Survey Of Fish Species In Waituna Lagoon

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A Research Report Submitted in Partial Completion of the Diploma of Environmental Management

Southern Institute of Technology

Invercargill

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ABSTRACT

Waituna Lagoon is recognised as a place of ecological importance and has been set aside as a Scientific Reserve under the Ramsar Convention, 1971. The *Waituna Lagoon Summary of Existing Knowledge and Identification of Knowledge Gaps* (2003) identified that "the aquatic fauna of the Lagoon has not been studied in detail" (Pg.21).

Surveys of the fish species were carried out in the lagoon using three different capture methods over a five month period during the winter. At total of 171 capture nights were used. Ten species of fish were caught including two specimens of Giant Bully which had previously not been recorded in Waituna Lagoon. Common Bully was the most captured species, making up 91% of the sampled population. Insufficient data was obtained on the physical and chemical parameters which influence the fish species in Waituna Lagoon. However the greatest influencing factor was the open and closed status of the Lagoon, which encompasses a number of the parameters measured.

Capture methods greatly influenced the abundance and diversity of fish species caught.

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GLOSSARY

Anterior - Tooth situated at the front of the mouth;

Benthos - Bottom dwellers, organisms that live in or on the bottom of a water column.

Caudal - Of or near the tail or hind parts of a fish.

Diadromous – Migratory fish species, between fresh and salt waters

Hypural - Applied to the bones which support the caudal fin rays in most fishes, under the tail.

Nekton – All aquatic species that actively swim in the water column, such as fish or squid.

Non-Diadromous – Non migratory fish species, confined to one environment

Plankton – Drifters, all aquatic organisms that are carried passively in the water currents, such as jelly fish. Most are microscopic.

Operculum - The protective cover over a fish's gills and most amphibians

1 OBJECTIVE

The object of this research project was to survey the fish species in Waituna Lagoon. This will be achieved by using Fyke nets, Minnow traps, Spotlight techniques and Seine Netting.

2 HYPOTHESIS

To date there have been limited studies of the benthic and nektonic species present in Waituna Lagoon and associated tributaries. Due to the Waituna Lagoon being an ecotone it would be expected that a significant diversity of species will be encountered.

3 SIGNIFICANCE OF THE PROJECT

According to the *Waituna Lagoon Summary of Existing Knowledge and Identification of Knowledge Gaps* (2003) the aquatic fauna of the Lagoon has not been studied in detail.

Waituna in the Maori language translates into English as "water of eels" indicating the Waituna area was an important source of eels for local Maori (Department of Conservation (DoC), 2000). The *Department of Lands and Survey* (DLS) *Management Plan* (1984) noted, Shortfin Eel *Anguilla australis,* Longfin Eel *Anguilla dieffenbachii* along with Brown Trout *Salmo trutta*, which was introduced by the Acclimatisation Society in 1900 and "other galaxiids".

A study carried out by Riddell, Watson and Davis for the Ministry of Agriculture and Fisheries (1988) also found:

Table 1 – Fish Known To Be In Waituna Lagoon

Common Name	Scientific Name
Giant Kokopu	*Galaxias argenteus*
Banded Kokopu	*Galaxias fasciatus*
Inanga	*Galaxias maculatus*
Common Smelt	*Retropinna retropinna*
Redfin Bullies	*Gobiomorphus huttoni*
Lowland bullies	*Gobiomorphus cotidianus*
Laprey	*Geotria australis*

Other fish suited to estuarine conditions were also present, these include:

Table 2 – Fish Suited to Estuarine Conditions

Common Name	**Scientific Name**
Yelloweye Mullet	*Aldrichetta forsteri*
Cockabully	*Grahamina nigripenne*
Kahawai	*Arripis trutta*
Stargazer	*Leptoscopus macropygus*
Parrotfish	*Pseudolabrus celidotus*
Blackflounder	*Rhomboslea retiaria*
Yellow flounder	*Rhomboslea leporina*
Sand flounder	*Rhomboslea plebia*

(Galloway et. al., 1971) (Riddell et. al., 1988)

In total, 17 species of estuarine and lagoon fish have been identified.

4 LITERATURE REVIEW

4.1.1 Physical Setting and Geology

The Waituna area is classed as a lagoon. The classification is due to the irregular breaching of the gravel bar to form a connecting channel to the sea. This channel is restrictive in the water it can carry, limiting the amount of water able to ebb and flow. The restriction in flow also forces the water to pool behind the bar. Waituna Lagoon can further be classed as a 'coastal lake; these are usually connected with smaller tributaries and have a range of salinities (Kirk & Lauder, 2002).

The Lagoon is situated on a gravel outwash plain which dates back to the last ice age, 1.63 million years ago. (Thornton, 1990) The bed of the lagoon is composed of quartz gravels. Peat deposits 120 – 240cm deep are on the northern side of the lagoon. These peat deposits extend back and connect with the bogs, tarns and salt-marshes associated with the surrounding area (Kelly, 1968).

4.1.2 Classification of the Lagoon

Waituna Lagoon was first recognised as a place of ecological importance in 1971 when it was reserved "for wetland management purposes", under the Reserves Act 1977 (Department of Lands and Survey (DLS), 1984).

In 1976 the Waituna Wetland's status was elevated to Scientific Reserve under the Ramsar convention, 1971. Waituna Wetland was recognised as being an area of international significance because it covered three wetland types, Peatlands, gravel coastal beach and Lagoons, ponds and lakes (http://www.ramsar.org 2004).

Waituna Wetland's also provided significant waterfowl habitat and met five of the eight criteria for selection (Thompson & Ryder, 2003), these included:

- Ability to support a sizable amount of endemic and threatened species and communities.
- The ability to maintain the genetic and ecological diversity of the region.
- The ability to provide a habitat for plants and animals at particular stages of their life cycles.
- The importance of the area to migratory species.
- The Lagoons represents a wetland with minimal human impact.

(DLS, 1984), (Thompson & Ryder, 2003).

4.1.3 History

Little is known of the Maori history except that it was probably used as a fishing area, Waituna meaning "water of eels" (DLS, 1984).

Most of the land surrounding the wetland was regarded as unfit for development but was leased by the Crown for grazing on a yearly basis from 1849, the final lease expired in 1966 (DLS 1984).

Gold mining occurred at Busy Point gold field in 1866; it covered an area from the low tide mark to 800 meters above the high water mark and was situated from the Te Wai Peninsula to the Mataura River. The mining operation was not successful and the gold was considered an inferior quality to gold found else where in Southland (DLS 1984).

A number of huts were erected around the Waituna Lagoon from 1900 to 1971 without authority. These huts were mainly fisherman or waterfowl enthusiasts. In 1984 the DLS required that the huts be removed (DLS, 1984). Approximately 11 huts were removed. To date 15 huts remain standing and there are no concessions for these huts. However the policy has been as long the as huts are maintained and used they can continue to occupy the area (DoC, 2000).

4.1.4 Landcare Group

In 1998, Waituna Landcare was established (Pers. Comm., G Munro, 20.02.2005). It is one of a 187 Landcare groups set up around New Zealand. The Landcare Trust is a nationwide, independent body established in 1996. Their staffs are located around the country and facilitate local Landcare groups in encouraging sustainable land management and biodiversity. As well as representing outdoor recreation, environmental issues and agriculture interests (http://www.landcare.org.nz, n.d).

At present, the Waituna Landcare group undertake regular monitoring of the water in catchments which feed into the Waituna Lagoon. The testing is to build a profile of water quality in response to intensification of land use and development around the area (http://www.es.govt.nz, n.d).

4.1.5 Recreational and Economic Values

At present the lagoon is used for recreational activity, including fishing, shooting, bird watching and beachcombing. There are no commercial ventures in the lagoon although it does possess some economic values. These include:

- The bar is composed of shingle which could be used as a building material.
- Lignite deposits suitable for the liquid fuels industry.
- Eel fisheries.
- Extraction of peat for horticultural use.
- Gold, although this is of poor quality.

(Thompson & Ryder, 2003)

5 SUPERVISORS

Table 3 - Supervisors

Name	Title	Institution
Eric Edwards	Technical Support Supervisor Biodiversity Asset	Department of Conservation
Glen Webster	Lead Tutor Diploma of Environmental Management	Southern Institute of Technology

6 METHODOLOGY

Two methods were used for capturing fish, one passive method and one active method.

When nets were set or retrieved an inflated inner tube with a material cover and tow line was used to assist in holding and carrying equipment out to the different netting sights. The inner tube also acted as a floating desk.

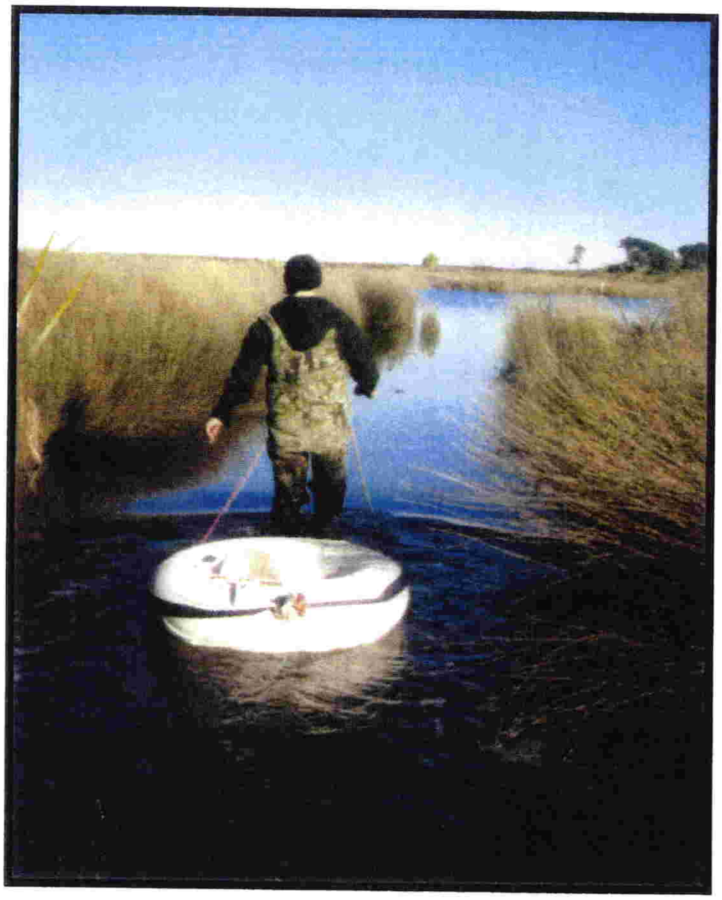


Figure 1 – Method for Transporting Equipment

6.1 7.1 PASSIVE CAPTURE METHODS

These methods involve capturing fish in traps which are stationary and are not moved by humans or machines while the fish are being captured. Entrapment methods are defined by the fish entering the device of their own free will. Bait or a diversion may be created to encourage the fish to enter the net. Once the fish enters the trap, it is able to escape through the entrance it came in, however the entrapment equipment is designed to make exiting more difficult (Starrett & Barnickol, 1955).

The advantage of passive equipment is that the technology is simple in design and structure, making it easy to use and care for. Also, few specialist skills are required to use the equipment. In addition, passive methods don't require the use of machinery for launching (Murphy & Willis, 1996).

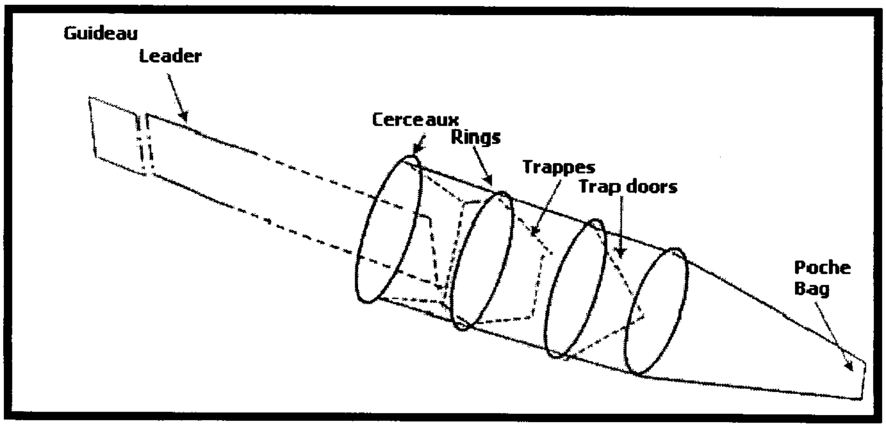
The disadvantage of passive equipment is the net size can greatly influence the fish size captured. If the mesh is large, juvenile or small fish species will pass through the net. Passive methods are dependent first on fish encountering the net. Secondly becoming entangled or trapped long enough to retain the fish until the net is retrieved (Starrett & Barnickol, 1955).

6.1.1 Fyke Nets

Fyke nets are tailored for habitats with little or no current. They have a elongated body and are held ridged by hoped, boxed or 'D' shaped rings. They have a lead net and a 'V' shaped opening to guide the organism into the equipment. The 'V' shaped opening makes it easy for the organism to enter but more difficult for it to escape (Starrett & Barnickol, 1955).

Fyke nets are generally used in shallow water and are effective at catching migratory species, which follow shorelines and fish which prefer cover. For this reason they are effective in swamp type habitats where vegetation if dense (Kelley, 1953).

Fyke nets are less stressful on captured fish because they do not suffer entanglement and can be released unharmed. However larger, more aggressive fish may prey on some small species while trapped in the net (Schneeberge, Rutecki and Jude 1982).



(www.glf.dfo-mpo.gc.ca/ fm-gp/mgmt-plan/nb-nb/evo)

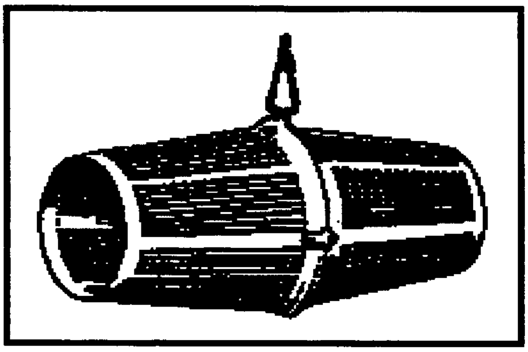
Figure 2 – Fyke Net

Fyke Nets were set in clusters of five or fourteen nets. The cluster of five Fyke nets was used during the preliminary survey to gain an understanding of method and obstacles which may of being encountered. The cluster of fourteen nets used during the main survey to provided a larger set of data.

The cluster of nets was set at nine different locations within the lagoon. The clusters of five nets were all set on the same evening in different locations and collected at the same time the following day. The clusters of fourteen nets were all set on different nights, in different locations of the Lagoon and collected the following day.

6.1.2 Minnow Traps

Pot gear refers to a variety of ridge traps, which includes Minnow Traps. These traps allows the fish to enter through a small opening that is difficult to exit. Pot gears is used to capture fish and crustaceans and are most effective in catching bottom dwelling species while they are looking for food or shelter. (Murphy & Willis, 1996).



(http://srmwww.gov.bc.ca/risc/pubs/aquatic/fishcol/fish-3.htm)

Figure 3 – Minnow Trap

Minnow Traps were set in Waituna Lagoon in clusters of four or eleven Traps at eight different locations. The different clustering of the Minnow Traps and Fyke Nets were due to the availability of equipment.

The cluster of four Minnow Traps was used during the preliminary survey to gain an understanding of method and obstacles which may of being encountered. The cluster of eleven traps was used during the main survey to provide a larger set of data.

The cluster of Minnow Traps was set at eight different locations within the lagoon. The clusters of four Traps were all set on the same evening in different locations and collected at the same time the following day. The clusters of eleven Traps were all set on different nights, in different locations of the Lagoon and collected the following day.

Generally the Minnow Traps and Fyke Nets were set in the same vicinity as each other.

6.2 Summary of Passive Sample Methods

Passive sampling is a useful tool for assessing fish species. However there are a number of environmental variables, such as physical, chemical, biological seasons, current, velocity and habitat type which influence quantity and species caught.

Equipment variables include material the mesh is constructed of, mesh size, duration the net is set for, location, escape rates and mobility of species.

6.3 ACTIVE FISH CAPTURE METHODS

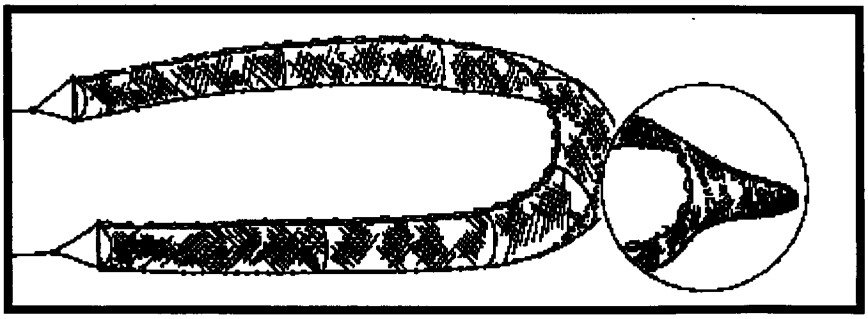
Active capture methods involve human or equipment moving through the water to capture the fish species. They tend to cover a specified area and occur over a classified time frame. Although there are a variety of active capture methods, Seine Nets are the most practicable method for Waituna Lagoon.

6.3.1 Seine Nets

Seine nets collect the species sample by capturing them in a large net. The Seine Net used required a minimum of two people on each end to drag it through the water. The Seine net has a cod end, where the captured specimens collect. The cod end is tied shut while fishing and opened when the net is retrieved (Murphy & Willis, 1996).

In estuarine habitats, seine nets are the most common method of sampling species as a small area can be sampled over a set timeframe. A variety of species ages and sizes can be caught depending on the mesh size and abundance of species can be determined (Murphy & Willis, 1996).

The tow net method should be done over a short time period and carried out slowly. This will increase survival of the fish and reduce the amount of injury while captured (Murphy & Willis, 1996). Seine nets can be easily damaged when snagged on underwater obstacles. Time needs to be taken to assess the trawl area for any obstruction (Murphy & Willis, 1996).



(http://srmwww.gov.bc.ca/risc/pubs/aquatic/fishcol/fish-3.htm)

Figure 4 – Seine Net

Five Seine Net sweeps were carried out different locations within the Lagoon. These sweeps were carried out on two separate days. Three sweeps were carried out on 2nd March 2005 and two sweeps were carried out on 12th August 2005. Each sweep was 100 metres long.

6.4 Summary of Active Sample Methods

Active methods are a good tool for determining species density or relative abundance. As well, benthic species can be targeted as the net can be set to cut into the substrate. Active methods can also be applied to streams or a river, However it maybe difficult to control the net in a current (Murphy & Willis, 1996).

6.5 BAITS

A variety of lures were used to attract fish species.

Marmite is known to appeal to fish and was set in nets using a small container with small perforations (Pers. Comm., E. Edwards, 01.03.2005).

On moonless nights chemical glow sticks were used in Minnow and Fyke nets to attract fish species.

6.6 FISH HANDLING

Fish have a protective mucilaginous outer layer of 'slime' that shields them from infection, parasites and the effects of water. Handling of the fish can remove this protective layer, causing burning when the fish is returned to water. A thrashing fish can scratch or harm itself making it prone to infection and disease, as well there wounds can take longer to heal without the mucilaginous layer (Goldes & Nothcote, 1997).

Fishes chest organs are not well supported by the muscle. Handling out of water for long periods of time increases the risk of internal injuries, for this reason fish should be kept in their natural horizontal position (Goldes & Nothcote, 1997).

6.6.1 Careful Handling

Studies have shown that all aspects of handling (time out of water, data collection, netting time) are highly stressful on the fish (Thomas & Robertson 1991). To prevent injuries occurring some precautions were taken to prevent squeezing or dropping when the fish thrashed.

- Hands were kept cool and wet. Fish are cold-blooded animal and need to maintain their cool body temperature. Oils and chemical residues on hands can burn the fish's skin (Pers. Comm., E Edwards, 01.02.2005).

- Care was taken to handle the fish gently to prevent dislocation of the vertebrates and not to handle the fish by the operculum as this can interrupt the blood flow to the gills, cause haemorrhage and affect respiration.

- Keep contact time with the fish as short as possible to reduce any disease or harmful elements the fish is exposed to.

- All equipment was organised prior to the nets being retrieved, keeping the time the fish were handled to a minimum increasing its chances of survival once released.

- All fish were released back into the environment it was caught to insure it was returned to the correct habitat.

6.6.2 Animal Welfare

Depending on the type of equipment being used to survey fish, mortality rates and stress can vary. Trapping over long periods of time increases the risk of mortality. To reduce trauma, stress and mortality, the nets in the Waituna Lagoon will be set for no long than a 24 hour period (Pers. Comm., E. Edwards, 11.03.2005).

As outlined in section 9.0 Fish Handling, all precautions were taken to minimise the stress to the fish.

This research project met all guidelines set down by the Southern Institute of Technology's Animal Ethics Committee.

6.7 DATA COLLECTED

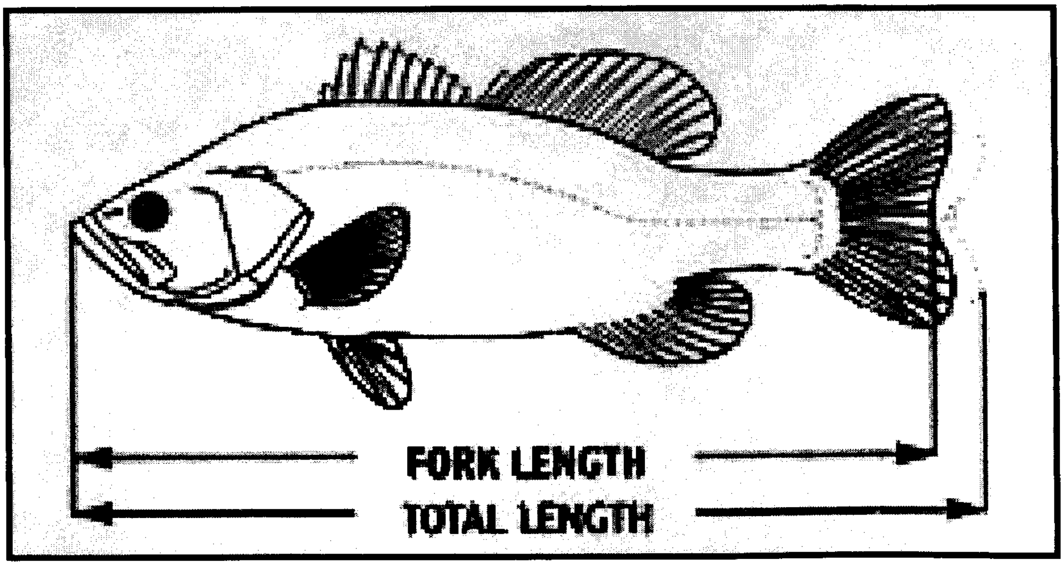
Data collected from the fish consisted of species identification and length of the fish.
Field guides, reference books, internet and experts in their field were used to identify fish species. Length of the fish provides information on the range of sizes present in Waituna Lagoon, indicating if the population is well represented or if age gaps are present.

6.7.1 Length

Length is important for determining the age and growth rates in a fish population.
There are two common measurements which will be used. Theses dimensions measure the length of the fish (Anderson & Gutreuter, 1983).

Fork length is measured from the tip of the nose (anterior) to the fork of the tail (caudal). This method and is only suitable for fish with forked tails such as salmon or trout (Anderson & Gutreuter, 1983).

Total length is the distance from the most anterior part of the head to the tip of the longest caudal fin. This measurement is useful on fish without forked tails (Anderson & Gutreuter, 1983).



(http://www.mdcoastalbays.org, 2005)

Figure 5 – Measuring Fish Length

6.8 ENVIRONMENTAL MONITORING METHODS

6.8.1 Environmental Cycles

Annual, monthly and daily cycles were recorded as fish behaviour, including breeding; feeding, spawning and migrating can be affected by these cycles. For this reason the following data has been recorded

Table 4 – Environmental Variables Monitored

ENVIRONMENTAL CONDITIONS	HOW RECORDS ARE KEPT	IMPACTS OF ENVIORNMENTAL CONDIIONS
Weather Conditions	Record weather conditions when nets are set	Will indicate if there is a relationship between fish using Waituna Lagoon and weather conditions
Date/Time	Record when nets were set.	Allows weather patterns and lunar cycles to be looked at in more detail at a later data.
Lunar Cycle	Lunar Cycle affects feeding patterns of fish	The number of fish caught maybe influence by the Lunar Cycle.
Tides	Tidal pattern at Waituna Lagoon vary greatly from the recorded Bluff Harbour area	Influence how effective capture methods are.

6.8.2 Location

A variety of environmental measurements were taken to ascertain if there is any correlation between fish species captured and the physical and chemical environment.

Table 5 – Water Chemistry Monitored

Depth	▪ Measurements were taken when the net were set ▪ The measurement was taken at the entrance of the Fyke and Minnow nets and at the beginning of Seine tows. ▪ **Measured in:** Millimetres (mm)
Temperature	▪ Measurements were taken when the nets were set. ▪ Temperature was taken at the entrance of Fyke and Minnow nets and at the beginning of Seine tows. ▪ **Measured in:** degrees Celsius (C')
Salinity	▪ Measurements were taken when the nets were set ▪ Electro conductivity was taken at the entrance of Fyke and Minnow nets and at the beginning of Seine tows ▪ **Measured in:** (μS/cm) (http://www.affa.gov.au, 2004)
Composition of the Substrate	▪ Measurements were taken when the net ▪ Samples were taken at the entrance of Fyke and Minnow nets and at the beginning of Seine tows ▪ **Method:** percentage estimation of different materials present on substrate
Electro conductivity	▪ Measurements were taken when the net ▪ Samples were be taken at the entrance of the Fyke and Minnow nets and at the beginning of Seine tows. ▪ **Measured in:** (mS/cm). (http://www.hydroponics.com, 2005).

6.8.3 HEALTH AND SAFETY

Table 6 – Health and Safety

Hazard	Mitigation
Mud • In places of the Waituna Lagoon the mud is deep and viscous, making it hard to move around or causing impediment.	▪ Work in pairs ▪ Use a pole for support ▪ Keep hands free
Weather ▪ Sudden Change in the Weather: ▪ Cold ▪ Wet ▪ Wind ▪ Hypothermia ▪ Dehydration	▪ Carry extra warm clothing ▪ Carry water proof clothing ▪ Check coastal forecast before going to Waituna Lagoon ▪ Keep an eye on any changes in weather ▪ Where possible work with other people. ▪ Carry extra food and drink
Working By Self	• Where possible carry a cell phone ▪ Carry a first aid kit ▪ Carry extra clothing ▪ Carry extra food and drink

Tides and Currents • The tidal system at Waituna Lagoon are unique and varies greatly to Bluff, the nearest recorded coastal point.	▪ Check tides before departing Invercargill ▪ Use people with local knowledge ▪ Keep an eye on tides
Waders ▪ Slipping ▪ Drowning, ▪ Restricted movement.	▪ Be aware of uneven bottoms, currents and slippery surfaces. ▪ Waders need to fit correctly and allow mobility ▪ Where appropriate use a stick for support. ▪ Keep hands free ▪ Ensure wader clips are fasten and unfasten correctly ▪ Ensure volunteers are comfortable wearing waders and know the dangers associated with them
Cross Contamination ▪ Exposure to infection or disease through cuts or abrasions on skin. ▪ Damage to skin when skin is wet for long periods of time	▪ Wear gloves where appropriate to reduce the risk of cuts to hands ▪ Keep skin dry where possible. ▪ Take care when handling rough/coarse objects.
Duck Hunting Season	▪ Wear high Visibility vest at all times ▪ Leave note on dashboard of car so hunters in the area are aware there is someone in the lagoon

6.9 EQUIPMENT

Table 7 - Equipment

Areas To Consider	**Item**	**Quantity**
Passive Nets	Fyke Net	14
	Minnow Net	11
Active Nets	Push Nets	2
	Seine Net	1
Other Equipment	Floats	11
	Bamboo Poles	40
Recording Equipment	Thermometer	1
	Salinity Tester	1
	Clarity Tube	1
	Sample Containers – various sizes	10
	Buckets	2
	Waders	3
	GPS	1
	Waterproof Paper	20 Sheets
	Flagging Tape	1
	Clip Board	1
	Pencils	10
Safety Equipment	Wet Weather Gear	1 set
	Warm Clothing	1 set
	Visibility Vest	3
Floating Desk	Inner Tube	1
	Inner Tube Cover	1
	Rope	1
	Fish Keys	1

7 RESULTS

The study was carried over the winter months from the 2nd March to 29th August 2005. The bar of the Waituna Lagoon was closed by shifting gravel for 54 days from the 1st June to 24th July 2005, when it was reopened by Environment Southland (ES) using machinery. Over the period of time the Lagoon was closed the water level rose by about 1.2 meters, making access into the Lagoon difficult in places and impossible in others.

Prior to the survey commencing a preliminary survey was carried out under the guidance of Eric Edwards and Helen Kettles from DoC. This preliminary survey was over two days and one night, 1st and 2nd March 2005, the findings have been included in this report.

Table 8 – Species of Fish Captured in Survey

Common Name	Scientific Name	Total	% of Species Captured
Yelloweye Mullet	*Aldrichetta forsteri*	12	1.05%
Common Bully	*Gobiomorphus cotidianus*	1045	91.43%
Redfin Bully	*Gobiomorphus huttoni*	1	0.09%
Giant Bully	*Gobiomorphus gobioides*	2	0.17%
Longfin Eels	*Anguilla dieffenbachii*	6	0.52%
Shortfin Eels	*Anguilla australis*	25	2.19%
Yellowbelly Flounder	*Rhombosolea leporina*	14	1.22%
Black Flounder	*Rhombosolea retiaria*	1	0.09%
Brown Trout	*Salmo trutta*	5	0.44%
Common Smelt	*Retropinna retropinna*	31	2.71%
Estuarine Stargazer	*Leptoscopus macropysus*	1	0.09%
	Total	**1143**	**100%**

Between the preliminary survey carried out with DoC and the survey for this report a total of ten different fish species were captured, totalling 1146 individual fish.

Of the ten species of fish captured in the Lagoon, the Giant Bully (*Gobiomorphus gobioides*) was not previous recorded in Waituna Lagoon.

Table 9 - Habitat and Behaviour of Species Captured

Scientific Species Name.	*(Aldrichetta forsteri)*	*Gobiomorphus cotidianus*	*Gobiomorphus gobioides*	*Anguilla dieffenbachii*	*Anguilla australis*	*Rhombosolea leporina*	*Rhombosolea retiaria*	*Salmo trutta*	*Retropinna retropenna*	*Leptoscopus macropygus*
Common Fish Species Name	**Yelloweye Mullets**	**Common Bully**	**Giant Bully**	**Longfin Eel**	**Shortfin Eel**	**Yellow Belly Flounder**	**Black Flounder**	**Brown Trout**	**Common Smelt**	**Estuarine Stargazer**
Fresh Water Species								X	X	X
Brackish Water Species (Estuary)	X		X			X	X	X	X	X
Marine Water Species (Sea)	X								X	X
Migrate to Marine Water	X	X	X	X	X	X	X			X
Migrate To Fresh Water								X		
Marine Spawning	X			X	X	X	X			X
Freshwater Spawning		X	X					X	X	
Introduced								X		
Native	X	X	X	X	X	X	X		X	X

7.1.1 Marine Species

The Yelloweye Mullet (*Aldrichetta forsteri*), Estuarine Stargazer (*Leptoscopus macropysus*) and Common Smelt (*Retropinna retropinna*) were the only marine species captured of the ten species identified. All three species can live in brackish water and can tolerate fresh water but their preferred habitat is the marine environment.

7.1.2 Estuarine Species

Six estuarine species were identified. The Yellowbelly Flounder (*Rhombosolea leporina*) resides in brackish water and migrates into the fresh water environment.

7.1.3 Fresh Water Species

In contrast the Brown Trout (*Salmo trutta)* and Giant Bully (*Gobiomorphus gobioides)* tolerate brackish water but reside in fresh water.

Common Bully *(Rhombosolea retiaria)*, Black Flounder *(Gobiomorphus cotidianus*), Shortfin *(Anguilla australis)* and Longfin Eel *(Anguilla dieffenbachii)* are fresh water species; however the Short and Longfin Eel migrate to the subtropical Pacific Ocean to spawn.

Brown Trout (*Salmo trutta*) was the only introduced fish species captured in this survey.

All of the species captured were diadromous. Six of the species migrated to the marine environment for spawning while the Common and Giant Bully (*Gobiomorphus spp.*) migrate to the marine environment during the larva stage for 3-4 months. In contrast the Brown Trout travels upstream, migrating within the fresh water environment for spawning.

Common Smelt (*Retropinna retropenna*) migrate from the marine environment to fresh water to spawn (McDowall, 2000).

A total of 171 nets were set over the survey period. A variety of different results were obtained from the three capture methods employed. The capture methods have being presented as a percentage of the total number of times each capture methods was used.

Table 10 – Net Types and Capture Rates

	Percentage of Total Fish Caught	**Percentage of Total Time Net Type Was Use**
Fyke Minnow	20.44%	57.89%
Minnow Traps	18.16%	39.18%
Seine Net	61.40%	2.92%

7.1.4 Fyke Nets

Of the total capture methods used, Fyke nets were set 99 times or 57%. The Fyke Nets caught 20% of the total sampled population of fish species captured.

Fyke Nets trapped eight different species of fish in the Lagoon, of the species captured 76% of them were Common Bully.

7.1.5 Minnow Traps

Minnow Traps were used 39% of the time or 67 net nights and caught 18% of the sample population.

Only two species of fish were caught in the Minnow Traps, these were the Common Bully and Shortfin Eels less than 250 mm in length.

7.1.6 Seine Net

Seine Netting was used les than 3% of the time or five sweeps in the Lagoon and captured the greatest abundance of fish, a total of seven different fish species were caught using the Seine Net.

7.1.7 Open and Closed Status of the Lagoon

The open and closed status of the Lagoon influenced the abundance of fish captured. The Lagoon was closed 20% of the time during which 12% of the surveyed population was captured. In contrast the Lagoon was open 80%of the time and a larger abundance of fish were caught, 88% of the surveyed population.

8 DISCUSSION

A total of ten species of fish were captured over the survey period. Some species, such as the Estuarine Stargazer (*Leptoscopus macropysus*), were caught in low numbers. The low capture rate of such species has limited the ability for discussion. Some species which are abundant in Waituna Lagoon have been further examine in detail.

8.1.1 Giant Bully (Gobiomorphus gobioides)

Two Giant Bullies were caught in Waituna Lagoon. Both specimens were caught in the same Fyke Nets on the same night. The Giant Bully (*Gobiomorphus gobioides*) is the largest member of the Bully family. Giant Bullies less than 80mm in length have rarely being identified as they are not easily distinguished from Common Bully (McDowall, 2000).

Little is known of the life cycle of Giant Bully. It is believed that the larvae have a marine phase, but no juvenile Giant Bullies have ever been positively identified. It is unclear if small Giant Bullies have not been distinguished from Common Bullies or if they reside in a different habitat. Adult Giant Bullies have only ever been found a few kilometres inland and it is possible that they may spend a long periods in estuaries before moving into fresh water environment (McDowall, 2000).

(NIWA Atlas of New Zealand Freshwater Fishes, 2005)

Figure 6 – Giant Bully *(Gobiomorphus gobioides)*

8.1.2 Common Bully (Gobiomorphus cotidianus)

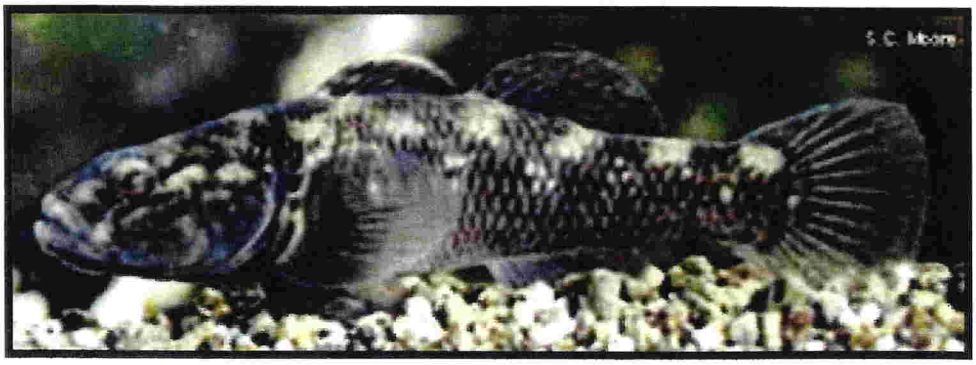
Common Bully (*Gobiomorphus cotidianus*) was the most abundant of all the species captured, making up 91% of the sampled population.

Common Bully is a freshwater fish (Graham, 1974) found throughout New Zealand, from sea level to 313km in land. Common Bullies have been established on Steward Island, Chatham Islands, many coastal islands and inland lakes, with human assistance (McDowall, 2000).

Common Bullies prefer habitat that has a gravely bottom and a gentle current, they occupy the margins of lakes and wetlands (McDowall, 2000). Waituna provides ideal habitat for this species

The Common Bully spawns in the spring and summer months. Eggs take several weeks to develop. The hatched larvae then migrate out to sea for three to four months and return when they are 15-20 millimetres long (McDowall, 2000).

Populations which become landlocked discard their migration to the sea and live all their life stages in the one environment. Often non-diadromous Common Bullies are much smaller, reaching only 60mm, compared to diadromous Common Bullies, which often reach 100mm (McDowall, 2000).



(NIWA Atlas of New Zealand Freshwater Fishes, 2005)

Figure 7 – Common Bully *(Gobiomorphus cotidianus)*

One thousand one hundred and forty five Common Bullies were caught and their length recorded in 10mm class sizes.

Figure Eight shows the distribution of class sizes of Common Bullies caught. This graph is negatively skewed, representing a bias to the lower end of the graph which indicates the majority of the sampled population is between 21-40mm.

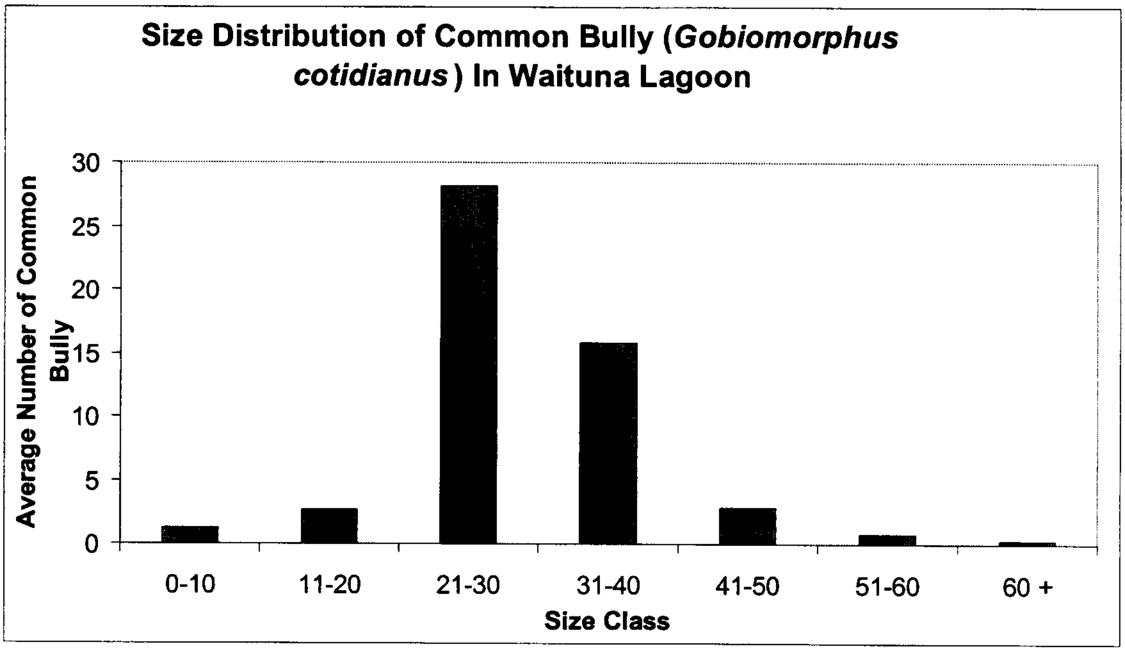


Figure 8 – Size Distribution of Common Bully

Common Bullies, 60mm plus made up only 1.2% of the sample population. The low number of Common Bullies over 60mm indicates that Common Bullies in Waituna Lagoon have discarded the migration phase. This may be due to the irregular opening and closing of the Lagoon.

8.1.3 Common Smelt (Retropinna retropinna)

Common Smelt were the second most common species caught in Waituna Lagoon. All the samples captured were caught during two seine net sweeps. Common Smelt were 67% of the sampled population. The seine net sweep completed on the 2nd March captured 32% of the sampled population compared to 68% on the 12th August.

Common Smelt migrate from the sea to fresh water to spawn (McDowell, 2000). They live in flowing and still water, and there are both diadromous and non-diadromous. Diadromous populations of Common Smelt are usually greater than 70mm in length (Woods, 1963). Of the 31 specimens captured from the Waituna Population 29% were longer than 70mm, indicating that some specimens may be diadromous.

(NIWA Atlas of New Zealand Freshwater Fishes, 2005)

Figure 9 – Common Smelt *(Retropinna retropinna)*

There are a number of factors which may have influenced the different capture success of Common Smelt in March and August. Common Smelt die after spawning in summer and autumn (McDowall, 2000). The lower captured rate experienced in March may be due to the reduced adult population size.

Although August may be considered early for migration (Woods, 1963) it may account for the higher numbers of Common Smelt captured in this month.

Common Smelt are sensitive to environmental changes, such as temperature and ammonia levels, making them good indicators. (http://www.niwascience.co.nz, 2005). The absence of pollutants may have contributed to the higher capture numbers in August. Alternately environmental variables with in the Lagoon may have contributed to the capture rates. Very little data is available on the water chemistry during the capture period except for the water temperature. The water temperature in the Lagoon during the March capture averaged 14 degrees Celsius and ten specimens were caught. In comparison the temperature in August averaged 8.5 degrees Celsius and twenty one specimens were caught.

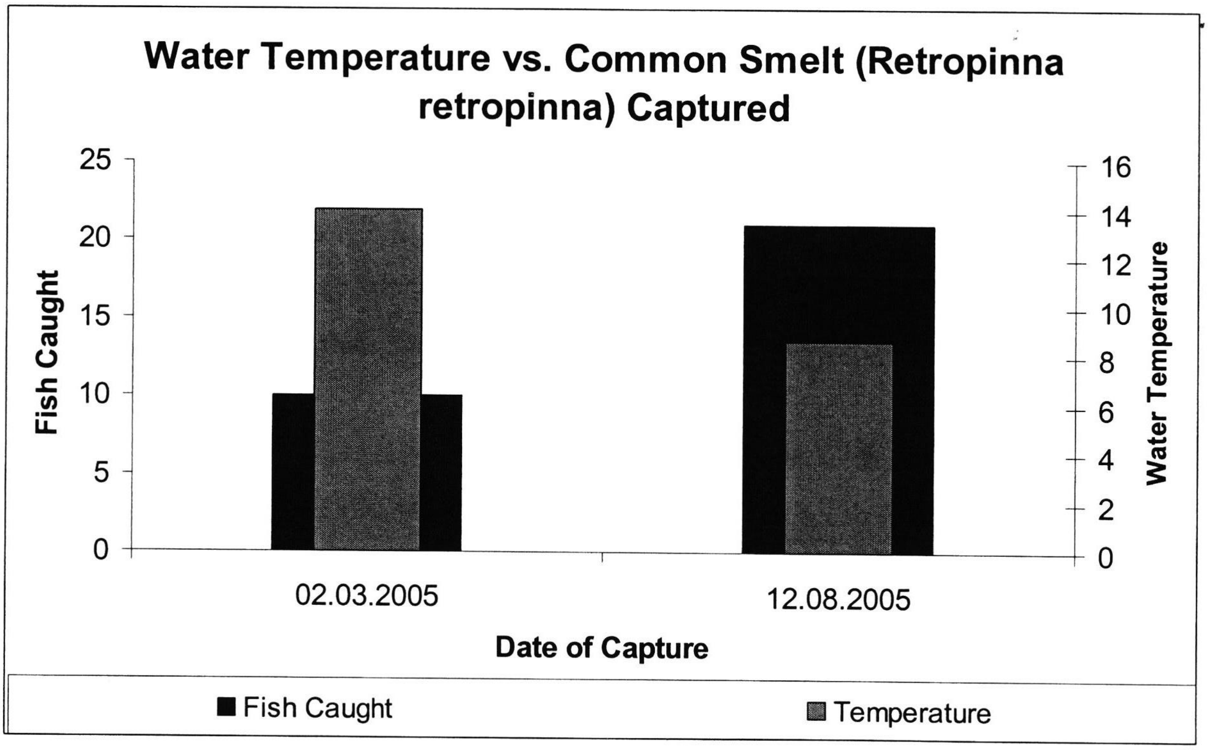


Figure 10 – Size Distribution of Common Smelt

In 1985 fish species were sampled in the Waituna Lagoon as part of an investigation in to lignite deposits. Two seine net drags were completed sometime between January and August 1985.

The methodology and seine net used were similar to this current survey; however the results differed in that the 1985 survey caught 382 Common Smelt, making it the dominant species caught in the Lagoon (Investigation of the suitability of three lignite deposits in Otago and Southland, 1985).

It is believed the habitat in Waituna Lagoon is deteriorating due to changing land uses surrounding the Lagoon (pers. comms, Ray Waghorn, 07.8.2005). However the presences of Common Smelt in the Lagoon indicate the habitat is still reasonable pristine.

8.1.4 Shortfin (Anguilla australis) & Longfin Eels (Anguilla dieffenbachii)

Shortfin eel (*Anguilla australis*) were common, with 25 specimens being captured in the Lagoon. In comparison, the Longfin Eel (*Anguilla dieffenbachii*) was far less common and constituted only six specimens being caught, only a quarter of the total Eel specimens captured.

Male Eels reach between 600 - 700mm; in comparison the female eels are much larger, ranging in size from 1200 – 2000mm (McDowall, 2000). The average size class of both the Longfin and Shortfin Eels captured in Waituna Lagoon was 500-750mm. This size class may consist of large male eels or immature female eels which have yet to reach their full length.

None of the Shortfin Eels captured displayed the enlarged eyes, thin lips or change in colour of a mature Shortfin Eel (McDowall, 2000).

Similarly, the Longfin Eels caught all had the distinguished domeon the head (McDowall, 2000), indicating they had not migrated to sea.

These features as well as indicating maturity also provide an indication of age. Shortfin eels mature between 15-30 years and Longfin Eels mature later, between 25-25 years (McDowall, 2000). Because none of the specimens captured in Waituna Lagoon showed signs of maturity it can be assumed specimens were less than 30 years old.

(NIWA Atlas of New Zealand Freshwater Fishes, 2005)

Figure 11 – Shortfin Eel (Anguilla australis)

Eels are more active in water above 10 degrees Celsius (McDowall, 2000). During the period surveyed Waituna Lagoons water averaged 7.52 degrees Celsius which may have influenced how inactive the Eel population was and there fore how many individual specimens were captured. It would be expected that the abundance of Eels caught would increase as the water temperature rose.

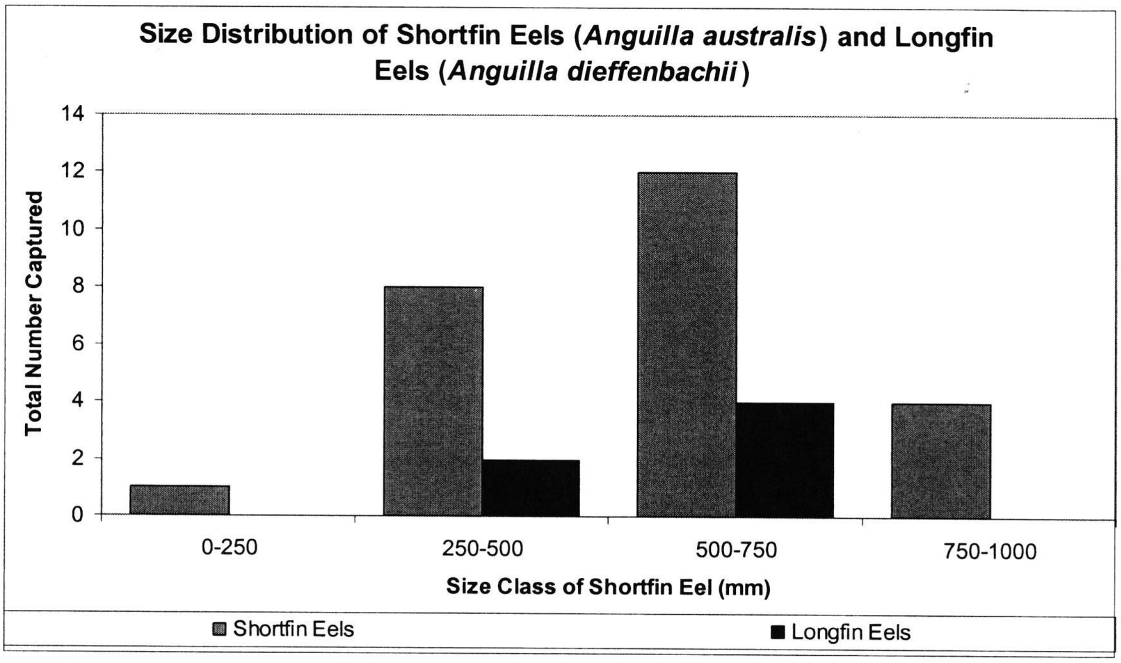


Figure 12 – Size Distribution of Shortfin and Longfin Eels

8.1.5 Yelloweye Mullet (Aldrichetta forsteri)

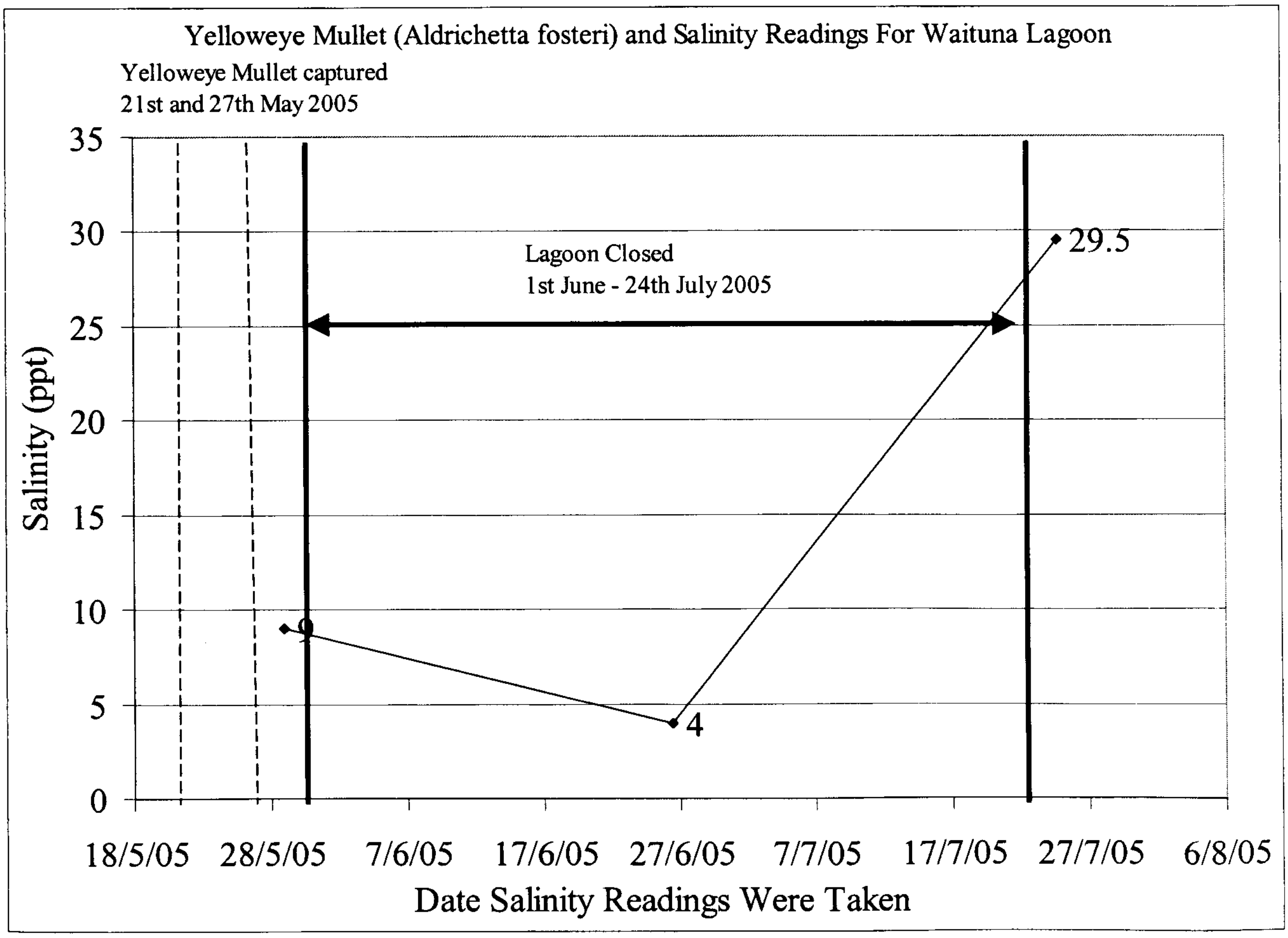
The Yelloweye Mullet (*Aldrichetta forsteri*) is a marine species, which reside in brackish water and journeys into fresh water. They often enter estuaries and tidal reaches on an incoming tide and depart on the outgoing tide (McDowall, 2000).

In this survey Yelloweye Mullets were only caught on two occasions, both instances with Fyke Nets. Eleven specimens were caught on the 21st May, 2005, while one specimen was caught the following week on the 27th May, 2005.

(NIWA Atlas of New Zealand Freshwater Fishes, 2005)

Figure 13 – Yelloweye Mullet (Aldrichetta forsteri)

All the specimens were captured a month prior to the Lagoon closing. According to Environment Southlands ongoing collection of data in Waituna Lagoon, (provided by Michelle White) the salinity level of 29th May was around 9.3 parts per trillion (ppt), dropping to 4.5 on 26th June, 2005. Although the Yelloweye Mullet can spend considerable amount of time in fresh water it is a marine species and cannot permanently live in fresh water (NIWA Atlas of New Zealand Fishes, 2005). With the Lagoon closed to the marine environment until the 24 July, 2005 it can be assumed the salinity level continued to decrease making the environment uninhabitable to the Yelloweye Mullet.



(Environment Southlands Ongoing Collection Of Data In Waituna Lagoon)

Figure 14 – Yelloweye Mullet and Salinity

8.1.6 Yellowbelly Flounder (Rhombosolea leporina)

Yellowbelly Flounder is an estuarine species, preferring brackish water but is occasional found in fresh water. Little is know about this species (McDowell, 2000).

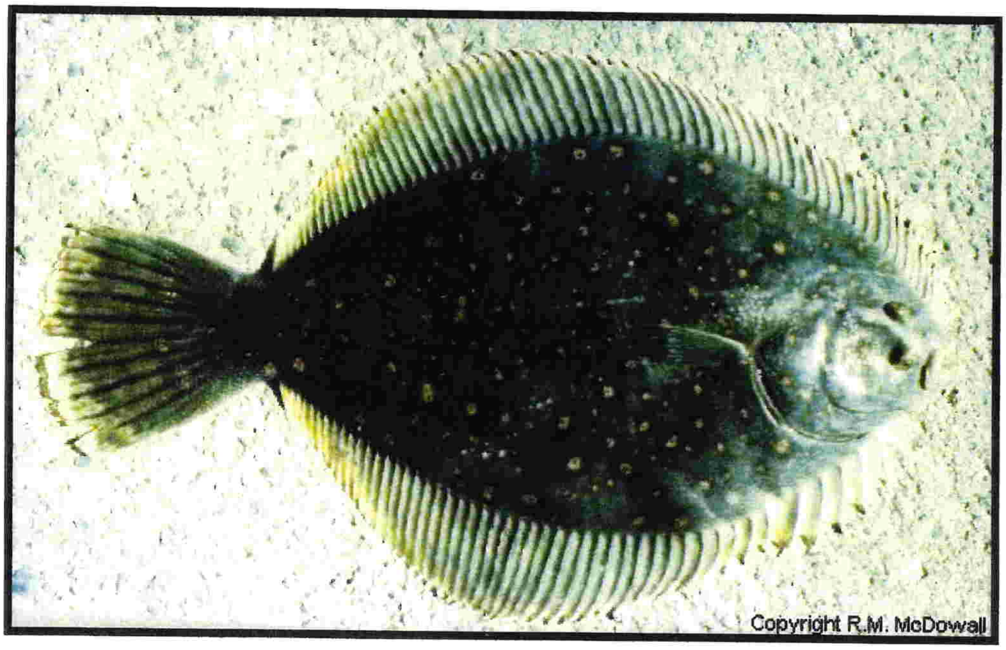
Although Yellowbelly Flounder can grow up to 500mm in length, of the 14 specimens caught none were greater than 300mm in length. The *Investigation of the suitability of three lignite deposits in Otago and Southland* (1985), only found three specimens in the Waituna Lagoon.

The sample of Yellowbelly Flounder captured in Waituna Lagoon was only 1% of the sample population captured so it is unlikely to provide a representation of the population.

8.1.7 Black flounder (Rhombosolea retiaria)

The Black Flounder is unique to New Zealand. It is the only member of the Flounder family that is considered a freshwater species. The Black Flounder is generally found near the coast and provided the incline of a river isn't too steep they can move in land.

Waituna Lagoon provides ideal habitat for the Black Flounder as it is is carnivorous, eating a variety of macro invertebrates and white bait. Little is know about their life cycle but is likely to have a marine phase.



(NIWA Atlas of New Zealand Freshwater Fishes, 2005)

Figure 15 – Black Flounder (Rhombosolea retiaria)

8.1.8 Brown Trout (Salmo trutta)

Past capture rates of Brown Trout (*Salmo trutta*) in Waituna Lagoon are low (Summary of Existing Knowledge, 2003). The findings from this survey are consistent with the historical data. Only Five Brown Trout were captured, which constituted less than 1% of the sampled population. Although the catch rates of Brown Trout in Waituna Lagoon is low, the population is self sustaining with both a diadromous and non diadromous population (Summary of Existing Knowledge, 2003). Due to the low number of Brown Trout captured no conclusions can be drawn.

(NIWA Atlas of New Zealand Freshwater Fishes, 2005)

Figure 16 – Brown Trout (Salmo trutta

8.2 VARIABILITY IN NET TYPES

A total of 171 nets were set from 20th June to 29th August 2005. It would appear that the capture method and characterises of the net tyes influenced the diversity and abundance of fish species captured.

8.2.1 Capture Method

Of the three capture methods employed, Fyke Nets were employed most often, 57.89% of the time followed by Minnow Traps, (39.18%) and Seine nets for the least amount of time, less than 5%.

The Seine Net was employed the least but captured the most specimens, more than 60% of the total sampled population. Seine Nets are an effective method for surveying Waituna Lagoon for a variety of species.

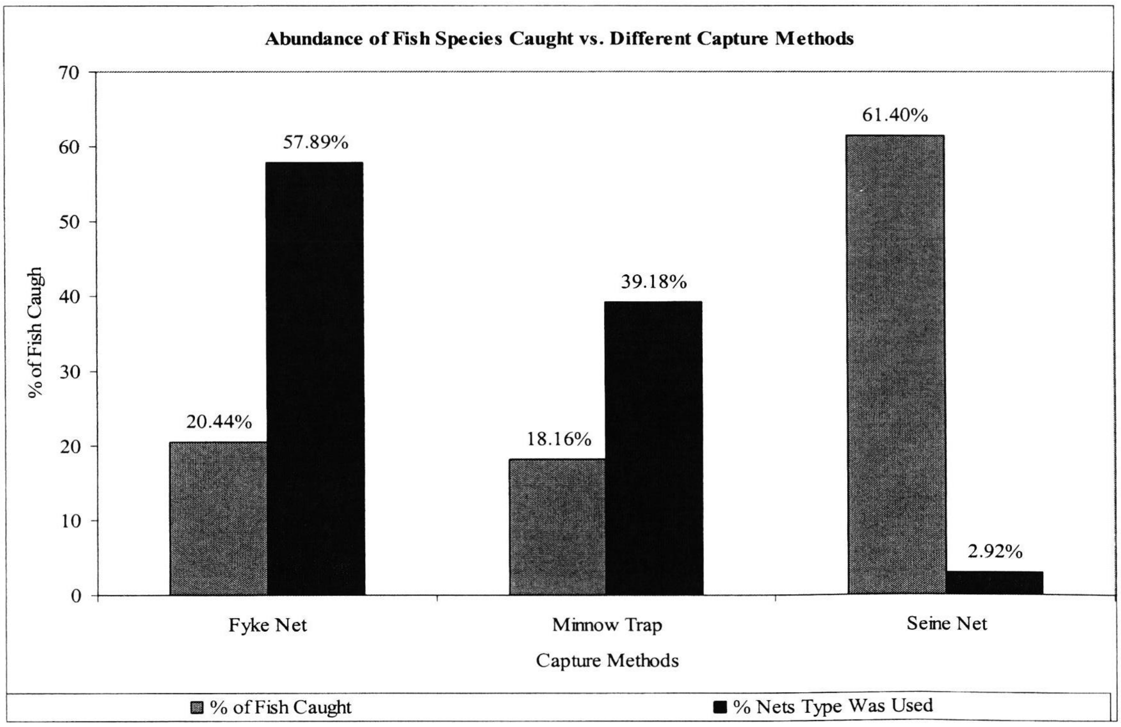


Figure 17 – Fish Numbers Caught vs. Capture Methods

As well as the Seine Net capturing the greatest abundance of fish species it also captured a variety of different species. These species included Brown Trout, Black Flounder, Common Smelt and Estuarine Stargazers.

In comparison the Fyke Nets caught Yelloweye Mullets, Giant Bully, Yellow Belly Flounder and eels.

Table Seventeen illustrates the different species captured using the different capture methods. To display the findings more clearly Common Bullies have been omitted from this figure as their abundance (91 of the sampled population) skewed the graph.

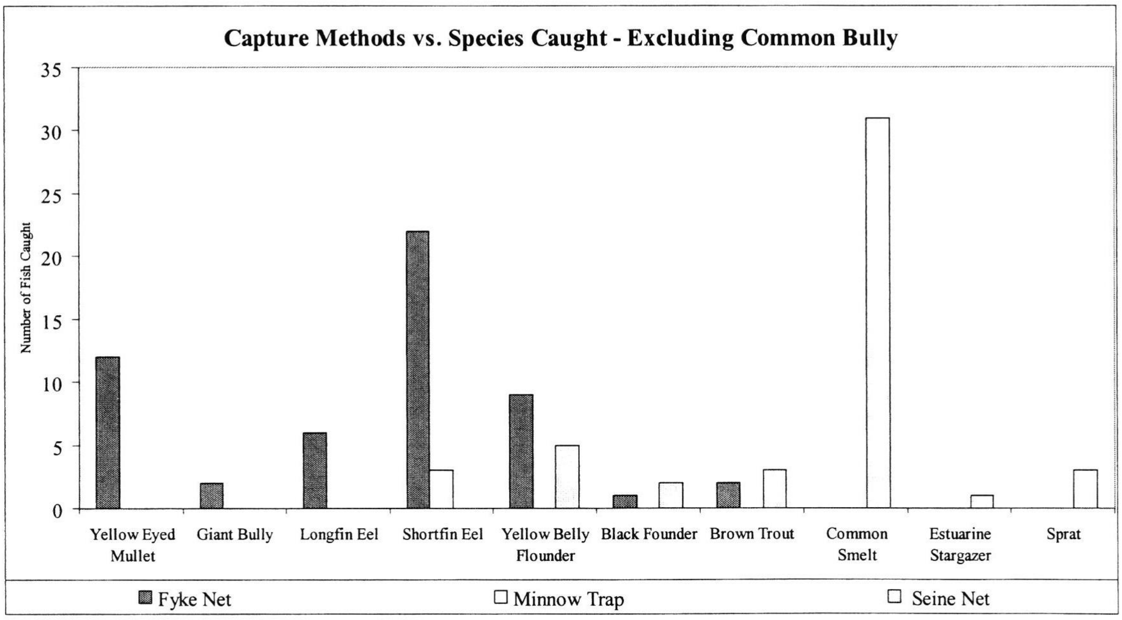


Figure 18 – Capture Method and Species Caught

Another area of biases was the construction and characteristics of individual nets. This is clearly demonstrated in the Fyke Nets. Of the fourteen Fyke Nets used, Fyke One, Five and Seven captured the most fish specimens. All of these nets share some similar characterises. All were constructed of the finest mesh, 5mm. Two were white in colour and two had similar length lead nets and entrances.

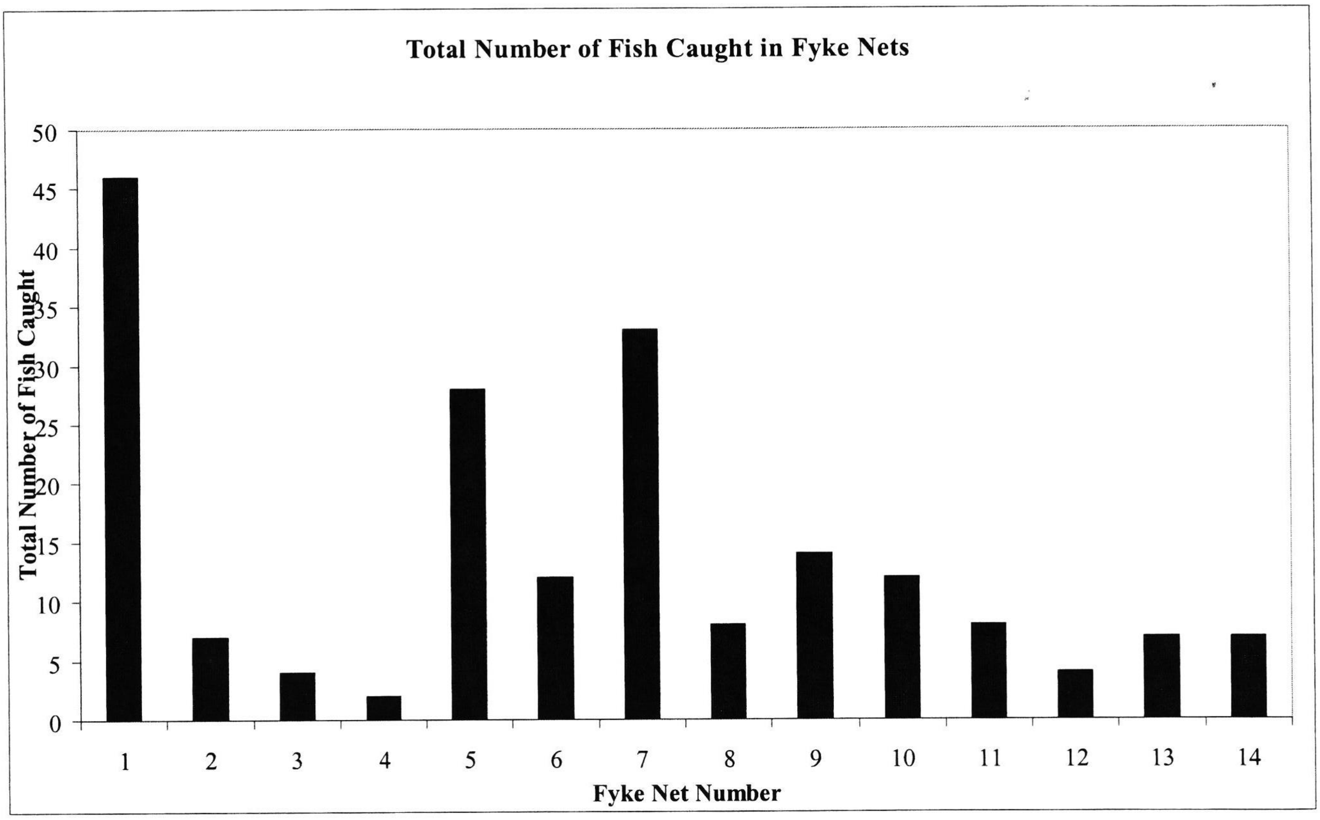


Figure 19 – Fyke Net Results

Similarly Fyke Three, Four and Twelve captured the least specimens. These nets were all black in colour, two with large mesh, 30mm in diameter. Two had long lead nets and entrances.

Table 11 – Description of Individual Fyke Nets

Fyke No.	Total Length (cm)	Length of Lead Net (cm)	Length of Hooped Net (cm)	Hoop Entrance diameter (mm)	Mesh size (mm)	Colour
1	350	?	?	420	5	White
2	320	180	140	4400	30	Black
3	260	98	162	370	30	Black
4	450	230	220	700	2.5	Black
5	360	160	200	430	5	White
6	465	280	185	450	30	Black
7	330	160	170	400	5	Brown
8	470	260	210	450	30	Black
9	320	160	160	440	5	Black
10	850	550	300	650	30	Brown
11	330	160	170	400	5	Black
12	480	270	210	450	30	Black
13	730	470	260	700	30	Brown
14	450	270	180	550	2.5	Green

The different characterises in Fyke Nets may explain the different capture rates of individual nets. But when this theory is applied to Minnow Traps the results are quite different.

All eleven Minnow Traps were of the exact same construction and identical in appearance but there is variance in the capture rate of individual Minnow Traps.

Minnow Traps Five and Six caught the most specimens while Minnow Trap Nine captured none at all. From these findings it can be concluded that although the Minnow Traps were identical in appearance other variable influence may have determined the success rate of a capture methods and are discussed in section 8.3 titled Physical and Chemical Influencing Factors.

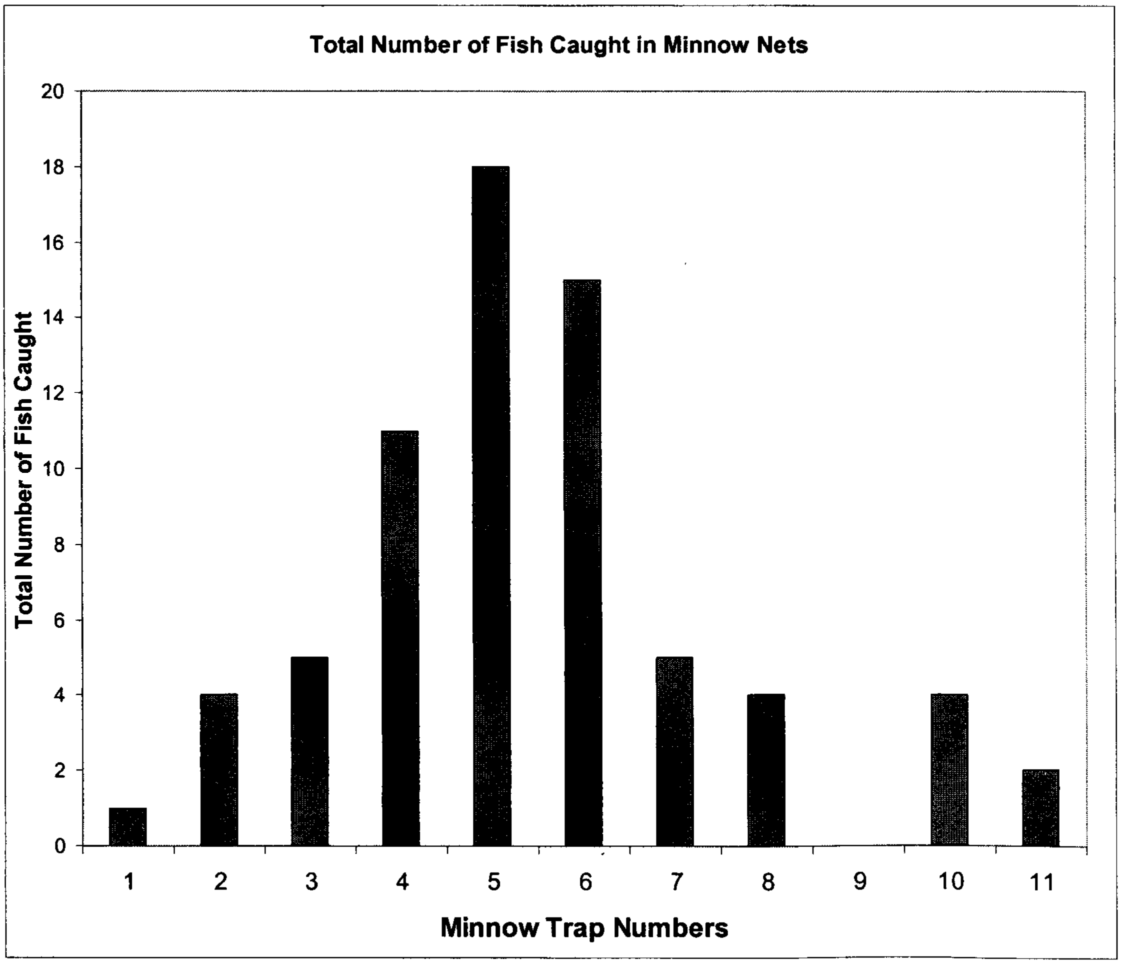


Figure 20 – Minnow Trap Results

8.3 PHYSICAL AND CHEMICAL INFLUENCING FACTORS

Three hundred and fifty one readings were taken of electro conductivity, salinity and temperature, pH, clarity, depth the nets were set and bearing of each net. From these readings few correlations were found between the physical and chemical parameters measured and the sampled fish population.

Complicating the issue of collecting this data was avoiding stirring up the thick mud at the bottom of the Lagoon, thereby affecting some of the parameter readings obtained. The lack physical and chemical findings in this area may be due to a number of factors:

- The sample size may have been too small to obtain any clear correlation in fish behaviour and the physical and chemical parameters measured.

- Sample sites were selected randomly around Waituna Lagoon. The randomness of the survey sites prevented a profile being established of physical and chemical factors within an area and how fish species are influenced. For example temperature varied between sites by as much as 6 degrees Celsius.

- A total of nine sites were surveyed, six while the Lagoon was open and three while the Lagoon was closed. According to Environment Southlands ongoing collection of data. The opening and closing of the Lagoon greatly influenced the water chemistry. Furthermore fish were restricted in their movement to and from the marine environment while the Lagoon was closed influencing what species were captured

8.3.1 Lunar Cycle

Similarly there is no confidence interval for the number of fish captured and the phases of the Lunar Cycle. All Fyke Nets set in the first quarter experienced low capture rates, the majority capturing less than 20 specimens across the 14 Fyke Nets Set. Similarly capture rates for the second and third quarter were as low as the first quarter however Fyke Nets were only set once during the second and third phase of the moon, limiting the amount of data collected. The forth quarter of the moon experienced a variety of capture rates, from third lowest at Site Six to most the largest sample population at Site Eight.

The variety of results obtained indicates that Lunar Cycle does not greatly influence fish behaviour in Waituna Lagoon and other influences such as open and closed state and location of nets have a greater bearing.

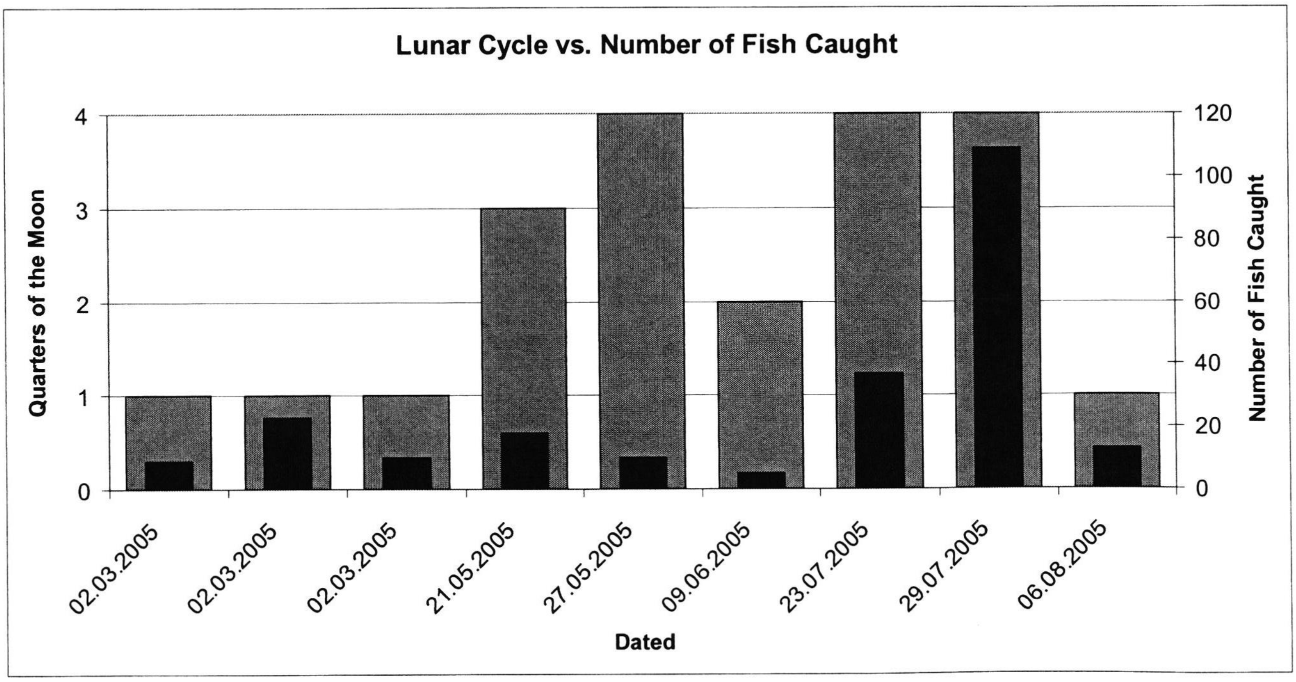


Figure 21 – Lunar Cycle vs. Number of Fish Caught

8.3.2 Open and Closed Status of the Lagoon

The greatest factor influencing the abundance of fish species captured in the Lagoon appears to be the open and closed status of the Lagoon. During the nine population samples that were taken over the survey period the Lagoon was open for six survey samples and closed for three.

Although the Lagoon was open more often than it was closed mathematical analysis shows the overall capture rates of fish species was significantly greater while the Lagoon was open.

The open and closed status of the lagoon encompasses some of the physical and all the chemical parameters measured.

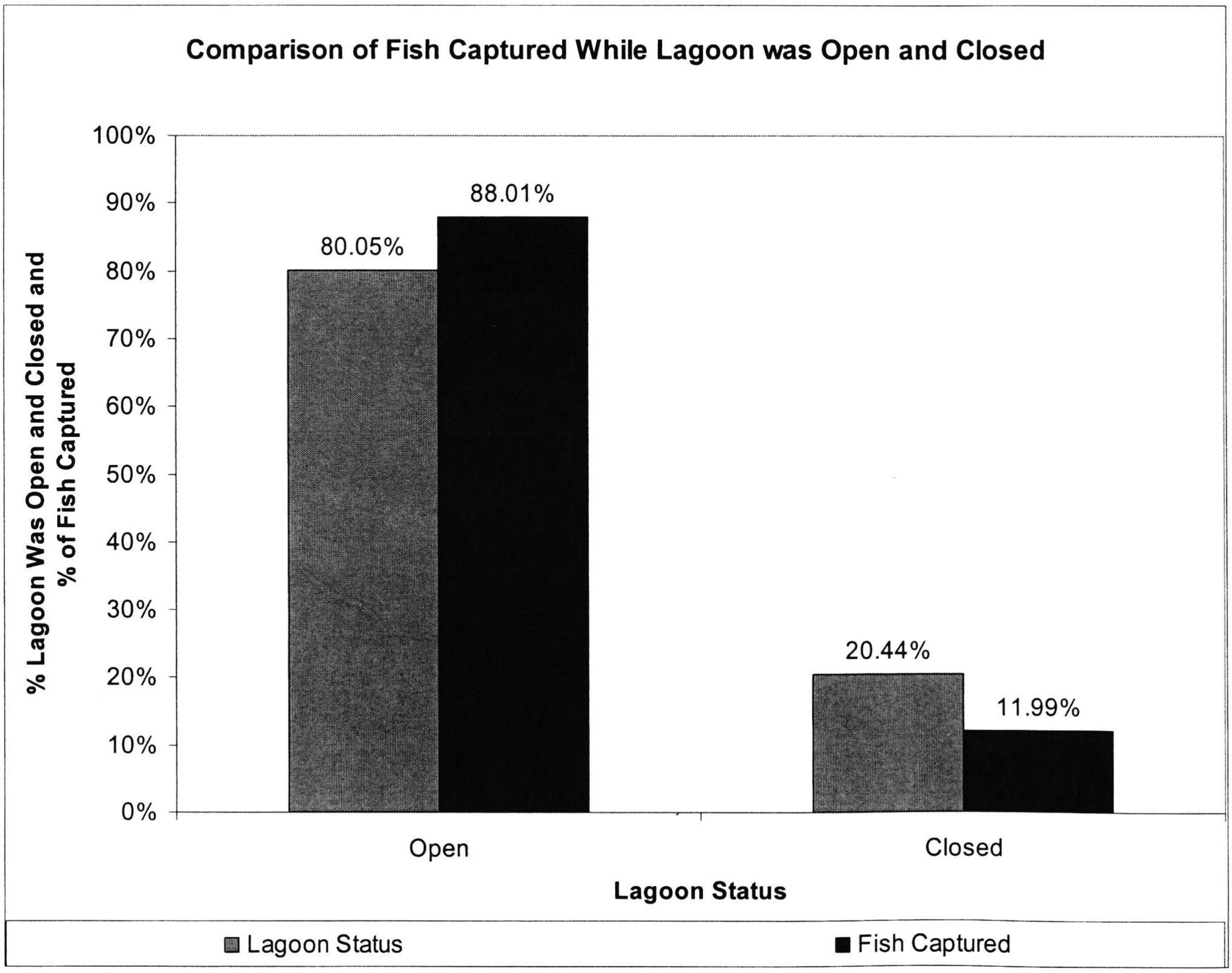


Figure 22 – Comparison of Fish Captured – Lagoon Open and Closed

9 CONCLUSION

The results of this research report disproved the hypothesis that a significant diversity of fish species would be encountered in Waituna Lagoon. Ten species were captured; nine of these were previously recorded; only the Giant Bully had not being identified in Waituna Lagoon prior to this survey.

The types of netting methods utilised greatly influenced the abundance and diversity of fish specimens captured as well as variations within a single net type.

Fish species which utilise Waituna Lagoon are generally tolerant of a variety of environments. Specimens captured came from marine, brackish and fresh water environments.

Insufficient data was collected on physical and chemical parameters during the survey period to draw any conclusions. The most significant factors influencing the abundance of species captured was the open and closed status of the Lagoon, which encompasses the chemical parameters in the Lagoon at the same time.

10 RECOMENDATIONS

10.1.1 Animal Ethics Approval

Ensure Animal Ethics Approval is sort in advance as the process is drawn out and delayed the start of the fish survey.

10.1.2 Continue Survey Work Over Summer Months

The *Waituna Lagoon: Summary of Existing Knowledge and Identification of Knowledge Gaps*, (2003) recommended that a "survey of aquatic communities of the Lagoon be carried out ....while the Lagoon is open and closed. These surveys should include benthic invertebrates, zooplankton and small fish."

As this survey only covers a short period of time it is recommended that the study continues, covering as many different season and variables of the Lagoon.

Fish are more active during the spring and summer months as water temperature increases and migration and spawning occur. During this increased activity it would be expected a greater abundance of fish species could be captured. .

10.1.3 Evaluate The Parameters To Measure

When working in the Lagoon the researcher is limited in the amount of equipment they are able to carry, without it becoming damaged or wet, while at the same time laying or retrieving nets and recording fish data.

It is important to streamline the parameters of the survey which need to be measured. Identify equipment that will suit the field work, while keeping equipment to a minimum as too much equipment can be cumbersome in the field.

Difficulty also arose when taking readings of water chemistry as the very fine silts of the substrate was stirred up while walking. This may have distorted some water chemistry readings.

10.1.4 Utilise the Seine Nets More Thoroughly

The abundance and diversity of specie caught with the Seine net made it a very useful tool for surveying fish species in Waituna Lagoon. However Seine Netting is limited to areas without snags and the availability of volunteers to provide the man power to haul the net.

It would be advised in the future to utilise the Seine Net more fully there by obtaining a larger sample population. In using the Seine Net more often it will increase the validity of the data collected.

10.2 TECHNICAL DIFFICULTIES

10.2.1 Weather

As the survey was carried out over the winter months, a close eye was kept on the coastal weather forecasts. Adverse weather conditions prevailed throughout much of the collection of data. Efforts were made to utilise good weather and tilde conditions whenever they occurred..

On more than one occasion the weather unexpectedly deteriorated and a decision had to be made whether to abandon setting or retrieving the nets. This type of situation served to reduce available time spent in the field.

10.2.2 Fish Identification

Identification of fish species was sometime difficult due to seminaries between species or variations within a species. To overcome these difficulties a number of sources were utilised.

Identification of fish species through reference books such as McDowall (2002), *The Reed Field Guide To New Zealand Freshwater Fishes* and Graham (1974) *Second Edition: A treasury of New Zealand Fishes* were utilised.

Key's were also used to identify species in the field. The keys identified different structural features of the fish, such as the Dorsal fin, Jaw, Pectoral Fin, Anal Fin, Tail, Gill cover, scales and patterns as identifying features of fish species. Keys were obtained from the National Institute for Water and Atmospheric Research web site.

Species that were difficult to identify the expertise of Eric Edwards from the Department of Conservation were utilised.

10.2.3 Closure of the Lagoon

Difficulty arose when the Waituna Lagoon's channel was closed. This caused the water level to rise, making access to areas of the lagoon, impossible. Limited points of access were used, while the lagoon filled over a number of months and the study was suspended for six to eight weeks, when the lagoon was too full to access.

10.2.4 Animal Ethics Approval

The process of obtaining animal ethics approval to undertake this research project was essential under Southern Institute of Technology's (SIT) Animal Ethics Committee Guidelines, but the process was more complicated and took significantly longer than anticipated.

The seasonal nature of the fish being studied meant that the timing of the fieldwork for the research was crucial. To ensure that preliminary reconnaissance work was able to be carried out for the project prior to SIT Animal Ethics approval being granted, assistance of DoC staff was sought. Initial work was carried out under the auspices of the Department of Conservation with a DoC staff member accompanying the researcher on fish surveys trips until Animal Ethics approval was granted.

10.2.5 Volunteers

Some aspects of the data collection would not have been possible with Waituna Landcare Groups assistance. Volunteers facilitated towing the seine net and data collection over the months the survey was carried out was invaluable.

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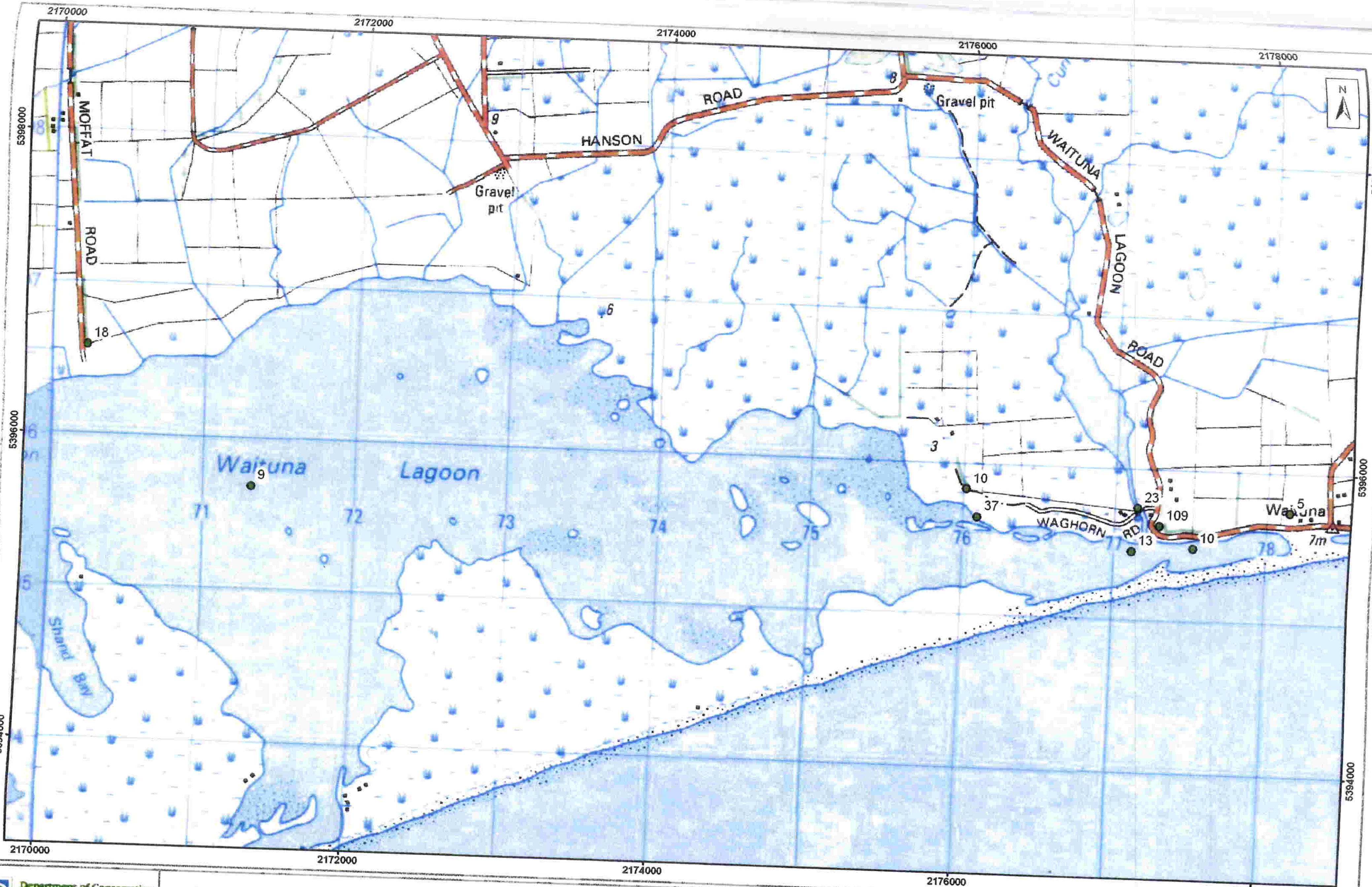
11 APPENDIX

11.1.1 Appendix One – Raw Data On Disk

11.1.2 Appendix Two – Maps of Capture Locations



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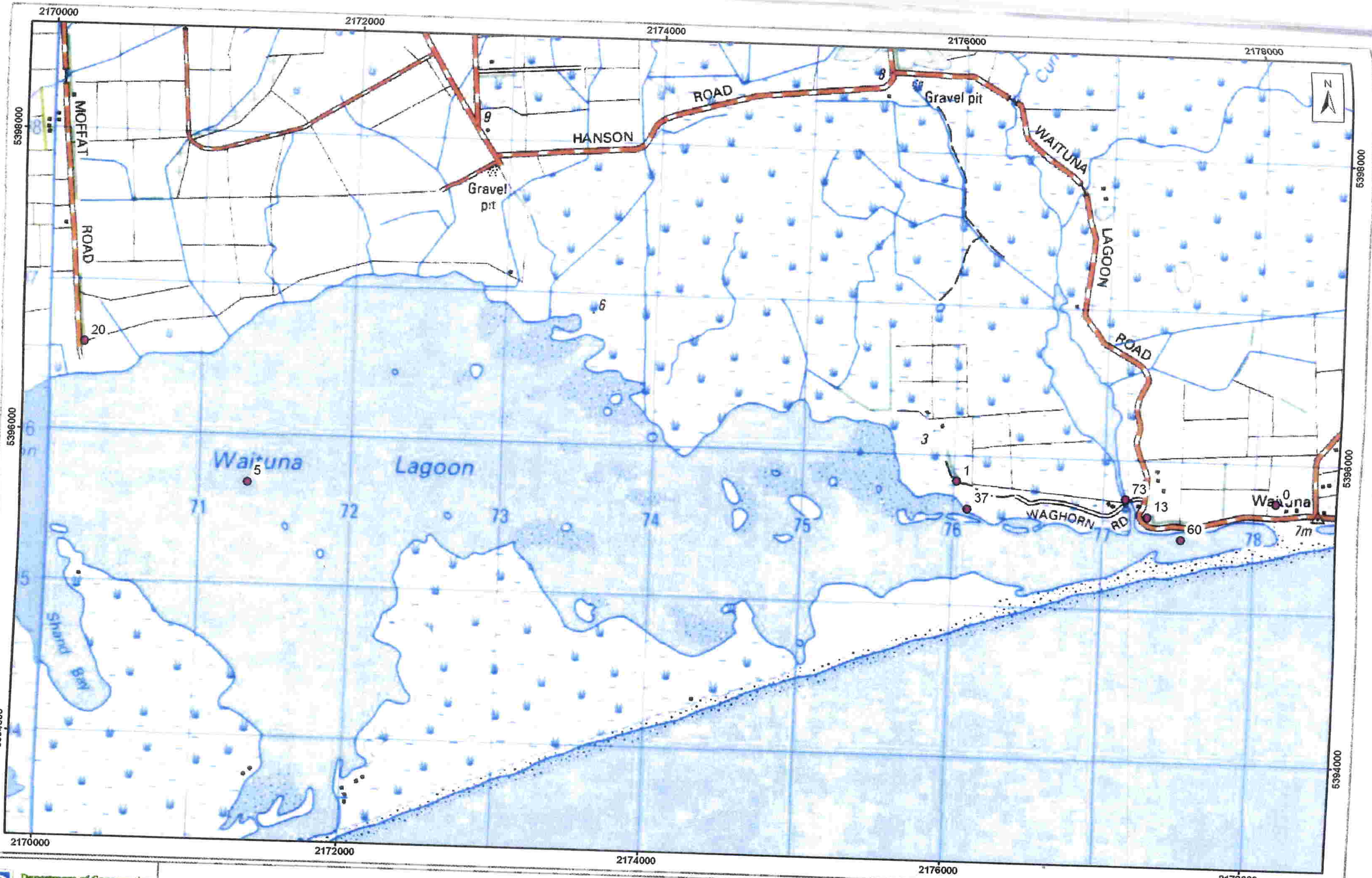
Map Date: 19/10/2005 CR
Map Scale: 1:32000

Numbers of fish caught in Fyke Nets

Project Name: WaitunaFishSurveySallyC18_10_05.mxd
Project Location: G:\GIS\Projects\Southland\NativeSpecies



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Map Date: 19/10/2005 CR
Map Scale: 1:32000

Numbers of fish caught in Minnow Nets

Project Name: WaitunaFishSurveySallyC18_10_05.mxd
Project Location: G:\GIS\Projects\Southland\NativeSpecies

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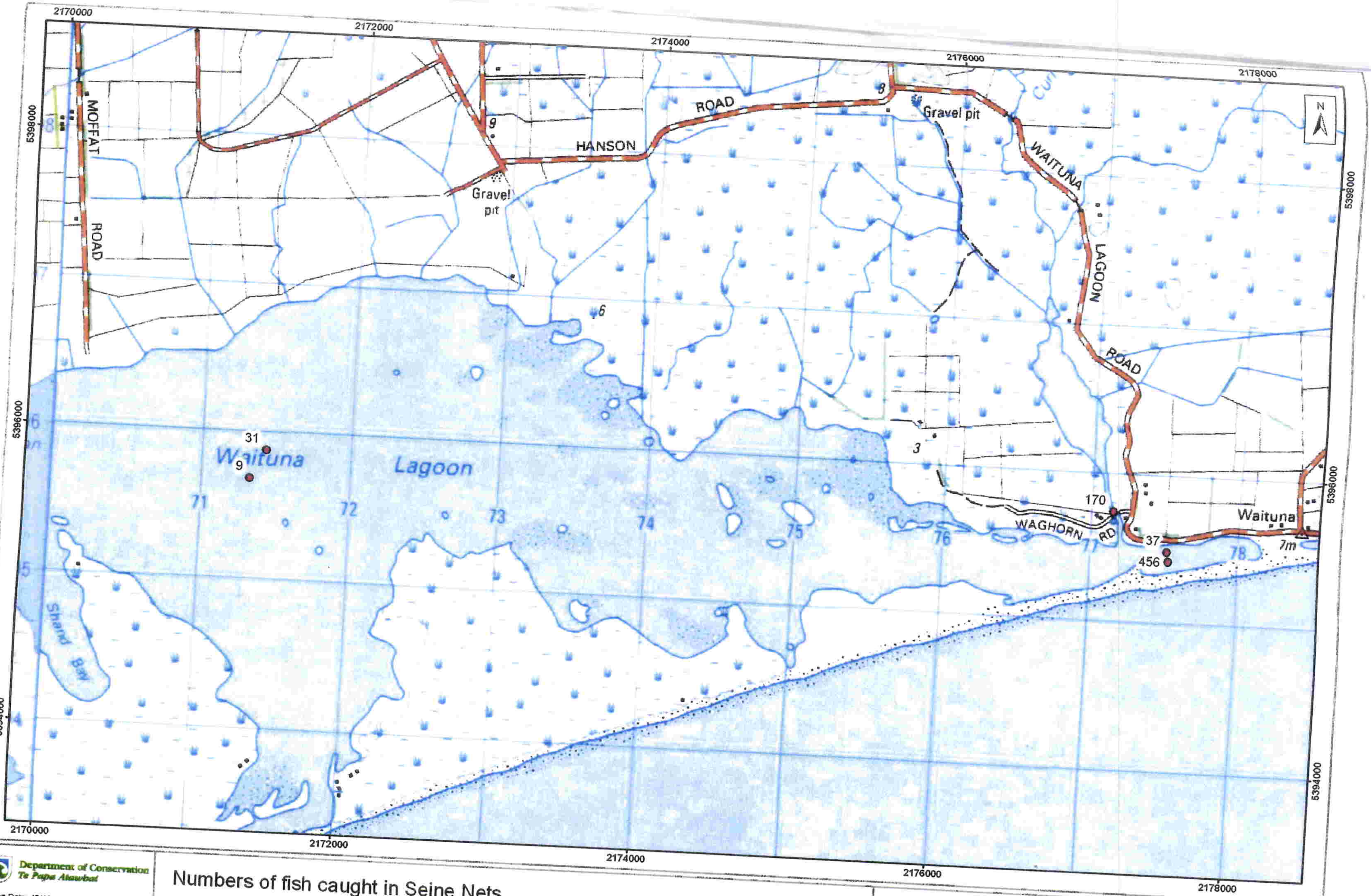

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Map Date: 19/10/2005 CR
Map Scale: 1:32000

Numbers of fish caught in Seine Nets

Project Name: WaitunaFishSurveySallyC18_10_05.mxd
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