Lake Wairarapa Fish Survey 2009

Prepared for

Greater Wellington Regional Council

By

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1.1 Executive summary

- Three sites in Lake Wairarapa were surveyed over April/May 2009 using five different netting and trapping methods.

- A total of 629 fish were captured, representing 8 native species and 3 exotic species. Two species of native crustacean were also found. Fish communities at the southern end of the Lake were distinct from the northern and western areas sampled.

- After shortfin eels, perch were the dominant large-bodied species found in the Lake. Perch appear to have increased in numbers and body size and those individuals caught showed sex ratios highly biased towards females.

- Perch that had food items in their stomachs contained native common bullies and mysid shrimp.

- Comparisons with historical data indicate that Lake Wairarapa appears to be continuing along a transitional gradient from an ecosystem dominated by diadromous native fish to one dominated by resident exotic fish.

1.2 Recommendations

- Further surveying in additional areas of Lake Wairarapa using greater fishing effort and targeting a wider range of habitat types would be beneficial in terms of providing more comprehensive data, especially regarding less commonly encountered species. Such data would be of maximum value if it formed part of an ongoing monitoring program and was collected in conjunction with data from Lake Onoke.

- Controlling perch numbers through systematic removal using nets and traps would reduce predation and competition pressure on native fish, thereby restoring and protecting components of indigenous biodiversity in Lake Wairarapa.

- Implementing measures to protect threatened, endemic longfin eel populations would also contribute to protecting indigenous local biodiversity. Illegal commercial fishing in Lake Wairarapa should be immediately curtailed. The effects of recreational/customary eeling could be reduced through education in the form of public talks or signage at popular eeling areas detailing the differences between longfin and shortfin eels and the implications of those differences.

- Research into competitive dynamics between flounder and perch and between eels and perch would provide greater understanding and quantification of some of the negative effects that perch are likely having on the Lake Wairarapa indigenous ecosystem.

2. Aim and scope of this study

This study aimed to provide information regarding fish communities in Lake Wairarapa as this large, nationally important Lake has only been comprehensively surveyed on a single occasion 18 years ago. The fishing effort involved in this study was limited in terms of number of sampling sites, replication and coverage of aquatic habitat types, thus this report would be most suitably treated as a precursor to one or more detailed and widespread survey initiatives.

3. Study area and methods

3.1 Lake Wairarapa

Lake Wairarapa is a large (18km long; 6km wide), shallow (mostly <2.5m deep) supertrophic lake located in the lower North Island, New Zealand. Historically, the Ruamahanga River flowed through both Lake Wairarapa and Lake Onoke – a system that contained extensive wetland areas and provided habitat and access for large numbers of

diadromous[1] native fish species. As a flood-protection initiative completed in 1974, the Ruamahanga was diverted away from Lake Wairarapa and barrage gates were installed at the southern end of the lake. These changes appear to have severely affected the ability of many species to migrate and native fish populations in Lake Wairarapa have dramatically declined or been apparently extirpated as a result (Hicks 1993). In addition, exotic non-diadromous species have been introduced to Lake Wairarapa, creating further changes in the fish community. Three sites were selected for surveying April/May 2009 (Fig. 1): site A at the northern end of the lake, site B on the western edge of the lake and site C at the southern end of the lake.

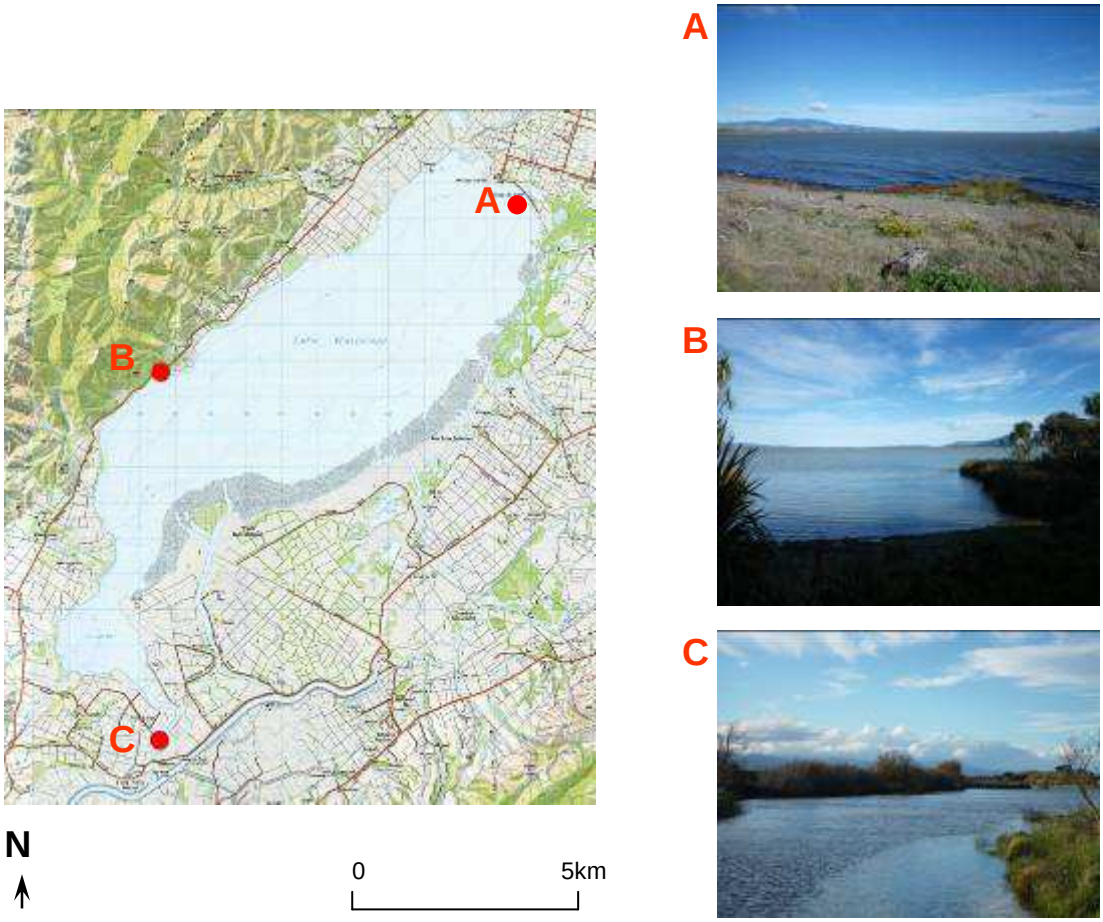

Figure 1. Map of Lake Wairarapa showing sampling sites with accompanying photographs of each site.

[1] Diadromous: an aquatic animal that completes part of its life cycle in freshwater and part in saltwater. New Zealand has a high proportion of diadromous species in its native freshwater fauna.

3.2 Existing fish data

A comprehensive survey of Lake Wairarapa and surrounding wetlands was carried out in 1991 (see Hicks 1993). In addition, a number of records are available in the New Zealand Freshwater Fish Database regarding fish species present in the Lake (Table 1).

Table 1. Records from the New Zealand Freshwater Fish Database (Richardson 1989) and from a survey conducted in 1991 (Hicks 1993) of fish species caught in Lake Wairarapa. DB: Database record; H: 1991 survey record.

Year(s)	Scientific name	Common name
1961[DB], 1991[H]	*Anguilla australis*	Shortfin eel
1961 [DB], 1991[H]	*Anguilla dieffenbachii*	Longfin eel
1961 [DB]	*Cheimarrichthys fosteri*	Torrentfish
1961 [DB]	*Galaxias argenteus*	Giant kokopu
1961 [DB]	*Galaxias fasciatus*	Banded kokopu
1961 [DB]	*Geotria australis*	Lamprey
1961 [DB], 1991[H], 2007 [DB]	*Gobiomorphus cotidianus*	Common bully
1961 [DB], 1991[H], 2007 [DB]	*Retropinna retropinna*	Common smelt
1991[H]	*Salmo trutta*	Brown trout
1991[H]	*Aldrichetta forsteri*	Yellow eyed mullet
1991[H]	*Galaxias maculatus*	Inanga
1991[H]	*Mugil cephalus*	Grey mullet
1991[H]	*Perca fluviatilis*	Perch
1996 [DB], 1998 [DB]	*Scardinius erythrophthalmus*	Rudd
1996 [DB], 1998 [DB]	*Tinca tinca*	Tench
2002 [DB]	*Carassius auratus*	Goldfish

3.3 Fishing methods

Five different netting and trapping methods were employed. At each site, a 20m, 100mm mesh set net and a 30m trammel set net, 2 large mesh fyke nets, 4 3mm gee minnow traps were set overnight. Site A was surveyed over 19th – 20th April. site B over 26th – 27th April and site C over 29th – 30th April. At sites A and B, both set nets were placed perpendicular to the shoreline, whereas the physical characteristics of site C meant that nets had to be set parallel to the shoreline. In addition, Sites A and B were dragged once each with a 14m handheld Danish seine net on the 14th of May. All fish were identified to species and their

total length recorded. All perch were sexed and a subset (n=15) had their stomach contents checked.

4. Survey results

4.1 Overall

In total, 629 fish were captured and identified. Eight native fish species, 2 native crustacean species and 3 exotic fish species were found in the lake (Table 2). Of the large-bodied species, the most numerically dominant was the native shortfin eel (*Anguilla australis*), followed by the exotic perch (*Perca fluviatilis*). Of the small-bodied species, the most numerically dominant was the endemic common bully (*Gobiomorphus cotidianus*), followed by the native common smelt (*Retropinna retropinna*).

Table 2. Fish species captured in Lake Wairarapa in April/May 2009[2]. * denotes exotic species. Common names are used hereafter.

			Site A (North)	Site B (West)	Site C (South)	Total
Scientific name	**Common name**	**Capture method**				
Aldrichetta forsteri	Yellow eyed mullet	Trammel set net	-	-	4	4
Anguilla australis	Shortfin eel	Fyke net	16	15	51	82
Anguilla dieffenbachii	Longfin eel	Fyke net Minnow trap	-	10	1	11
Galaxias maculatus	Inanga	Minnow trap Seine net	-	-	98	98
Gobiomorphus cotidianus	Common bully	Minnow trap Seine net	18	88	132	238
Mugil cephalus	Grey mullet	Fyke net	-	-	1	1
Tenagomysis spp	Mysid shrimp	Seine net	Many	Many	-	Many
Paratya curvirostris	Decapod shrimp	Minnow trap	-	-	1	1
*Perca fluviatilis**	Perch	Trammel set net Plain set net	19	36	-	55

[2] Mysid shrimp and common smelt were only captured by seine netting. The apparent absence of these species at site C is most likely due to this site not being seined.

		Fyke net				
Retropinna retropinna	Common smelt	Seine net	114	11	-	125
Rhombosolea retiaria	Black flounder	Trammel set net Plain set net	5	2	-	7
*Salmo trutta**	Brown trout	Trammel set net Plain set net	3	-	1	4
*Scardinius erythrophthalmus**	Rudd	Trammel set net	3	1	-	3
		Total	**178**	**162**	**289**	**629**

4.2 Site A

In order of numerical dominance, mysid shrimp, common smelt, perch, common bully, shortfin eel, black flounder, brown trout and rudd were found at the north end of the lake. All commonly encountered species except perch were present in a range of sizes. One of the brown trout was quite large, measuring 580mm$_{TL}$ (Fig. 2). Of the sixteen perch that were caught, all were a fairly uniform large size (285 – 340mm$_{TL}$) and 15 were females.

Figure 2. Large brown trout caught at site A.

4.3 Site B

A similar species complement and associated size distributions to site A was found at the western edge of the Lake. A relatively small number of differences at site B (compared to site A) include the presence of similar numbers (to shortfin eels) of the endangered longfin eel, much higher numbers of common bullies and much lower numbers of common smelt. No brown trout were captured. All 36 perch were again similarly sized (280 – 350mm$_{TL}$: Fig. 3) and all were females.

Figure 3. Thirty-six large perch caught in a single 30m trammel net at site B.

4.4 Site C

The community at the southern end of the lake was very different to those at the other 2 sites. No perch or rudd were found at this site and much higher numbers of both shortfin eels (Fig. 4) and common bullies were captured. In addition, four native species were found at site C that were not found at either of the other sites: decapod shrimp, inanga (Fig. 5), yellow eyed mullet and grey mullet.

Figure 4. High numbers of shortfin eels caught at site C

Figure 5. High numbers of inanga and common bullies at site C

5. Discussion

5.1 Differences between sites

Sites A and B had similar fish communities, while site C was distinct from both. Some of these differences can be partially attributed to differences in sampling methods but most are likely a reflection of habitat type, geographic position (i.e. proximity to the Ruamahanga/Onoke access to the sea) and physico-chemical characteristics (e.g. salinity). The most distinct differences between sites A and B were the eel species' ratios and the relative densities of common smelt and common bullies. The latter can most likely be attributed to differences in local habitat complexity, while the cause of the former is less certain. Site B possessed more complex fish habitat in the form of cobbles, boulders, submerged logs and emergent macrophytes compared to Site A which was mostly bare fine sediment with small amounts of submerged macrophytes. This explains the much higher proportion of benthic[3] common bullies at site B. Common smelt are pelagic[4] and are thus less dependent on substrate complexity. The observed much lower densities of smelt at site B could be due to heavier predation by perch. Perch are well known predators of small native fish (e.g. Griffiths 1976) and nearly twice as many perch were caught at site B compared to site A. The high number of longfin eels found at the western lake edge compared to both other sites is a pronounced and interesting difference. Fyke net setting and placement was consistent at all sites so this difference is not a sampling artefact. Neither is it likely due to local habitat conditions as sites B and C were very similar in this regard.

Site C had a distinct fish community compared to both other sites (Fig. 6), with much higher numbers of shortfin eels and common bullies, four additional native species that were not found elsewhere and an apparent absence of introduced perch and rudd. Site C was located in a small backwater approximately 150m north of the barrage gates. The substrate was fairly uniform fine sediment but submerged macrophytes were present along

[3] Benthic: description of an aquatic animal that dwells on and amoungst substrate. Most New Zealand native fish are benthic.
[4] Pelagic: description of an aquatic animal that lives free-swimming in the water column. Most Exotic fish introduced to New Zealand are pelagic.

with large numbers of emergent macrophytes, both of these provide habitat for fish. Based on appearance, perch were expected to be captured here and are known to be present in nearby areas (Perrie, Pers. comm.; Pers. obs.). The thick sediment and water depth at site C meant that both set nets had to be set parallel to the shore instead of perpendicular and this site was also not able to be seined. The net positioning is unlikely to be wholly responsible for the zero perch capture as other species were caught in the trammel net at this site. The much higher numbers of shortfin eels (potential food competitors with perch), much higher numbers of common bullies and the additional capture of 98 inanga (both common perch prey items) also indicate that the absence (or much lower density) of perch observed here is genuine. It should be noted however, that the high inanga numbers at site C could be partially due to behaviour associated with spawning as inanga migrate downstream to spawn collectively in estuaries anytime between late summer and late Autumn (McDowall 1990). Yellow eyed mullet and grey mullet are both more estuarine/marine than other species found in Lake Wairarapa and their presence at the southern end of the lake (right next to the barrage gates) in the more saline water of south Lake Wairarapa (compared to northern areas) makes the site C fish assemblage more similar to the fish community of Lake Onoke (see Hicks 1993).

5.2 Changes over time

Historical records together with present day fish species data indicate that Lake Wairarapa is undergoing (and probably close to completing, if intervention does not occur) a transition from a lake dominated by diadromous native species to one dominated by resident exotic species. Freshwater Fish Database records from 1961 show the presence of the endemic species giant kokopu, banded kokopu, torrentfish and the native lamprey in the Lake – no records of these species have occurred since and none were found in the 1991 survey or in this survey. Exotic species rudd, tench and goldfish first appear in Database records in 1996 and 2002 and moderate numbers of the exotic perch were reported in the 1991 Hicks survey. This survey found no tench or goldfish but did find large numbers of perch and moderate numbers of rudd.

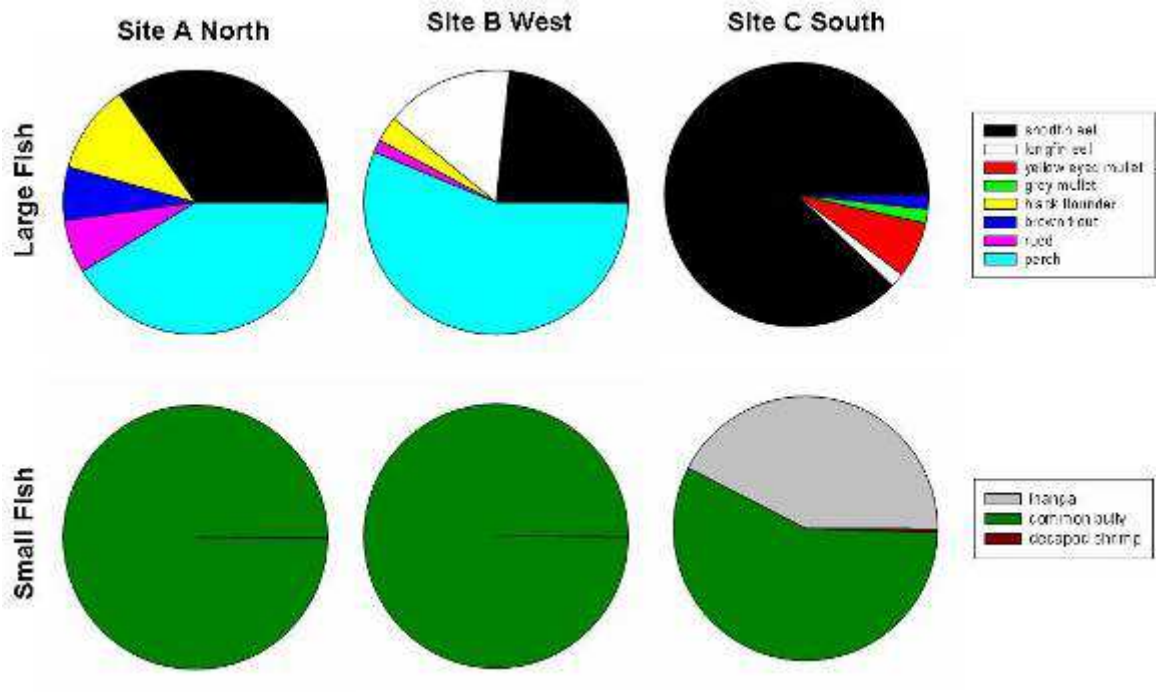

Figure 6. Numbers of large- and small-bodied fish captured at 3 sites in Lake Wairarapa. Excludes common smelt and mysid shrimp to facilitate valid comparisons between sites as these species were only caught by seining and site C was not able to be seined.

5.2.1 Eels

With caution (applied due to possible small differences in fyke net setting – location, orientation etc), it appears numbers of shortfin eels (Fig. 7) in Lake Wairarapa may have increased. In 1991, Hicks reported catching 6.6 shortfin eels and 1.3 longfin eels per fyke night, whereas in this study 13.7 shortfins and 1.7 longfins were caught per fyke night. Eel size however is still low – 82% of all eels captured were <550mm$_{TL}$, which is consistent with eels sizes in 1991. Numbers of longfin eels remain very low (Fig. 8). Longfin eels are an endemic species classified as nationally threatened. While commercial eeling is prohibited in Lake Wairarapa without a concession from the Department of Conservation, apparently illegal commercial fishing occurs in the area (Perrie, Pers. comm.). This, together with the impacts of recreational and customary harvest of longfin eels will undoubtedly be impacting negatively on longfin eel populations in Lake Wairarapa.

Figure 7. Shortfin eel *Anguilla australis*

Figure 8. Longfin eel *Anguilla dieffenbachii*

5.2.2 Black Flounder

The Hicks report summarises historical data regarding black flounder (Fig. 9) in Lake Wairarapa: Prior to the diversion of the Ruamahanga River, this species was so numerous that it supported a number of small commercial fisheries, reporting catches of 40-60 flounder per gill net night. Following the diversion, these numbers dropped to 15-25 flounder per gill net night up until 1988, then fell further to around 2-3 flounder per gill net per night in 1991. This survey produced only 1.7 flounder per gill net night (0-3), indicating further declines may have occurred. However, due to potential seasonal differences in black flounder distributions and the limited number of individuals caught during this survey (n=7), more quantitative data on black flounder numbers would be needed to confirm this decline.

Figure 9. Black founder *Rhombosolea retiaria*

5.2.3 Perch

The perch (Fig. 10) population of Lake Wairarapa appears to have grown in both numbers and body size. The 1991 survey reported a total of 48 perch caught across multiple sites in

Lake Wairarapa, Lake Onoke and Lake Pounui. Despite the lower fishing effort and restriction to Lake Wairarapa associated with the present survey, 55 perch were caught. Average perch size in 1991 was 203mm$_{FL}$, whereas the smallest perch caught in this survey was 280mm$_{TL}$ and the average size was 312mm$_{TL}$. This narrow distribution of large sized perch is likely partially due to sampling methods, as additional methods were used in the 1991 survey. However, the gill set net methods which caught 3 perch per net night at the northern end of the lake were comparable to those used here, which caught 8 perch per net per night in the same area. In addition, the 1991 survey reported 10 members in the size class 260-340mm$_{FL}$, in contrast with this survey, in which all 55 perch measured 280-350$_{TL}$.

Figure 10. Perch *Perca fluviatilis*

5.2.4 Rudd

The presence of the noxious species rudd (Fig. 11) appears to be the result of one or more recent illegal introductions. Rudd were not found during the comprehensive 1991 survey

but first Lake Wairarapa records appear in the Freshwater Fish Database in 1996, then again in 1998. This survey caught 4 large (280-300mm$_{TL}$) rudd, indicating that this species is not uncommon in Lake Wairarapa in present times.

Figure 11. Rudd *Scardinius erythrophthalmus*

5.3 Perch sex ratios

A single male perch was captured, along with 54 females. Jellyman (1980) reported male to female ratios for perch at 1:4 in nearby Lake Pounui. This extreme female bias could partially be due to netting methods selectively capturing large individuals - male perch in Lake Pounui were significantly smaller than their female conspecifics (Jellyman 1980). However, the small-mesh trammel net that was used was expected to catch smaller perch and did catch flounder that measured only 170mm$_{TL}$. Male perch are also known to have lower survival probabilities than females (McDowall 1990), thus established populations naturally contain more females. Despite this, the male to female ratio of 1:54 found in this survey seems extreme.

5.4 Perch stomach contents

The majority of perch that were examined had no or very few (small numbers of mysid shrimp) food items in their stomachs, presumably from a prolonged non-feeding period associated with being trapped in a net for a number of hours. The exception was a number of perch at site B – all identifiable stomach contents consisted of common bullies (Fig. 12)

Figure 12. Common bullies found in the stomachs of perch caught at site B.

5.5 Perch control

Adult perch are usually exclusively piscivorous[5] (Persson 1988) and the high numbers of this exotic species present in Lake Wairarapa is undoubtedly impacting negatively on small-bodied native fish communities through predation. The endemic black flounder and longfin eel and the native shortfin eel also rely heavily on small fish for food during their

[5] Piscivorous: describes an animal that feeds exclusively on fish.

adult life stages (McDowall 1990), thus high numbers of perch are also likely impacting negatively on these species through food competition. The potential for control of perch numbers through netting and trapping was been evaluated in a set of lakes in the South Island (Closs et al 2001). Progressive removal was judged to be worthwhile as it was effective in lowering perch numbers and efforts also coincided with marked increases in numbers of common bullies.

5.6 Future research

Relatively little is known regarding the fish communities of Lake Wairarapa and further research in the form of comprehensive surveying would be of great value. Ideally such surveying should cover a greater area of the lake, a wider range of aquatic habitats, include multiple replicates at each site and would be of highest value if it was part of an ongoing (perhaps annual) monitoring program. Lake Onoke has also only been formally surveyed for fish populations once (as part of the same 1991 study). Lake Onoke is more saline and tidal than Lake Wairarapa (Perrie, Pers. comm.) and contains a distinct fish community (Hicks 1993). However, this community is inextricably linked with Lake Wairarapa fish communities as Lake Onoke provides access (albeit now limited due to the barrage gates installation) for native fish migrating from the sea. Standardised data collected from Lake Onoke in conjunction with further data from Lake Wairarapa would provide the most comprehensive picture of local lake fish populations and would also be of national interest as a case study. Additional research into competitive dynamics between flounder and perch and between eels and perch would provide greater understanding and quantification of some of the negative effects that perch are likely having on Lake Wairarapa indigenous ecosystems.

Acknowledgements

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6. References

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Appendix

set 19.04.09	**North end: site A**	lost one minnow Total length mm		weightg	notes
sfe	minnow		200		
sfe	minnow		200		
sfe	Fyke		700		
sfe	Fyke		800		
sfe	Fyke		700		
sfe	Fyke		500		
sfe	Fyke		400		
sfe	Fyke		350		
sfe	Fyke		400		
sfe	Fyke		350		
sfe	Fyke		900		
sfe	Fyke		600		
sfe	Fyke		300		
sfe	Fyke		450		
sfe	Fyke		400		
sfe	Fyke		350		
common	minnow		35		
trout	trammel		580	2494.712	male
trout	trammel		290	240.9665	
trout	gill		325	340.188	
flounder	gill		380	566.98	
flounder	gill		330	481.933	
flounder	trammel		370	708.725	
flounder	trammel		165		
flounder	trammel		175		
rudd	trammel		280	368.537	
rudd	trammel		280	340.188	
rudd	trammel		290	368.537	
perch	trammel		285	311.839	female
perch	trammel		310	340.188	female
perch	trammel		340	510.282	female
perch	trammel		320	396.886	female
perch	trammel		310	396.886	female
perch	trammel		320	425.235	female
perch	trammel		300	340.188	**male**
perch	trammel		290	340.188	female
perch	trammel		300	396.886	female
perch	trammel		290	340.188	female
perch	trammel		330	481.933	female
perch	trammel		330	481.933	female
perch	trammel		300	368.537	female
perch	trammel		310	481.933	female

perch	trammel		290	368.537	female
perch	trammel		300	368.537	female
perch	trammel		290	368.537	female
perch	trammel		340	652.027	female
perch	trammel		340	538.631	female

SEINING	14.05.09		TLmm	
			Smallest	Largest
Smelt		114	25	88
Commons		17	15	45
Mysid	many			

set 22.04.09 **Western edge site B**

		Total length mm	weightg	notes
sfe	fyke	250		
sfe	fyke	700		
sfe	fyke	400		
sfe	fyke	550		
sfe	fyke	600		
sfe	fyke	600		
sfe	fyke	400		
sfe	fyke	400		
sfe	fyke	500		
sfe	fyke	350		
sfe	fyke	600		
sfe	fyke	600		
sfe	fyke	400		
sfe	fyke	450		
sfe	fyke	400		
lfe	fyke	450		
lfe	fyke	500		
lfe	fyke	400		
lfe	fyke	800		
lfe	fyke	700		
lfe	fyke	800		
lfe	fyke	450		
lfe	fyke	550		
lfe	fyke	750		
lfe	minnow	250		
perch	fyke	350	566.98	female
perch	gill	310	396.886	female
perch	trammel	310	425.235	female
perch	trammel	320	425.235	female

perch	trammel	320	453.584	female	
perch	trammel	310	396.886	female	
perch	trammel	310	453.584	female	
perch	trammel	330	453.584	female	
perch	trammel	310	425.235	female	
perch	trammel	290	340.188	female	
perch	trammel	310	481.933	female	
perch	trammel	300	396.886	female	
perch	trammel	300	396.886	female	
perch	trammel	290	396.886	female	
perch	trammel	310	453.584	female	
perch	trammel	290	340.188	female	
perch	trammel	310	396.886	female	
perch	trammel	290	368.537	female	
perch	trammel	350	396.886	female	
perch	trammel	310	538.631	female	
perch	trammel	300	368.537	female	
perch	trammel	340	481.933	female	
perch	trammel	330	538.631	female	
perch	trammel	300	368.537	female	
perch	trammel	300	368.537	female	
perch	trammel	280	311.839	female	
perch	trammel	320	481.933	female	
perch	trammel	310	425.235	female	
perch	trammel	320	481.933	female	
perch	trammel	310	425.235	female	
perch	trammel	350	566.98	female	
perch	trammel	340	566.98	female	
perch	trammel	310	396.886	female	
perch	trammel	350	595.329	female	
perch	trammel	280	340.188	female	
perch	trammel	310	425.235	female	
perch	trammel	310	396.886	female	
rudd	trammel	300	453.584	female	
flounder	trammel	170			
flounder	trammel	170			

		number caught	smallest	largest	
common	minnow	13	26	71	

SEINING	14.05.09				
			smallest	largest	
Smelt		114	25	90	
Commons		75	15	55	
Mysid	many				

South End site C

set 29.04.09

		Total length mm	weightg	notes
sfe	fyke	550		
sfe	fyke	500		
sfe	fyke	500		
sfe	fyke	500		
sfe	fyke	500		
sfe	fyke	450		
sfe	fyke	500		
sfe	fyke	400		
sfe	fyke	450		
sfe	fyke	400		
sfe	fyke	500		
sfe	fyke	450		
sfe	fyke	550		
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sfe	fyke	400		
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sfe	fyke	500		
sfe	fyke	500		
sfe	fyke	550		
sfe	fyke	700		
sfe	fyke	500		
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sfe	fyke	450		
sfe	fyke	550		
sfe	fyke	500		
sfe	fyke	500		
sfe	fyke	450		
sfe	fyke	450		
sfe	fyke	450		
sfe	fyke	550		
sfe	fyke	450		
sfe	fyke	600		
sfe	fyke	500		

sfe	fyke	550
sfe	fyke	500
sfe	fyke	500
sfe	fyke	400
sfe	fyke	450
lfe	fyke	600
grey mullet	fyke	370
trout	trammel	450
ye mullet	trammel	272

		number caught	smallest	biggest
Inanga	minnow	98	55	110
common	minnow	132	23	60
paratya	minnow	1		