation is protected, openings are made in the bar during whitebait run times, and soil erosion controls in the upper catchment continue to be improved.

Use of the direct opening with addition of a weir, which has been proposed as an alternative option, would prevent whitebait from entering the lagoon and probably cause a further decline in the already diminished population.

Shellfish

The tangata whenua report both ngupara (a variety of mussel) and pipi as important shellfish for them in earlier times, and that the ngupara once grew in great numbers at Paakaa and Patangata Lagoon.[170] The ngupara is gone, and the pipi presumably is found near the direct opening instead, if at all.

Both species would require saline/brackish waters, and clean hard substrates (rocky for the ngupara, sandy for the pipi). Shifting the Lagoon exit to the west removed the direct influx of salt water, and heavy siltation over the 1950s-70s would have changed the substrate and clogged the filter-feeding mechanism of the shellfish.

To reinstate these species will require not only a return of the opening to Paakaa, but also deep dredging and clearance of the channel, siltation control in the upper catchment, and sufficient head of water in times of flood to flush silt clear.

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[169] McDowall 1990 pp. 94-125, 295-321.

[170] Solomon 1992.

TABLE 3.5: Summary of significant habitat changes for fish species in the Whakaki Lagoon area

SPECIES	Salinity changes	Siltation changes	Dewatering	Timing of openings	Loss of wetlands, vegetation on margins	Other
Eels (Short-finned)	**minor impact** - stress on food species	**minor impact** - some habitat filled in	**minor impact** - stress on food species	**SIGNIFICANT** - young need seasonal entrance from sea	**MAJOR IMPACT** - loss of wetland habitat	**use of fyke nets, caught in drainage pumps**
Carp (Goldfish)	**MAJOR IMPACT** - fresh to salt/ brackish in Whakaki	**minor impact** - some habitat filled in	**MAJOR IMPACT** - strandings, washed out to sea	not significant	not significant	
Mullet, Herring	not significant	**minor impact** - some habitat filled in	**MAJOR IMPACT** - strandings, washed out to sea	not significant	not significant	
Flounder	not significant	**possible impact** - silt covering sand	**MAJOR IMPACT** - strandings, washed out to sea	**possible impact** - entry of young to lagoon	not significant	Possible stratification and deoxygenation.
Inanga	not significant	**minor impact** - some habitat filled in	**minor impact** - majority not in main lagoon	**SIGNIFICANT** - young need seasonal entrance from sea	**MAJOR IMPACT** - veg. on margins essential for egg laying	
Kokopu, Bullies	not significant	**MAJOR IMPACT** - loss of sand, rocky bottom	**minor impact** - majority not in main lagoon	**SIGNIFICANT** - young need seasonal entrance from sea	**SIGNIFICANT** - provides shelter, some insect food	
SHELLFISH **Ngupara, Pipi**	**possible impact** -- saline changed to fresh in Patangata	**MAJOR IMPACT** - loss of sand, rocky bottom, clog filter feeding	not significant - Patangata does not dewater with direct opening	not significant	not significant	

GLOSSARY

Maori words

kaitiaki / kaitiakitanga	guardian, steward / guardianship, stewardship
kawanatanga	governance, government (includes central and local)
tangata whenua	"people of the land": the Maori iwi or hapu which has mana whenua over a particular area
taonga	anything of significance to Maori culture and spirituality; includes intangibles as well as objects of a tangible nature
tino rangatiratanga	chiefly authority, chieftainship, full authority
	... refers not to a separate sovereignty but to tribal self management on lines similar to what we understand by local government ... denotes the mana not only to possess what one owns but ... to manage and control it in accordance with the preferences of the owner.[171]

Technical terms

eutrophication	increase of nutrients in a water body
habitat	the place in which an animal or plant lives; particular features required for a healthy population to be sustained
riparian	along the edge of a waterway
R.L.	"reduced level": metres above mean high water sea level plus 10 (sea level set at a nominal 10.0 metres; therefore R.L. 11.8 means 1.8 metres above sea level)
salinity	degree of dissolved salts in water; (see Table 3.4 for salinity levels of fresh, brackish, or salt water)
turbidity	lack of clarity in water due to suspended particles

[171] Waitangi Tribunal, 1991, Ngai Tahu Report, pp.230-33.

REFERENCES

Acheson, A. R., 1968, *River Control and Drainage in New Zealand,* Ministry of Works.

Adams, J. S., 1982, *Statement by J.S. Adams, Senior Wildlife Officer, in support of water right application 810314/5 by the Trustees of Whakaki Lagoon before a special tribunal at Wairoa on 28 September 1982,* Wildlife Service, Department of Internal Affairs, Rotorua.

de Winton, Mary, **Champion,** Paul, **and Clayton,** John, 1992, *The Aquatic Vegetation of Whakaki Lagoon,* report prepared for the Hawkes Bay Regional Council, Ruakura Agricultural Centre, Ministry of Agriculture and Fisheries, Hamilton.

Chisnall, Ben, 1987, "Juvenile Eel Biology in the Backwaters of the Waikato River", MS Thesis in Biology, Waikato University.

Gerbeaux, P. J., 1989, "Aquatic Plant Decline in Lake Ellesmere: A Case for Macrophyte Management in a Shallow New Zealand Lake", Ph.D. Thesis, University of Canterbury, Christchurch.

Hawkes Bay Catchment Board: files 5/212000.

Hawkes Bay Regional Council: files 5/212000.

Jellyman, D., 1992, *A review of the eel fishery within New Zealand,* Freshwater Catch 49:14-15.

Jellyman D. J. and Todd P. R., 1982, *NZ Freshwater Eels; their biology and fishery,* Fisheries Research Division Information Leaflet 11, MAF, Wellington.

Jones J. B., Astill M., Kerei E., 1983, *The pond culture of Anguilla australis in NZ with special reference to techniques and management of the experimental farm at Te Kaha, Bay of Plenty,* Revista Italiana di Piscicoltura e Ittiopatalogia 18(3):85-117.

Leslie, V. J., "Funding of Land and Water Management in New Zealand", (dissertation), Lincoln University, 1989.

McDowall, R. M., 1975, *Reclamation and swamp drainage; their impact on fish and fisheries,* Fisheries Research Division Information Leaflet 6, MAF, Wellington.

McDowall, R. M., 1990a, *New Zealand Freshwater Fishes: A Natural History and Guide,* Heinemann Reed (Auckland) and MAF Publishing Group (Wellington).

McDowall, R. M., 1990b, *Conservation of New Zealand's Freshwater Fishes, New Zealand Freshwater Fisheries Report No. 116,* Ministry of Agriculture and Fisheries, Christchurch.

Ministry of Works: files (Head Office) 96/212000 (1938-1987)
(Napier District Office) 96/212000 (1948-1964, 1975-1984)

Mitchell, C., 1984, *The Lake Poukawa Traditional Eel Fishery: Problems and suggestions for a management strategy*, Fisheries Research Division, Ministry of Agriculture and Fisheries, Rotorua.

Nature Conservation Council, 1986, *Coastal Wetlands*, Information Booklet N. 25, Nature Conservation Council, Wellington.

Porter, S., 1991, *Objective 3.21 - Whakaki Lagoon Outlet (Planning/Ecological Input)*, memorandum to P. Koutsos and R. Coles, 23 September 1991, Hawke's Bay Regional Council, Napier.

Solomon, Huki, 1992, *Whakaki Lagoon Restoration project; tangata whenua - cultural aspects*, letter to the Parliamentary Commissioner for the Environment, 25 May 1992.

Stack, D. J., 1991, *Protection of Whakaki Lagoon - Wairoa Coastal Area*, background paper prepared 2 September 1991, Eastern Region Fish and Game Council, Rotorua.

Todd P. R., 1982, *Managing NZ's Eel Fisheries*, Catch (NZ) 9(2):5-6.

Town, J. C., 1985, *Commercial Freshwater Eel Fishery*, Fishery Management Planning Series No. 12, Ministry of Agriculture and Fisheries, Wellington.

Town J. C., 1986, *Eel fishery: future management*, Fisheries Management Plan Series No. 23, Ministry of Agriculture and Fisheries, Wellington.

Wairoa County Council: Minutes of Council meetings.

Whakaki Drainage Board: Minutes of Board meetings.

Williams G. J., 1982, *Whakaki Lagoon - Outlet Alternatives - report for the Wildlife Services*, Water and Soil Division, Ministry of Works and Development, Napier, Report No. WS &/212000.

Wilson, R. C., *Wairoa County Council - the First Hundred Years*, Wairoa County Council, 1978.