Fish health profile manual

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Contents

Abstract

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The adoption of a simple but reliable method for assessing fish health would allow resource managers to routinely monitor biological outputs from impacted systems rather than simply measuring inputs. The fish health profile (FHP) procedure, developed in the U.S. over the past 25 years, is a field necropsy method that provides a rapid and inexpensive assessment of fish health. The procedure, which is based on observation and categorical assessment of selected organs and tissues, can be used in the field by persons with only limited training or equipment.

This manual provides instructions for conducting a fish health profile, following the U.S. methodology, but with adaptations for some New Zealand species. Step by step instructions for conducting the procedure, analysing and interpreting the results, and a discussion of some alternative procedures are incorporated into the manual. A database of FHP indices for fish from unimpacted environments in New Zealand has been collated and is included for comparative purposes, as are colour plates of normal and abnormal organs. Copies of the database on computer disk, blank copies of the forms used with the procedure, a laminated sheet summarising the organs to be observed and their assessment categories, and original photographs of the colour plates are available from the author on request.

Introduction

Historically, indicators of waterway health in New Zealand have focused on water quality (chemical) measures or habitat (physical) assessments. Assessments of the biological health of aquatic ecosystems are not usually incorporated into routine monitoring programmes. In aquatic ecosystems, fish, particularly those near the top of the food chain, are generally regarded as representative indicators of overall system health, integrating the effects of many variables acting upon the system. The adoption of a simple but reliable method for assessing fish health would allow resource managers to routinely monitor the biological outputs from impacted systems rather than simply measuring inputs. In addition, a measure of fish health is easily understood by the public and may therefore be useful for state-of-the-environment reporting.

The fish health profile (FHP) procedure developed by Goede & Barton (1990) and its refinements (Adams *et al.* 1993) provide a simple and reliable method for assessing the health of fish that can be used in the field by persons with only limited training or experience. The procedure is based on observation and categorical assessment of selected organs, and has been shown to be effective for monitoring fish in hatcheries (Novotny & Beeman 1990) as well as in the field (Adams *et al.* 1993, Barton 1994, Coughlan *et al.* 1994). Although the FHP was developed primarily for

salmonid species, it has been applied to both warm water and cool water species of freshwater fish.

The FHP is a population approach, and the key to its success is the basic assumption that if fish are in good condition, then vital organs and other easily observable body structures will also be in good condition. As an assessment of the overall health and condition of fish, the FHP is mainly used to identify sites where fish show significant departures from normality compared with baseline profiles for healthy fish populations. The FHP therefore has most application as a medium to long term monitoring tool for assessing the biological health of impacted waterways. The FHP is not a diagnostic procedure, but can be used in conjunction with diagnostic analyses to demonstrate whether abnormalities in metabolic processes affect the appearance and, by assumption, the health of vital organs.

This manual provides instructions for conducting a fish health profile following the methodology described by Goede (1993), but with adaptations for some New Zealand species. Instructions for conducting the FHP, analysing and interpreting the results, and a discussion of some alternative procedures are included. A database of FHP indices for fish from unimpacted environments in New Zealand is included for comparison. Colour plates of normal and abnormal organs are also included to assist with interpretation. The original organ photographs, blank copies of the forms used for recording and reporting the data, a laminated sheet summarising the organs to be observed and their assessment categories, and a computer disk containing the database are all available from the author.

Methods

FHP procedures for five species of freshwater fish, longfin (*Anguilla dieffenbachii*) and shortfin (*A. australis*) eels, rainbow (*Oncorhynchus mykiss*) and brown (*Salmo trutta*) trout, and common bully (*Gobiomorphus cotidianus*), are included in this manual. These species were chosen to represent the New Zealand fauna because they range from very tolerant to intolerant species, include important commercial and recreational fish, represent fish with bottom and mid-water dwelling habits, are widespread throughout New Zealand, are present in waterways year-round, and are relatively easy to capture. With the exception of the common bully, these fish are generally large, with readily visible organs and structures.

In preparing this manual, I have assumed that readers will have a basic knowledge of capture techniques and of fish identification and anatomy. A comprehensive identification guide by McDowall (1990) also contains diagrams of typical external structures and methods of collecting freshwater fish. Basic internal organs are shown in Figure 1 and the photographs provided with this manual show the location of most structures. Detailed external and internal anatomical drawings may be found in textbooks, such as that by Lagler (1973).

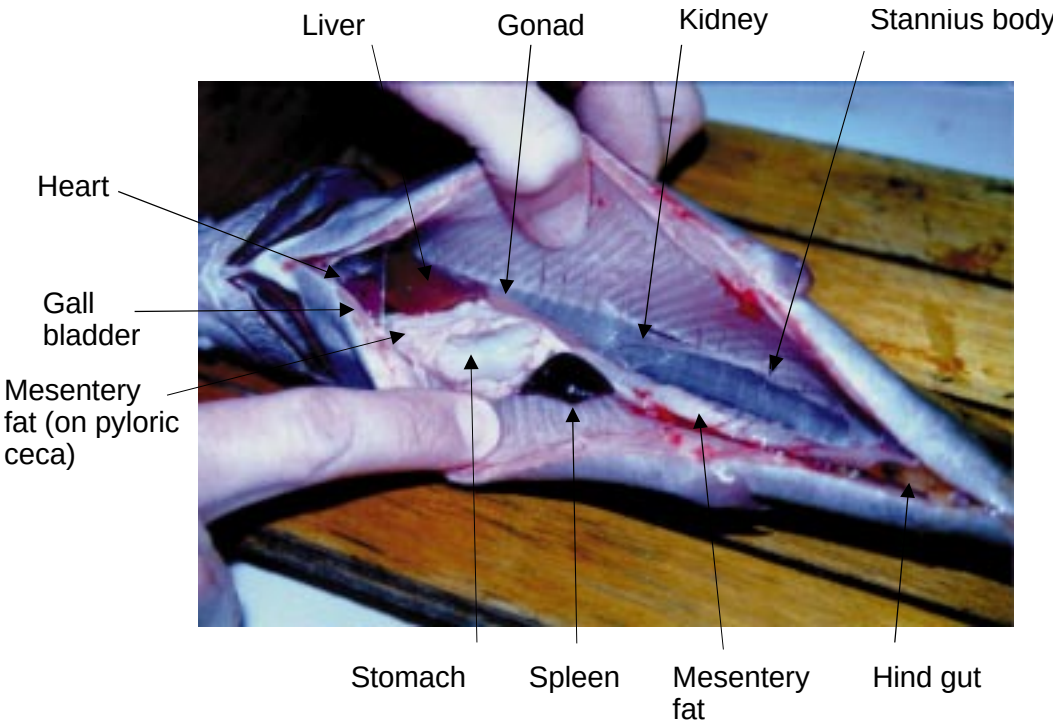

Figure 1: **Location of internal organs assessed in the FHP. Fish shown is a trout, but organ location in eels and bullies is similar.**

Fish collection

The desired sample size for the procedure is 20 fish, ideally of a similar size and age, but this is not always possible. I believe that a minimum of 10 fish is necessary for meaningful results, particularly if the fish are exhibiting abnormalities.

When collecting fish for routine monitoring programmes, it is important that the samples are collected from the same location and at the same time of year. Collecting from the same location reduces any effects of pollutant gradients on the fish, particularly for the territorial bottom-dwelling species, such as eels and common bully. Sampling at the same time of year means that seasonal variations in indices such as gonad stage or mesenteric fat are minimised. Avoid sites that might give ambiguous results; for example, a sample collected at the mouth of a tributary might contain some fish that spent most of their time in the tributary and others that live in the mainstem.

Fish used for the FHP should be freshly dead. The colour and appearance of organs in moribund fish are not the same as those in freshly dead specimens and can cause mistaken assessments. Thus, it is best to obtain live specimens and kill them yourself just before assessment. Trout are most easily killed by a sharp blow to the head. Eels and common bully can be killed with an overdose of anaesthetic. I prefer benzocaine (3.3 g dissolved in 100 ml

isopropyl alcohol (stock solution); use about 50 ml of stock solution per 3000 ml of water for eels, less for common bully). Eels should be left in the anaesthetic for at least 10–15 minutes, but 5 minutes should be sufficient for bullies. There are a number of other suitable anaesthetics for fish and Summerfelt & Smith (1990) have written a very good discussion of these, including their toxicity to mammals (e.g., you!). Ensure that your fish are completely dead — ethically and practically, having a specimen "revive" during autopsy is a very unpleasant experience.

In large water bodies, such as lakes and big rivers, rainbow trout can be most easily captured in gill nets. These nets must be tended regularly, and any fish removed and processed immediately upon capture. In my experience, trout are most readily captured at dusk, which means you should be prepared to work late when targeting trout. Brown trout can also be captured in gill nets and will enter fyke nets. Angling is time consuming, but can be used to obtain samples of trout, and electric fishing is appropriate in small rivers and streams. The use of stop nets with the latter method is recommended, as often larger trout are herded rather than stunned by electric fishing. Whichever method you employ, ensure you have prior permission from the local fish and game council to capture and remove trout.

Eels and common bullies are readily captured in fyke nets or Gee minnow traps which are baited and left overnight. Electric fishing is suitable for all three species, and adult bullies can also be obtained by seine net at dusk. Because bullies are a small fish, it is difficult to obtain a blood sample from and to properly assess small specimens; only bullies over 5 g (over 80 mm total length) should be used for the FHP.

Equipment

The equipment needed for the FHP is simple and portable and can be used in the field or in the laboratory (Plate 1). If you have a choice, choose the laboratory, as it is generally more comfortable and has better lighting than the field. Electronic, battery-powered scales that weigh to at least 0.1 g are necessary, and a container to hold eels on the scale pan helps keep them in place (Plate 2). Fish length has to be measured accurately, so a measuring board or ruler is required. A selection of sharp knives, scissors, and tweezers assists with opening and examining the internal and external organs and tissues.

Blood samples are collected in heparinised, micro-hematocrit capillary tubes (length 75 mm, internal diameter 1.1–1.2 mm). These are available in packets of 200 from suppliers of scientific or medical equipment, such as Medic Corporation Ltd. The tubes need to be sealed at one end with a commercial clay made for that purpose, such as Critoseal®, which is also available from medical or scientific supply companies.

If you are going to process the blood samples yourself, then access to a micro-hematocrit centrifuge, a hematocrit reader, and a protein refractometer is needed. If you are going to send

the blood samples to a laboratory for processing, then you will need facilities for keeping the samples cold but not frozen (a chilli bin with a re-freezeable ice block is fine).

Old newspapers and a supply of paper towels are useful for keeping surfaces, equipment, and hands clean. A magnifying apparatus is helpful for assessing the organs of common bully, and a bright and reliable head lamp is needed when processing trout in the field after dark. Cleaning up is made easier with a small scrubbing brush and detergent or disinfectant, and a rubbish bag for fish remains and other rubbish is essential.

The results of your assessment should be recorded in a standard format on a copy of the form shown on page 31, or one similar to it. A blank copy of this form is available on diskette from the author. You should photocopy the form onto waterproof paper. It's a bit messy, but not impossible, to record for yourself if working alone, but having a helper or a voice-activated tape recorder is preferable.

Fish processing

This section describes the steps to follow when processing the fish. The length and weight of your fish should be collected before any other assessments, including blood sample collection. The external assessment can be done before or after the blood collection, but usually I collect the blood first.

1. Length and weight

The length should be measured in millimetres and the weight in grams. Trout are measured to the fork in the tail; for other species, measure the total length (Plate 3).

2. Blood sampling

Blood samples are collected to measure the hematocrit (percentage of blood volume consisting of red cells), leucocrit (percentage of blood volume consisting of white cells), and plasma protein (weight/volume percent of protein) of your fish. Goede (1993) recommends collecting blood through a cardiac punch with a sharpened micro-hematocrit tube. Although this works reasonably well for trout, the small eel and common bully hearts make this method somewhat hit and miss. To use this method, one end of the micro-hematocrit tube must be sharpened by hand, which is both difficult and time consuming.

Although messier, I find that cutting off the tail just behind the vent (Plate 4) and holding the micro-hematocrit tube at an angle to the severed dorsal aorta (Plates 5–7) is the quickest,

easiest, and most reliable way to collect blood. A sharp, clean cut is best, and, if necessary, first wipe the cut with an alcoholic swab to remove any potential contaminants such as slime or water. Fill the tube between one half and two-thirds full, not overflowing. Collecting blood from bullies takes practice: be patient and don't squeeze your specimen too hard. Once the blood has been collected, seal one end of the tube with Critoseal® or a similar commercial clay and place the tube upright in a holder in a cold place (e.g., as in Plate 8, or use the holder supplied with the Critoseal®). The tubes MUST be kept in order.

If you are processing the blood samples yourself, they should be placed (in order) in a micro-hematocrit centrifuge and spun for 5 minutes at 13 000 G. Before spinning, it is advisable to cut off the end of the tube plugged with Critoseal® and use a Bunsen burner to gently melt the end of the tube closed, as sometimes the commercial clay allows the contents to leak when the tube is spun. Be careful not to heat or boil your sample.

Goede (1993) recommended spinning the samples within 1 hour of collection, after which they can be transported and read in a more convenient location, but within 2 hours of spinning. Although sooner is better, I found this to be totally impractical as many field assessments occur without access to an electric power source and few laboratories have access to a micro-hematocrit centrifuge. I overcame this by keeping the tubes upright and cold while in the field, and sending them to an animal health laboratory (such as AgResearch) for processing. Often this meant keeping them in the refrigerator overnight and using a same-day courier service to deliver them to the processing depot so that the samples were processed within 24–36 hours.

Whether you process the samples yourself or not, you need to understand what the measures used with the FHP are.

Hematocrit. Hematocrit is the packed red cell volume of the blood and is expressed as a percentage of the total column. It is measured by placing the centrifuged tubes on a micro-hematocrit reader (available from scientific suppliers) so that the bottom of the red zone of the column is at the zero line and the meniscus of the clear plasma portion of the column is on 100% (Figure 2). The location of the top of the red zone is the percentage of red blood cells or hematocrit.

Leucocrit. Usually, there is a buffy or grey zone just above the red zone. This is composed of the leucocytes, or white blood cells, and is used to estimate the leucocrit or percent leucocytes in the packed column. The card reader can be used to read this, but a magnifying glass is helpful. This zone may be too small to discern in common bully.

Plasma protein. The protein content of the plasma is read using a hand-held refractometer (obtainable from medical equipment specialists or scientific suppliers). First calibrate the refractometer with distilled water so that the boundary line is adjusted to the "w" or "wt" mark. Then, carefully break the micro-hematocrit tube just above the cloudy zone, express some clear

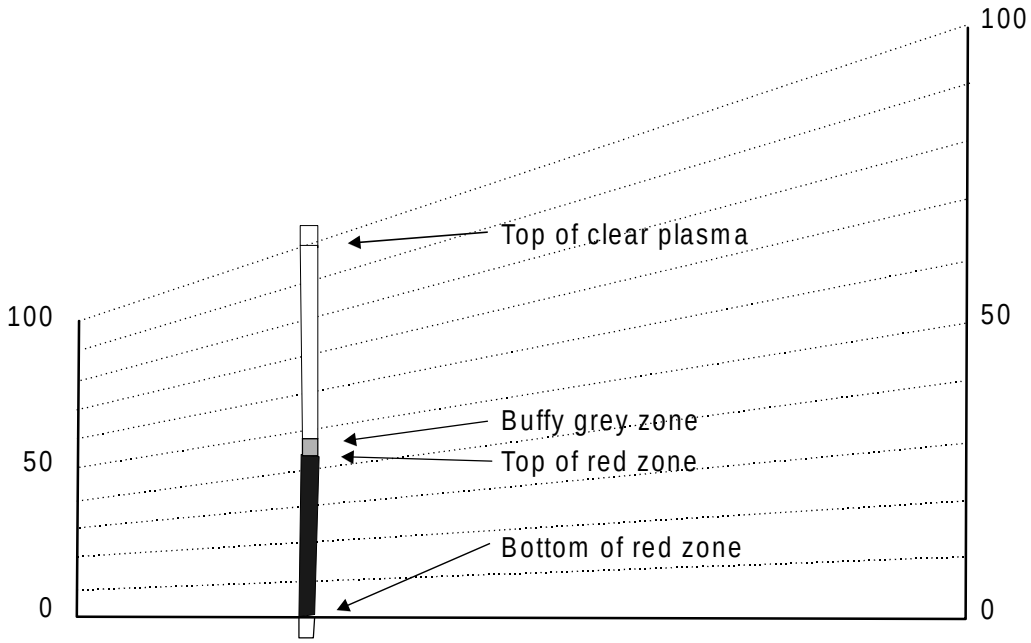

***Figure 2*: Micro-hematocrit tube reader showing correct placement of a hematocrit tube for reading the hematocrit and leucocrit. The proportions on this figure are not to scale and this figure should not be used to read tubes.**

plasma onto the clean and dry glass surface of the reader, and read the weight/volume percent of protein. The instrument should be cleaned between readings with lens paper to avoid scratching the surface.

If you are sending the blood samples to a laboratory for processing, ensure they can measure these three components from a micro-hematocrit tube of blood and find out what the cost per sample will be. My samples were processed by animal health laboratories at AgResearch at a reasonable cost.

Currently, there is some controversy about the accuracy of the blood parameters used with the FHP. For example, Houston (1997) suggested that hematocrit measures are influenced by the age of the fish, the sex, environmental conditions such as water temperature, and, of course, sampling and storage conditions. He recommended establishing an erythron profile instead (estimating the relative abundance of the various developmental stages of the red cells) from a blood smear. This may have merit, as blood smears can be easily prepared in the field. Likewise, the buffy/grey layer on top of the red cells may contain platelets as well as white cells (G. Hoggard, Alpha Scientific, pers. comm.), and will give only a rough estimate of leucocrit. Refractometer protein measurement is not as accurate as the biret method, but this requires 2–3 micro-hematocrit tubes of blood, a quantity that may be too difficult to collect for some species. Although these are valid concerns, so long as the samples are collected and processed in the same manner each time, the blood parameters should be comparable. In addition, the blood parameters are just one component of the FHP.

3. External examination

The formal external examination consists of observation and assessment of the eyes, fins, opercules, gills, pseudobranchs, and thymus. These are paired organs, so be sure to observe both of them. It is important to take into consideration the circumstances of collection. For example, eels caught in fyke nets often have damaged eyes or abraded fins that can be attributed to rubbing against the nets. Trout drowned in gill nets sometimes have swollen pseudobranchs, and killing them with a sharp blow can sometimes cause bleeding in the eye or the eye to protrude. General remarks about the overall external appearance of the fish are also useful, such as deformities, scale loss, and the presence of sores and blemishes. The organs listed above are assessed as follows.

Eyes

Observe both eyes and categorise them as follows.

Normal (N)	No aberrations, a good clear eye (Plates 9–11).
Exopthalmic (E1 or E2)	Swollen protruding eye (popeye). Coded as E1 or E2 if present in one or two eyes, respectively.
Hemorrhagic (H1 or H2)	Bleeding in the eye.
Blind (B1 or B2)	This generally refers to opaque eyes. It is not important to know whether the eye is functionally blind or not.
Missing (M1 or M2)	When an eye is missing from the fish.
Other (OT)	Any manifestations that do not fit the above descriptions. Describe the condition in your notes.

Fins

Evaluation of the fins is relative to the degree of erosion in progress. Previously eroded fins that are completely healed over and showing no evidence of active erosion are considered normal. The number and location of the eroded fins is not significant. Even if only one fin is showing active erosion, the observation must be ranked and recorded. If several fins are showing different degrees of erosion, the assessment must refer to the most severe erosion in progress. Generally, trout which were reared in a hatchery will show signs of previous fin erosion, particularly on the dorsal fin. Note this in your remarks. The classification is as follows.

No active erosion (0)	Fins with normal appearance and no active erosion, including previous erosion that is completely healed (Plates 12–14).

Mild active erosion (1) Active erosion, but no hemorrhage or secondary infection present (Plate 15).

Severe active erosion (2) Active erosion with hemorrhage and/or secondary infection (Plate 16).

Opercules

The opercules cover the gills and for this assessment only the degree of shortening is noted.

Normal (0) No shortening; gills completely covered (Plates 9, 17)

Mild shortening (1) Slight shortening of the opercule with a small portion of the gills exposed (Plate 18).

Severe shortening (2) Severe shortening of the opercule with a considerable portion of the gill exposed.

Gills

The gills of trout can be easily observed by lifting the opercule, but in common bully and eels it is probably easiest to cut away the opercule for a better view. The appearance of the gills can be easily affected by the manner of collection and handling as indicated below; be aware and take plenty of notes.

Normal (N) No apparent aberrations and a deep, rich, red. Note that common bully gills are usually paler than trout or eel gills (Plates 19–21).

Frayed (F) Erosion on the tips of the gills resulting in a ragged appearance. This should not be confused with separation of the gill lamellae, a condition which may be caused by the manner in which the gills were exposed by the investigator.

Clubbed (C) Swelling on the tips of the gill lamellae so that they appear bulbous or club-like (Plate 22).

Marginate (M) A gill with a light discoloured margin along the distal ends or tips of the lamellae or filaments. Marginate and clubbed gills often occur together (Plate 23) — if both apply, use the one that is most appropriate. What is most important is that you have noted an abnormality.

Pale (P) Gills which are very light in colour. Severe anaemia can result in gills that are almost white, but severe bleeding during blood collection can also result in pale gills. Gills begin to pale after death, so pale gills are not uncommon in

	fish taken from nets. Common bully gills are often rather pale.
Other (OT)	Any observation which is not described above. Make remarks on your recording sheet.

Pseudobranchs

The pseudobranch is located dorsally and anterior to the gills in the branchial cavity (Plate 24). In trout it can be easily observed under the operculum and is normally quite flat or even concave in aspect. Eels have no pseudobranch and the organ may be difficult to discern in common bully. If you don't feel confident about finding the organ, then leave it out of the assessment. The grades are as follows.

Normal (N)	Flat or concave with no aberrations (Plate 24).
Swollen (S)	Convex.
Lithic (L)	Pseudobranchs with mineral deposits manifested as white amorphous spots or foci. Do not confuse this with the normal white connective tissue at the base of the organ.
Swollen and lithic (S&L)	Lithic pseudobranchs are often also swollen.
Inflamed (I)	Refers to redness in the pseudobranch: may result from hemorrhage or other causes.
Other (OT)	Manifestations not covered by the categories listed above. Describe in the remarks.

Thymus

The thymus is also located in the branchial cavity (Plate 25) and is readily observed in trout. In most fish, the thymus involutes or ceases to function as the fish matures. In salmonids, this is thought to happen at 2 or 3 years of age, and in eels over 250 mm the thymus is very small. It is not known when the thymus of common bully ceases to function. There is uncertainty among researchers as to whether an inactive thymus will show abnormalities. I suggest the thymus of trout, but not of eels and common bully, be assessed. Assessment involves grading the degree of pinpoint hemorrhage.

No hemorrhage (0)	No pinpoint hemorrhages present.
Mild hemorrhage (1)	A few (perhaps only two or three) red spots in evidence (Plate 25).
Severe hemorrhage (2)	Many pinpoint hemorrhages with some coalescing. If the general area is swollen, record this in the remarks.

4. Internal examination

Expose the internal organs by making a ventral cut from the anal vent forward to the pectoral girdle, cutting closely to one side of the pelvic girdle. I use a sharp knife for trout and scissors for the other species. Do not insert the knife or scissors so far that the internal organs are damaged; in particular try not to puncture the gall bladder. A short length of the hind gut should also be opened to permit later observation.

I usually start by assessing the liver and working backward, but that is a matter of personal choice. It assists your recorder if you do things in more or less the same order each time, particularly if the order is the same on the recording sheet.

Liver

The liver in fish is generally a large organ, but one of the most difficult to assess because its appearance can be affected by the length of time from collection to observation and the nature and extent of blood loss during sampling. For example, blood can pool in the liver after death causing what looks like focal discoloration. The categories are primarily based on colour. Categories A and B are considered normal in trout and eels, and A, B, and C are considered normal in common bully[1]. I generally remove and weigh the liver at the end of the internal examination so that the liver somatic index can be calculated. This index gives an indication of the relative size of the liver.

Normal (A)	Solid red (Plates 26–28, 32).
Normal (B)	Lighter or less vivid than A, but not so pale as to be classified as general discoloration.
Fatty (C)	Light tan colour, like coffee with cream (Plate 29).
Nodular (D)	Nodules imbedded in the liver — white mycobacterial cysts or incipient nodules.
Focal discoloration (E)	Change of colour in local areas or foci in the liver (Plate 30).
General discoloration (F)	Colour change in the whole liver (Plate 31).
Other (OT)	Aberrations or deviations which are not described above. Describe these in remarks.

[1] Of the 151 bullies examined, 111 (73.5%) had fatty (grade C) livers. Statistical analysis showed that this condition was significantly related to high plasma protein and that fatty livers were relatively larger than livers graded as A or B. Fatty livers were not related to any of the other FHP indices or variables. I concluded that this was a normal condition for common bullies and perhaps where they might store fat.

Spleen

The spleen is located just behind the liver and stomach and is assessed for colour and size. In eels, the spleen is tucked into the intestinal folds (Plate 32) and it may be necessary to tease these apart to expose it (Plate 33). The first three categories are all considered to be normal.

Black (B)	Very dark red.
Red (R)	Lighter red (Plates 33–35).
Granular (G)	Granular or rough appearance, easiest to see in outline. Common in brown trout.
Nodular (NO)	Containing nodules of varying size. These are often cysts, such as those encountered with mycobacterial infections.
Enlarged (E)	Significantly and noticeably enlarged (Plates 36, 45).
Other (OT)	Aberrations not covered by the above descriptions. Sometimes spleens may have a grey mottling or be very small — these should be classified as OT and remarks recorded.

Hind gut

If you have not already opened a short length of the hind gut, do so now. With the handle of a pair of forceps, or some other blunt instrument, lightly scrape out the gut contents to expose the inner lining or mucosa to observe reddening or inflammation.

No inflammation (0)	No inflammation or reddening (Plates 37, 38).
Mild inflammation (1)	Slight inflammation or reddening.
Severe inflammation (2)	Considerable, severe inflammation or reddening (Plate 39).

Kidney

The kidney lies along the backbone of fish: clear away the swim bladder and some of the mesenteric membrane to view it properly. In common bully, the kidney lies along either side of the backbone and is very hard to see without magnification (Plate 40). The categories are as follows.

Normal (N)	Kidney lying relatively flat along the ventral surface of the vertebral column. Dark red (Plates 41, 42).
Swollen (S)	Enlarged or swollen, wholly or in part.

Mottled (M)	Grey discoloration, mottled or patchy in appearance even with the mesenteric membrane removed.
Granular (G)	Granular appearance and texture, which may be induced by granulomatous concretions.
Urolithiasis (U)	White or cream coloured amorphous mineral material in the tubules of the kidney. These can range from very small white spots to severe developments with large twisting deposits. These deposits should not be confused with Stannius bodies (Plate 36) which are present in salmonid, eel, and probably common bully kidneys and have an endocrine function. The Stannius bodies generally occur at the edges of the kidney in an area midway along its length. They appear more round than the urolithic deposits.
Other (OT)	Aberrations not described above. As usual, record as OT and describe the condition.

Mesenteric fat

There is great variation among fish species in the way they store fat. In trout, the FHP rankings are based on the amount of fat deposited around the prominent pyloric caeca. Neither eels nor common bully have pyloric caeca, and mesenteric fat is stored along the stomach and intestines. The categories for these species are based on the relative amounts of fat in the body cavity, and require some familiarity with what is usually encountered. Eels rarely store large amounts of mesenteric fat except as they approach sexual maturity and migration to spawning grounds. At this stage, it is easy to confuse mesenteric fat deposits in eels with the developing gonads. The fat index calculated from this assessment is not a major component of the FHP, and another component, the condition factor, helps assess the fatness of the fish from the length and weight measures.

0	No fat deposited around the pyloric caeca. If there is no fat in evidence anywhere in the visceral cavity, then clearly it is grade 0 (Plate 43).
1	Less than 50% of the caecum is covered with fat or there is a slight amount of fat in the visceral cavity (Plates 44, 52).
2	50% of each caecum is covered in fat.
3	More than 50% of each caecum is covered with fat (Plate 45).
4	Pyloric caeca are completely covered by a large amount of fat or there is a considerable amount of fat in the visceral cavity (Plate 46).

Bile

The bile is assessed indirectly by observing the gall bladder, which is found underneath the liver. The ranking scheme considers the colour and fullness of the gall bladder. If you can do so without tearing it open, hold the gall bladder up to the light to properly assess the colour or use a small torch to light up the contents.

0	Yellow or straw colour, bladder empty or only partially full. If you can't find the bladder and are confident you haven't punctured it, then grade it 0 (Plates 47, 48).
1	Yellow or straw colour, gall bladder full (Plate 49).
2	Light green to grass green.
3	Dark green or dark blue-green (Plates 50, 51).

Parasites

The assessment of parasite infestation is not part of the original FHP described by Goede (1993). However, as this index has provided some insights into why factors such as fat or condition may be low in an otherwise healthy population of fish, I provide an assessment scheme here. It is meant to be a quick, visual assessment of the degree of external and internal infestation, not a detailed examination of every tissue and organ. Although common bully are generally riddled with parasites and eels and trout rarely have many, the relative degree of infestation can still be judged: look for whitespot (externally), and shagworms, nematodes, and cysts (internally).

0	No parasites present externally or internally.
1	One or two parasites present (Plate 52).
2	Numerous parasites present.
3	Heavy parasite infestation (Plate 53).

Sex

The sex of the fish can be determined from the gonads. Except in eels (which are almost always immature), this is relatively straightforward. The testes are generally white and smooth, whereas the ovaries are orange or yellow often with visible eggs inside.

M	Male.
F	Female (Plates 54–56).
U	Unknown.

Gonad stage

Common bully appear to have an extended spawning period and individuals may spawn more than once. All gonad stages may therefore be present in your sample. Trout have a more definite spawning period, although the timing varies between species. All the eels will be immature. The degree of gonad development is graded with the following scheme.

Immature (1)	Small gonad which may be impossible to sex.
Developing (2)	Easy to decipher the sex, but gonad not really mature (Plate 54).
Maturing (3)	Gonad larger with clearly visible eggs if female (Plate 55).
Ripe (4)	Fish close to spawning, large gonad with loose eggs or running sperm (Plate 56).
Spent (5)	Spawned fish, gonad may be large or small and may still contain a few loose eggs.
Unknown (U)	Unknown stage of development.

Other

Anything else which appears to be abnormal should be noted, for example, bruising of the visceral wall (see Plate 45). An example of a filled-in recording sheet is shown on page 31. I will use the data from this sheet to show how the data are analysed.

Data analysis

It is now time to summarise the measurements and assessments you have made, and from these calculate a number of FHP indices. All the calculations can be made with a pocket calculator provided it has a mean and standard deviation function. Software packages such as Microsoft Excel are also suitable. The data should be summarised on a standard form, an example of which is shown on page 32. A blank copy of this document on diskette is available from the author.

The top of the form should be filled in along with any remarks. Next, the mean, standard deviation, and coefficient of variation are calculated for length, weight, hematocrit, leucocrit, and plasma protein and entered on the form. The mean value is determined by summing all the values for that factor and dividing by the number of observations. The standard deviation gives a measure of the degree of variability of the data; use a calculator function or computer to determine this value as it is too time-consuming to calculate by hand. The coefficient of

variation expresses variation as a percentage of the mean. It is calculated by dividing the standard deviation by the mean and multiplying by 100 to convert the answer to a percentage.

The mean, standard deviation, and coefficient of variation should also be calculated for the condition factor (CON) and the liver somatic index (LSI). The condition factor is a measure of the weight of the fish relative to its length. There are a number of ways this can be calculated, but I use the following formula:

> CON = 100 x $W/(L/10)^3$, where W is the weight in grams and L is the length in millimetres.

The LSI is a measure of liver size adjusted to compensate for variations in fish size. It is calculated as:

> LSI = (LW/W) x 100 where LW is the liver weight and W is the total fish weight, both in the same units (e.g., grams).

Values as percentage of total sample

These values express the numbers assigned to each category for each organ or tissue as a percentage of the total sample. For example, on page 31 all the eels had normal eyes, so the percentage of normal eyes is 20/20 x 100 = 100. For the liver, the percentages are: category A, 16/20 x 100 = 80; category B, 1/20 x 100 = 5; and category F, 3/20 x 100 = 15.

Do this for each of the organs listed on the form. If you have less than 20 fish in your sample, the percentages may not be whole numbers — round the numbers to the nearest whole percent. You can double check your results by ensuring that the total of all the percentages is 100. In the liver sample above, 80 + 5 + 15 = 100, so I know I have counted and calculated each category correctly.

Summary of normals

The summaries in this section simplify departures from normality and provide a more accurate summary for organs and tissues in which more than one category is considered to be normal. For the liver example above, both A (80%) and B (5%) are considered to be normal, so the summary of normals for liver is 85%.

For those organs that are scored numerically, for example the fins or thymus, 0 is considered to be normal. Thus, the percentage of the sample that was scored 0 is carried down to the

summary of normals. In our example, the percentage of fins graded 0 was 85, so this value is entered in the summary of normals.

There are no normal categories for mesenteric fat, bile, or parasites as these values vary with the species. Data from these variables will be used to calculate other indices for comparison.

Summary of means

his section deals only with those organs and tissues where the assessment is quantified numerically; thymus, fat, hind gut, bile, fins, opercules, and parasites. The mean is calculated from the sum of the values in each column, divided by the total number of fish sampled. For example, using the data for fat from the form on page 31, you would add:

3 + 1 + 1 + 4 + 2 + 4 + 2 + 2 + 4 + 2 + 3 + 2 + 0 + 3 + 1 + 2 + 2 + 1 + 3 + 2
= 44/20
= 2.20

This value is entered on the form under the heading “summary of means”.

Summary of specific percentage indices

These indices represent the organ scores as percentages of the worst or highest possible scores. To calculate this, divide the mean value already calculated above by the highest possible grade. In the example given, to calculate the specific percentage index for fat, divide 2.20 by 4 (the highest grade possible for fat) and multiply by 100; 2.20/4 x 100 = 55.0. This value is now the fat index for this sample, and should be entered in the appropriate column. All the indices in this section are calculated in the same way, but remember that the highest possible score is different for each organ.

Summary of combined percentage indices

The results from the organ assessments are now grouped together into three indices, normality, severity, and feeding. These indices form the crux of the FHP and are used as the basis for comparison between samples of fish. The **normality index** represents the average percentage of normal organs in the sample. It is calculated by adding the “summary of normals” values and dividing by the number of values. For our sample, add 100 (eyes) + 85 (fins) + 100 (opercules) + 100 (gills) + 85 (liver) + 100 (spleen) + 100 (hind gut) + 100 (kidney) = 770/8 = 96.3. This is the normality index.

The **severity index** gives an indication of damage to the extremities of the fish. It is calculated by averaging the "specific percentage indices" for fins, opercules, thymus (if assessed), and hind gut; 7.5 (fins) + 0.0 (opercules) + 0.0 (hind gut) = 7.5/3 = 2.5. If the thymus has been assessed, you would divide the total by 4 to obtain the severity index.

The bile percentage index is used to calculate the **feeding index**; a low bile score indicates the fish has fed recently whereas a dark coloured bile indicates the fish last fed up to 5 days ago. The feeding index = 100 − bile percentage index, or, in our example 100 − 60 = 40. Unless you are sampling fish that have just been captured, be careful about placing too much emphasis on the feeding index. Fish which have been caught in nets may either not feed for whatever length of time they remain in the net or else eat their netted companions, and this can give misleading values for the feeding index. I use this index for comparison only if the fish have been caught by electric fishing or in gill nets and have been processed soon after capture.

Sex, stage, and general remarks

Enter the percentage of males, females, unknowns, and gonad stage in the appropriate boxes. A space is available for general remarks if required.

Data interpretation

The values and indices you have calculated can now be compared with expected values and normal ranges to determine whether your sample of fish is healthy or not. Even where values such as hematocrit fall within normal ranges, the means should be statistically compared between samples to see if there is a significant difference between sites. Thus, although the fish might have mostly normal FHP values, there still might be a measurable effect that shows a difference from control or relatively unimpacted sites. These comparisons are suitable for those factors only where it has been possible to calculate the mean for your sample, for example, condition factor or hematocrit.

The FHP values and indices should be interpreted as a suite of values, with the most weight given to the normality and severity indices. Samples where several values or indices are outside normal or acceptable ranges, or are statistically different from those of a control site, are obviously in worse health than samples where only one or two values are abnormal.

Table 1 lists normal or acceptable values for the FHP indices. The acceptable values for the normality, severity, and feeding indices are those supplied by Goede (1993). Normal ranges for all other factors were calculated from data collected by NIWA (FHP summaries for each species at each site are shown in Appendix 1). Values between the upper and lower quartiles (so that the middle 50% of the data was encompassed) were defined as the normal range of

values ***Table 1:*** **Acceptable values and normal ranges of FHP factors for five species of freshwater fish in New Zealand. Acceptable index values are from Goede (1993)**

Factor	Species	N	Acceptable value or normal range
Normality index	All		greater than 90
Severity index	All		less than 10
Feeding index	All		greater than 67
Mean hematocrit	Longfin eel	73	35.0 – 40.5
	Shortfin eel	109	33.0 – 40.0
	Rainbow trout	64	43.0 – 57.0
	Brown trout	24	42.0 – 50.0
	Common bully	131	28.0 – 42.0
Mean leucocrit	Longfin eel	73	1.3 – 1.9
	Shortfin eel	109	1.2 – 1.8
	Rainbow trout	64	0.5 – 1.2
	Brown trout	24	0.1 – 0.5
	Common bully	100	usually less than 0.1
Mean plasma protein	Longfin eel	73	5.9 – 7.0
	Shortfin eel	109	5.6 – 6.6
	Rainbow trout	63	4.7 – 8.3
	Brown trout	24	5.0 – 6.4
	Common bully	100	7.2 – 10.0
Mean condition factor	Longfin eel	75	0.23 – 0.26
	Shortfin eel	111	0.19 – 0.21
	Rainbow trout	76	1.08 – 1.27
	Brown trout	24	1.02 – 1.21
	Common bully	151	1.13 – 1.38
Mean LSI	Longfin eel	75	1.2 – 1.5
	Shortfin eel	111	0.8 – 1.1
	Rainbow trout	73	0.7 – 1.1
	Brown trout	24	0.6 – 0.8
	Common bully	151	1.5 – 3.0
Fat index	Longfin eel	5	25.8 – 53.2
	Shortfin eel	7	10.0 – 41.7
	Rainbow trout	5	30.0 – 73.7
	Brown trout	2	—
	Common bully	11	15.3 – 57.8
Parasite index	Longfin eel	5	0.0 – 0.9
	Shortfin eel	7	0.0 – 2.7
	Rainbow trout	5	0.0 – 20.2
	Brown trout	2	—
	Common bully	11	33.3 – 56.7

for the various factors. Only data from unimpacted sites where the normality and severity indices were normal were used to calculate these values.

One way to display your results is to place them in a table with values that are outside the acceptable or normal ranges highlighted in bold. Table 2 shows results for 75 longfin eels collected from five unimpacted sites, plus another sample of 20 eels collected from a site downstream of two pulp and paper mills. Although the normality and severity indices were normal at all six sites, there was a relatively high incidence of abnormal values (3) from eels at the impacted site. And, although there was a similar number of abnormal FHP values for longfin eels from the upper Tarawera, the normality index of longfin eels from the impacted area was much lower than that for eels in the upper river, the LSI was significantly higher (Tukey test, $P < 0.05$), and the fish had more parasites. It would also appear that high plasma protein and a low fat index were characteristic of longfin eels from this river. However, these findings should be viewed cautiously because only six eels were assessed from the upper river. Nevertheless, when viewed as a whole, the results suggest the health of eels is mildly affected in the Tarawera River and may be worthy of further monitoring.

At sites where the indices are unacceptable, you should determine whether similar abnormalities (for example, shortened opercules) were found in most of the fish examined or whether there were a variety of abnormalities that, added together, caused the indices to be unacceptable. If the former, reference to published literature may help to interpret your findings. In the Tarawera River example above, a review of the literature showed that an increase in relative liver size (LSI) is consistent with exposure to pulp and paper mill effluents (Okari & Nakari 1982, Andersson *et al.* 1988, Munkittrick *et al.* 1992).

It is beyond the scope of the FHP and this manual to provide an interpretation of every abnormality that might be encountered. Indeed, many abnormalities may have several possible causes (Hibiya 1982, Roberts 1989). What is most important is that you have or have not demonstrated that there is a measurable departure from normality in fish health. Diagnostic procedures can be employed later, if necessary.

Table 2: **Summary of FHP values for longfin eels from six sites. Values shown in bold are outside normal ranges. The feeding index is not shown because the fish were not processed immediately after capture**

Site	N	Normality index	Severity index	Mean hematocrit (%)	Mean leucocrit (%)	Mean plasma protein (%)	Mean condition factor	LSI	Fat index	Parasite index	Number of abnormal values
Waiau River	20	96.3	2.5	39.1	1.9	**7.1**	0.24	1.3	**55.0**	**1.7**	3
Mataura River	20	92.5	5.0	35.9	**1.2**	6.7	0.23	1.2	45.0	0.0	1
Kaikorai Stream	19	94.8	0.0	38.1	1.8	6.0	0.26	1.5	51.3	0.0	0
Waikouaiti River	10	91.3	0.0	37.8	1.7	**5.7**	0.24	1.5	35.0	0.0	1
Upper Tarawera River	6	100.0	0.0	40.4	1.6	**5.6**	0.23	**1.1**	**16.7**	0.0	3
Lower Tarawera River[†]	20	91.3	0.0	38.5	1.5	**5.6**	0.24	1.5	**16.3**	**5.0**	3

[†] impacted site

Acceptable levels	
Normality index	> 90
Severity index	< 10

Normal ranges of blood parameters	
Hematocrit	35.0 – 40.5
Leucocrit	1.3 – 1.9
Plasma protein	5.9 – 7.0

Normal ranges for other factors	
Condition factor	0.23 – 0.26
LSI	1.2 – 1.5
Fat index	25.8 – 53.2
Parasite index	0.0 – 0.9

Refinements to the FHP

One limitation of the FHP procedure is that there is no quantitative basis for statistically comparing the suite of FHP variables from one population to another, either in time or space. Adams *et al.* (1993) devised the health assessment index (HAI) to overcome this. For the HAI to have a statistical basis, all FHP variables must be assigned a numerical value. The details of how this is done were given by Adams *et al.* (1993): essentially, normal organs are given a score of 0 and abnormal organs a score of 30. For the organs and tissues that are already graded numerically, such as fins, the scores are multiplied by 10, i.e., no erosion = 0, mild erosion = 10, and so on. Values for the blood parameters, condition factor, and LSI are also assigned scores between 0 and 30 depending on the degree of deviation from the normal range for each species. The HAI value for a sample population is calculated by summing all individual fish HAI scores and dividing by the total number of fish examined for that sample. A standard deviation and coefficient of variation can be calculated for each sample, so statistical comparisons can be made among sample sites, between sample times for the same site, and even between species. Adams *et al.* (1993) tested the HAI on fish populations in the U.S., and the results gave similar conclusions to other biomonitoring approaches, such as measuring PCB levels in flesh and gonads or assessments of reproductive competence.

Table 3 summarises HAI values for longfin eels from the six sites shown in Table 2, which ranged from 21.1 for the Waiau River to 63.0 for the Waikouaiti River. With the exception of the Waikouaiti River, where for unknown reasons several fish had high leucocrit or high LSI, the HAI values accurately reflect the degree of impact. The lowest was found for the most pristine river, the Waiau, which drains Lakes Te Anau and Manapouri in Southland. Waterways which were somewhat impacted, such as the Mataura (meat and dairy processing wastes and sewage effluent) or the Kaikorai (various industrial wastes and rubbish tip leachate) received higher HAI values, and the highest value was from the lower Tarawera River, which receives considerable pulp and paper mill effluent. However, the mean value of the HAI for the lower Tarawera was not significantly different from that of the upper Tarawera (Tukey test, $P > 0.05$), confirming our previous conclusion that there was only a minor impact on longfin eel health at this site. This comparison between the upper and lower Tarawera sites may have been compromised by the small sample size of fish from the upper river, and emphasises the importance of obtaining adequate numbers of fish for assessment. The HAI appears to have merit, but more work needs to be done on the New Zealand species to correctly assign HAI scores to the various FHP variables.

Other supplements to the FHP can include indices such as a gonadosomatic index (relative gonad weight) or a skin lesion index, for example 0 = no lesions, 1 = one or two lesions, etc. The version of the FHP described in this manual already includes a parasite infestation index and an LSI, both of which have provided useful comparisons.

Table 3: **Summary of HAI values for longfin eels from six sites**

Site	N	Mean	Standard deviation	Coefficient of variation (%)
Waiau River	19	21.1	14.9	71
Mataura River	20	37.5	24.5	65
Kaikorai Stream	19	48.4	27.7	57
Waikouaiti River	10	63.0	39.7	63
Upper Tarawera River	5	28.0	30.3	108
Lower Tarawera River	19	57.9	28.4	49

Several approaches have been used to evaluate the effects of pollution on fish populations. Some of these have focused primarily on fish habitat or the population structure (e.g., Yelverton 1968, Swanson *et al.* 1994, Boubée *et al.* 1995). Although sophisticated equipment is not necessary for such surveys, it can be time consuming to ensure that all sites and available habitats receive an equal sampling effort. Such studies can also be compromised by environmental perturbations which occur independently of the effluent discharge (such as floods or drought), natural upstream/downstream habitat variation, year-to-year changes in fish recruitment, and even species specific behaviour, such as schooling. Thus, it can be difficult to attribute any observed differences in population structure or habitat solely to effluent discharges.

Other studies have concentrated on measures of biochemical, physiological, or pathological condition (e.g., Oikari *et al.* 1984, Andersson *et al.* 1988, Munkittrick *et al.* 1992, Kloepper-Sams *et al.* 1994). Results from these studies probably show a clearer cause and effect, but they cannot be applied rapidly in the field. Usually, samples have to be processed using sophisticated laboratory equipment, which requires various degrees of time, expense, and expertise. It may be difficult to associate measured abnormalities with adverse effects on fish health.

The FHP and the HAI provide an assessment of the overall health and condition of fish, species which are generally near the top of the ecosystem food chain. As such, they offer a holistic approach to monitoring ecosystem health. The procedures can be carried out in the field with little equipment and do not require an intensive effort so long as 20 fish of a particular species can be captured at each site. The results are quickly available and are easily interpreted — either the indices are within acceptable limits or they are not. Although there is a degree of subjectivity in assessing organ abnormality, the colour photographs in this and other manuals (Goede 1993) are available to help with interpretation. When used as a routine monitoring tool, the procedures can cheaply and efficiently alert water managers to populations under stress, and thus help focus further effort and research where they are most needed.

NIWA will continue to maintain an interest in, and an overview of, the FHP procedure and periodically update the database of FHP values. Water managers wishing to use the FHP

procedure may contact us for additional advice or assistance if required, and the contribution of data for inclusion in the database is encouraged. Colour photographs of organs assessed for the FHP, particularly those that appear abnormal, would be a welcome addition to the established, but far from complete, library of organ photographs.

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Example of recording form

Lake/River: Waiau River **Site:** lower river **Species:** Longfin eel **Date:** 13/03/97

No	Ln	Wt	Eye	Fin	Opl	Gill	Pbr	Thy	Liv	Spl	Hgut	Kid	Fat	Bile	Para	Sex	Stg	Liv Wt	Remarks
1	446	196.4	N	0	0	N	—	—	A	R	0	N	3	1	0	U	1	3.3	
2	498	280.4	N	0	0	N	—	—	A	R	0	N	1	1	0	U	1	3.4	
3	494	307.6	N	1	0	N	—	—	A	R	0	N	1	2	1	U	1	3.4	fungal growth in gills
4	517	348.4	N	0	0	N	—	—	A	R	0	N	4	2	0	U	1	3.3	
5	480	251.5	N	0	0	N	—	—	A	R	0	N	2	1	0	U	1	3.7	
6	557	416.8	N	0	0	N	—	—	A	R	0	N	4	2	0	U	1	5.2	small spot on fin
7	472	232.9	N	0	0	N	—	—	A	R	0	N	2	2	0	U	1	3.5	
8	518	314.4	N	0	0	N	—	—	F	R	0	N	2	2	0	U	1	4.0	
9	499	343.4	N	0	0	N	—	—	F	R	0	N	4	2	0	U	1	4.3	large liver
10	525	350.6	N	0	0	N	—	—	F	R	0	N	2	2	0	U	1	4.4	small cyst
11	493	316.1	N	0	0	N	—	—	A	R	0	N	3	2	0	U	1	3.7	
12	490	277.9	N	0	0	N	—	—	A	R	0	N	2	2	0	U	1	3.5	small cyst
13	492	254.4	N	1	0	N	—	—	A	R	0	N	0	1	0	U	1	3.4	erosion on pectorals
14	508	316.8	N	1	0	N	—	—	A	R	0	N	3	2	0	U	1	3.8	dorsal damaged
15	480	243.8	N	0	0	N	—	—	A	R	0	N	1	2	0	U	1	3.0	
16	510	290.1	N	0	0	N	—	—	A	R	0	N	2	2	0	U	1	3.9	
17	465	234.7	N	0	0	N	—	—	A	R	0	N	2	2	0	U	1	3.8	
18	490	276.0	N	0	0	N	—	—	B	R	0	N	1	2	0	U	1	4.3	
19	486	295.7	N	0	0	N	—	—	A	R	0	N	3	2	0	U	1	3.6	
20	530	310.1	N	0	0	N	—	—	A	R	0	N	2	2	0	U	1	3.8	skin yellow/black
Blood samples 41–60																			

SUMMARY OF FISH HEALTH PROFILE

Location: Waiau River	Site: lower river
Species: Longfin eel	
Autopsy date: 13/03/97	Sample size: 20
Capture method: fyke	Reason for autopsy: MFE70209
Remarks: Fish captured over two days and held until processing. Fin damage probably caused by keep nets. Good health assessment.	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	497.5	24.8	5%
Weight (g)	292.9	50.8	17%
Hematocrit (%)	39.1	2.6	7%
Leucocrit (%)	1.9	0.3	17%
Plasma protein (wt%)	7.1	0.8	11%
Condition factor	0.24	0.02	8%
LSI	1.3	0.2	14%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 85	**0** 100	**N** 100	**N**	**0**	**A** 80	**B**	**0** 100	**N** 100	**0** 5	**0**	**0** 95
B1	**1** 15	**1**	**F**	**S**	**1**	**B** 5	**R** 100	**1**	**S**	**1** 20	**1** 20	**1** 5
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 40	**2** 80	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 20		**3**
E2			**P**	**I**		**E**	**E**		**U**	**4** 15		
H1			**OT**	**OT**		**F** 15	**OT**		**OT**			
H2												
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	85	100	100	—	—	85	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.15	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	2.20	1.80	0.05

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	7.5	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	55.0	60.0	1.7

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 96.3	**Severity Index**: 2.5	**Feeding Index**: 40.0

Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: Few

Sores: Two fish with small cysts

Gonads: Immature

Other:

Appendix 1: Summaries of FHP values for five species of freshwater fish

Data are from unimpacted sites where the normality and severity indices were normal.

SUMMARY OF FISH HEALTH PROFILE

Location: Kaikorai Stream	Site:
Species: Longfin eel	
Autopsy date: 03, 04/03/97	Sample size: 19
Capture method: Baited fyke	Reason for autopsy: MFE70209
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	510.5	41.8	8%
Weight (g)	359.1	88.0	25%
Hematocrit (%)	38.1	5.0	13%
Leucocrit (%)	1.8	0.7	39%
Plasma protein (wt%)	6.0	0.7	12%
Condition factor	0.26	0.02	6%
LSI	1.5	0.3	18%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N**	**0**	**A** 58	**B**	**0** 100	**N** 100	**0** 11	**0**	**0** 100
B1	**1**	**1**	**F**	**S**	**1**	**B**	**R** 100	**1**	**S**	**1** 31	**1** 100	**1**
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 11	**2**	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 16	**3**	**3**
E2			**P**	**I**		**E** 42	**E**		**U**	**4** 31		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	—	—	58	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	2.05	1.00	0.00

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	51.3	33.3	0.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 94.8				**Severity Index**: 0.0					**Feeding Index**: 66.7	
Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: None

Sores: None

Gonads: Several fish close to migratory stage

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Mataura River	Site: Lower river
Species: Longfin eel	
Autopsy date: 11, 13/03/97	Sample size: 20
Capture method: Baited fyke	Reason for autopsy: MFE70209
Remarks: Bile high because fish held in keep nets for up to 4 days. Fin erosion probably caused by keep nets.	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	483.9	23.9	5%
Weight (g)	265.3	37.7	14%
Hematocrit (%)	35.9	6.4	18%
Leucocrit (%)	1.2	0.5	40%
Plasma protein (wt%)	6.7	0.7	10%
Condition factor	0.23	0.01	5%
LSI	1.2	0.2	15%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 75	**0** 100	**N** 95	**N**	**0**	**A** 45	**B**	**0** 100	**N** 100	**0**	**0**	**0** 100
B1	**1** 20	**1**	**F**	**S**	**1**	**B** 25	**R** 100	**1**	**S**	**1** 25	**1** 5	**1**
B2	**2** 5	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 70	**2** 85	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 5	**3** 10	**3**
E2			**P**	**I**		**E** 25	**E**		**U**	**4**		
H1			**OT** 5	**OT**		**F** 5	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	75	100	95	—	—	70	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.30	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	1.80	2.05	0.00

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	15.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	45.0	68.3	0.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 92.5				**Severity Index**: 5.0				**Feeding Index**: 31.7		
Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: None

Sores: Few

Gonads: Immature

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Tarawera River	Site: Upper river
Species: Longfin eel	
Autopsy date: 30/01, 19/03/97	Sample size: 6
Capture method: Unbaited fyke	Reason for autopsy: MFE70209
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	494.2	62.9	13%
Weight (g)	297.6	151.0	51%
Hematocrit (%)	40.4	6.3	16%
Leucocrit (%)	1.6	0.4	27%
Plasma protein (wt%)	5.6	0.8	13%
Condition factor	0.23	0.04	18%
LSI	1.0	0.3	24%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N**	**0**	**A** 83	**B**	**0** 100	**N** 100	**0** 50	**0** 17	**0** 100
B1	**1**	**1**	**F**	**S**	**1**	**B** 17	**R** 100	**1**	**S**	**1** 33	**1** 83	**1**
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 17	**2**	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3**	**3**
E2			**P**	**I**		**E**	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	—	—	100	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	0.67	0.83	0.00

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	16.7	27.7	0.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 100.0				**Severity Index**: 0.0					**Feeding Index**: 72.3	
Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: None

Sores: None

Gonads: Immature

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Waiau River	Site: Lower river
Species: Longfin eel	
Autopsy date: 13/03/97	Sample size: 20
Capture method: fyke	Reason for autopsy: MFE70209
Remarks: Fish captured over two days and held until processing. Fin damage probably caused by keep nets.	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	497.5	24.8	5%
Weight (g)	292.9	50.8	17%
Hematocrit (%)	39.1	2.6	7%
Leucocrit (%)	1.9	0.3	17%
Plasma protein (wt%)	7.1	0.8	11%
Condition factor	0.24	0.02	8%
LSI	1.3	0.2	14%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 85	**0** 100	**N** 100	**N**	**0**	**A** 80	**B**	**0** 100	**N** 100	**0** 5	**0**	**0** 95
B1	**1** 15	**1**	**F**	**S**	**1**	**B** 5	**R** 100	**1**	**S**	**1** 20	**1** 20	**1** 5
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 40	**2** 80	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 20	**3**	**3**
E2			**P**	**I**		**E**	**E**		**U**	**4** 15		
H1			**OT**	**OT**		**F** 15	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	85	100	100	—	—	85	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.15	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	2.20	1.80	0.05

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	7.5	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	55.0	60.0	1.7

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 96.3				**Severity Index**: 2.5				**Feeding Index**: 40.0		
Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: Few

Sores: Two fish with small cysts

Gonads: Immature

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Waikouaiti River	Site:
Species: Longfin eel	
Autopsy date: 05, 06/03/97	Sample size: 10
Capture method: Baited fyke & GMT	Reason for autopsy: MFE70209
Remarks: 2 abnormal spleens — grey/red in colour.	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	449.6	71.9	16%
Weight (g)	236.1	122.3	52%
Hematocrit (%)	37.8	3.0	8%
Leucocrit (%)	1.7	0.4	21%
Plasma protein (wt%)	5.7	0.6	11%
Condition factor	0.24	0.02	9%
LSI	1.5	0.4	24%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N**	**0**	**A** 20	**B**	**0** 100	**N** 100	**0**	**0** 10	**0** 100
B1	**1**	**1**	**F**	**S**	**1**	**B** 30	**R** 80	**1**	**S**	**1** 60	**1** 90	**1**
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 40	**2**	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3**	**3**
E2			**P**	**I**		**E** 50	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT** 20		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	—	—	50	80	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	1.40	1.00	0.00

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	35.0	33.3	0.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 91.3				**Severity Index**: 0.0				**Feeding Index**: 66.7		
Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: None

Sores: None

Gonads: Immature

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Kaikorai Stream	Site:
Species: Shortfin eel	
Autopsy date: 04/03/97	Sample size: 18
Capture method: Baited fyke	Reason for autopsy: MFE70209
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	601.3	75.3	13%
Weight (g)	484.3	185.9	38%
Hematocrit (%)	35.1	4.6	13%
Leucocrit (%)	1.8	0.4	22%
Plasma protein (wt%)	6.3	1.0	17%
Condition factor	0.21	0.01	5%
LSI	1.2	0.2	15%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N**	**0**	**A** 66	**B**	**0** 100	**N** 100	**0** 11	**0** 5	**0** 100
B1	**1**	**1**	**F**	**S**	**1**	**B** 17	**R** 100	**1**	**S**	**1** 28	**1** 90	**1**
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 44	**2** 5	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 17	**3**	**3**
E2			**P**	**I**		**E** 17	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	—	—	83	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	1.67	1.00	0.00

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	41.7	33.3	0.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 97.9				**Severity Index**: 0.0					**Feeding Index**: 66.7	
Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: None

Sores: None

Gonads: Several fish close to migratory stage

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Mataura River	Site: Lower river
Species: Shortfin eel	
Autopsy date: 11, 12/03/97	Sample size: 19
Capture method: Baited fyke	Reason for autopsy: MFE70209
Remarks: Bile high because fish in keep nets for 1–3 days. Fish erosion possibly from keep nets.	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	573.5	68.5	12%
Weight (g)	412.6	154.8	38%
Hematocrit (%)	37.2	3.2	9%
Leucocrit (%)	1.5	0.7	48%
Plasma protein (wt%)	6.6	0.7	10%
Condition factor	0.21	0.02	10%
LSI	1.0	0.2	22%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 90	**0** 100	**N** 100	**N**	**0**	**A** 85	**B**	**0** 95	**N** 100	**0**	**0**	**0** 100
B1	**1** 10	**1**	**F**	**S**	**1**	**B** 5	**R** 100	**1** 5	**S**	**1** 79	**1** 58	**1**
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 16	**2** 10	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3** 32	**3**
E2			**P**	**I**		**E** 5	**E**		**U**	**4** 5		
H1			**OT**	**OT**		**F** 5	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	90	100	100	—	—	90	100	95	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.10	0.00	xxxx	xxxx	—	xxxx	xxxx	0.05	xxxx	1.31	1.79	0.00

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	5.0	0.0	xxxx	xxxx	—	xxxx	xxxx	2.5	xxxx	32.8	59.7	0.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 96.9				**Severity Index**: 2.5				**Feeding Index**: 40.3		
Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: None

Sores: Few

Gonads: Immature

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Rangitaiki River	Site:
Species: Shortfin eel	
Autopsy date: 20/05/97	Sample size: 12
Capture method: Baited fyke	Reason for autopsy: FRI70202
Remarks: Fish damage probably from fyke nets so all graded as "0".	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	535.8	53.1	10%
Weight (g)	274.1	62.7	23%
Hematocrit (%)	41.1	3.8	9%
Leucocrit (%)	1.2	0.2	13%
Plasma protein (wt%)	6.4	0.8	12%
Condition factor	0.18	0.02	11%
LSI	1.1	0.2	15%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N**	**0**	**A** 92	**B**	**0** 100	**N** 100	**0** 8	**0** 58	**0** 100
B1	**1**	**1**	**F**	**S**	**1**	**B**	**R** 100	**1**	**S**	**1** 67	**1** 8	**1**
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 25	**2**	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3** 34	**3**
E2			**P**	**I**		**E**	**E**		**U**	**4**		
H1			**OT**	**OT**		**F** 8	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	—	—	92	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	1.17	1.08	0.00

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	29.3	36.0	0.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 99.0				**Severity Index**: 0.0					**Feeding Index**: 64.0	
Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: None

Sores: None

Gonads: Immature

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Tarawera River	Site: Upper river
Species: Shortfin eel	
Autopsy date: 30/01, 19, 20/03/97	Sample size: 20
Capture method: Unbaited fyke	Reason for autopsy: MFE70209
Remarks: Fin damage most likely from nets.	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	416.8	80.9	19%
Weight (g)	165.6	124.0	75%
Hematocrit (%)	40.5	4.9	12%
Leucocrit (%)	1.2	0.4	36%
Plasma protein (wt%)	5.6	1.5	26%
Condition factor	0.20	0.02	10%
LSI	0.7	0.2	24%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 95	**0** 85	**0** 100	**N** 100	**N**	**0**	**A** 95	**B**	**0** 100	**N** 100	**0** 70	**0**	**0** 90
B1 5	**1** 15	**1**	**F**	**S**	**1**	**B** 5	**R** 100	**1**	**S**	**1** 20	**1** 65	**1** 10
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 10	**2** 30	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3** 5	**3**
E2			**P**	**I**		**E**	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

95	85	100	100	—	—	100	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.15	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	0.40	1.40	0.10

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	7.5	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	10.0	46.7	3.3

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 97.5				**Severity Index**: 2.5				**Feeding Index**: 53.3		
Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: Few

Sores: Few

Gonads: Immature

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Waikouaiti River	Site:
Species: Shortfin eel	
Autopsy date: 05/03/97	Sample size: 12
Capture method: Baited fyke & GMT	Reason for autopsy: MFE70209
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	494.7	69.9	14%
Weight (g)	270.3	122.0	45%
Hematocrit (%)	34.2	4.4	13%
Leucocrit (%)	1.4	0.3	21%
Plasma protein (wt%)	6.3	0.9	14%
Condition factor	0.21	0.02	10%
LSI	0.9	0.1	12%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 75	**0** 100	**N** 100	**N**	**0**	**A** 84	**B**	**0** 100	**N** 100	**0** 25	**0** 17	**0** 92
B1	**1** 25	**1**	**F**	**S**	**1**	**B** 8	**R** 100	**1**	**S**	**1** 67	**1** 83	**1** 8
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 8	**2**	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3**	**3**
E2			**P**	**I**		**E** 8	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	75	100	100	—	—	92	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.17	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	0.83	0.83	0.08

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	8.5	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	20.7	27.7	2.7

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 95.9				**Severity Index**: 2.8					**Feeding Index**: 72.3	
Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: Few

Sores: None

Gonads: Immature

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Whakapipi Stream	Site:
Species: Shortfin eel	
Autopsy date: 17/04/97	Sample size: 16
Capture method: GMT	Reason for autopsy: MFE70209
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	415.3	50.1	12%
Weight (g)	138.8	49.6	36%
Hematocrit (%)	31.3	4.5	14%
Leucocrit (%)	1.5	0.3	17%
Plasma protein (wt%)	5.4	0.5	9%
Condition factor	0.19	0.01	5%
LSI	0.9	0.1	13%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 87	**0** 100	**N** 100	**N**	**0**	**A** 87	**B**	**0** 100	**N** 100	**0** 75	**0** 63	**0** 94
B1	**1** 13	**1**	**F**	**S**	**1**	**B**	**R** 100	**1**	**S**	**1** 25	**1** 37	**1** 6
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2**	**2**	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3**	**3**
E2			**P**	**I**		**E** 13	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	87	100	100	—	—	87	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.13	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	0.25	0.37	0.06

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	6.5	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	6.3	12.3	2.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 96.8	**Severity Index**: 2.2	**Feeding Index**: 87.7

Sex (%)	**M**:	**F**:	**U**: 100	**Stage (%)**	**1**: 100	**2**:	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: Few

Sores: None

Gonads: Immature

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Lake Maraetai	Site: 2
Species: Rainbow trout	
Autopsy date: 28, 29/03/95	Sample size: 21
Capture method: Gill net	Reason for autopsy: PPL301
Remarks: Many fish with generally discoloured livers.	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	330.3	68.3	21%
Weight (g)	467.5	238.2	51%
Hematocrit (%)	46.9	10.3	22%
Leucocrit (%)	0.9	0.4	40%
Plasma protein (wt%)	5.4	2.1	39%
Condition factor	1.19	0.08	7%
LSI	0.7	0.3	35%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 96	**0** 100	**0** 100	**N** 100	**N** 81	**0** 86	**A** 10	**B** 29	**0** 100	**N** 95	**0** 10	**0** 67	**0** 86
B1	**1**	**1**	**F**	**S** 19	**1** 14	**B** 19	**R** 71	**1**	**S**	**1** 43	**1** 10	**1** 14
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 47	**2** 5	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3** 18	**3**
E2			**P**	**I**		**E** 71	**E**		**U** 5	**4**		
H1 4			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

96	100	100	100	100	86	29	100	100	95	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	0.14	xxxx	xxxx	0.00	xxxx	1.38	0.71	0.14

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	7.0	xxxx	xxxx	0.0	xxxx	34.5	23.7	4.8

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 90.6	**Severity Index**: 1.7	**Feeding Index**: 76.3

Sex (%)	**M**: 52	**F**: 48	**U**:	**Stage (%)**	**1**: 62	**2**: 14	**3**: 24	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: A few shagworms

Sores:

Gonads:

Other: Pseudobranchs probably swollen from drowning in gill nets so these graded as normal

SUMMARY OF FISH HEALTH PROFILE

Location: Lake Tarawera	Site:
Species: Rainbow trout	
Autopsy date: 15–16/01/97	Sample size: 15
Capture method: Gill net	Reason for autopsy: MFE70209
Remarks: Smaller fish with heavy fat deposits, larger fish no or little fat.	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	468.5	113.7	24%
Weight (g)	1381.9	788.0	57%
Hematocrit (%)	48.9	10.0	20%
Leucocrit (%)	1.4	0.4	29%
Plasma protein (wt%)	7.1	2.4	35%
Condition factor	1.22	0.14	11%
LSI	0.9	0.2	21%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N** 100	**0** 53	**A** 80	**B** 33	**0** 100	**N** 100	**0** 13	**0** 67	**0** 93
B1	**1**	**1**	**F**	**S**	**1** 47	**B** 13	**R** 67	**1**	**S**	**1** 13	**1** 33	**1** 7
B2	**2**	**2**	**C**	**L**	**2**	**C** 7	**G**	**2**	**M**	**2**	**2**	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 13	**3**	**3**
E2			**P**	**I**		**E**	**E**		**U**	**4** 61		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	100	53	93	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	0.47	xxxx	xxxx	0.00	xxxx	2.93	0.33	0.07

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	23.5	xxxx	xxxx	0.0	xxxx	73.3	11.0	2.3

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 94.6				**Severity Index**: 5.9				**Feeding Index**: 89.0	
Sex (%)	**M**: 13	**F**: 33	**U**: 54	**Stage (%)**	**1**: 53	**2**: 7	**3**: 40	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: None

Sores: None

Gonads: Mostly immature fish

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Lake Taupo	Site:
Species: Rainbow trout	
Autopsy date: 21, 22/01/97	Sample size: 16
Capture method: Gill net	Reason for autopsy: MFE70209
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	480.6	82.2	17%
Weight (g)	1328.9	458.5	34%
Hematocrit (%)	53.7	6.3	12%
Leucocrit (%)	0.7	0.4	58%
Plasma protein (wt%)	9.3	1.9	20%
Condition factor	1.18	0.20	17%
LSI	1.3	0.2	18%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 88	**N** 100	**N** 94	**0** 56	**A** 75	**B**	**0** 100	**N** 100	**0**	**0** 88	**0** 100
B1	**1**	**1** 12	**F**	**S** 6	**1** 44	**B** 13	**R** 94	**1**	**S**	**1** 12	**1** 12	**1**
B2	**2**	**2**	**C**	**L**	**2**	**C** 6	**G**	**2**	**M**	**2** 38	**2**	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 12	**3**	**3**
E2			**P**	**I**		**E**	**E** 6		**U**	**4** 38		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	88	100	94	56	88	94	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.13	xxxx	xxxx	0.44	xxxx	xxxx	0.00	xxxx	2.75	0.13	0.00

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	6.5	xxxx	xxxx	22.0	xxxx	xxxx	0.0	xxxx	68.7	4.3	0.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 92.0				**Severity Index**: 7.1				**Feeding Index**: 95.7		
Sex (%)	**M**: 50	**F**: 50	**U**:	**Stage (%)**	**1**: 38	**2**: 12	**3**: 50	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: None

Sores: None

Gonads: Mix of gonad stages

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Lake Whakamaru	Site:
Species: Rainbow trout	
Autopsy date: 10/04/95	Sample size: 11
Capture method: Gill net	Reason for autopsy: PPL301
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	307.6	29.6	10%
Weight (g)	312.1	101.6	33%
Hematocrit (%)	51.9	9.3	18%
Leucocrit (%)	1.0	0.6	67%
Plasma protein (wt%)	3.9	1.1	29%
Condition factor	1.04	0.11	11%
LSI	0.6	0.1	17%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 91	**N** 55	**0** 100	**A** 91	**B** 36	**0** 100	**N** 100	**0**	**0** 64	**0**
B1	**1**	**1**	**F**	**S** 18	**1**	**B** 9	**R** 64	**1**	**S**	**1** 73	**1** 27	**1** 55
B2	**2**	**2**	**C**	**L** 27	**2**	**C**	**G**	**2**	**M**	**2** 27	**2** 9	**2** 36
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3**	**3** 9
E2			**P** 9	**I**		**E**	**E** 6		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	91	73	100	100	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	0.00	xxxx	xxxx	0.00	xxxx	1.27	0.45	1.55

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	0.0	xxxx	xxxx	0.0	xxxx	31.7	15.0	51.6

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 96.4	**Severity Index**: 0.0	**Feeding Index**: 85.0

Sex (%)	**M**: 27	**F**: 73	**U**:	**Stage (%)**	**1**: 45	**2**: 55	**3**:	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: Shagworm present in all fish — fish 8 with very heavy infestation

Sores: Generally none except fish 8

Gonads:

Other: Pseudobranchs probably swollen from drowning in gill nets so these graded as normal

SUMMARY OF FISH HEALTH PROFILE

Location: Waikato River	Site: Between Lakes Ohakuri and Aratiatia
Species: Rainbow trout	
Autopsy date: 03/12/96	Sample size: 14
Capture method: Gill net	Reason for autopsy: COE70203
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	346.9	53.1	15%
Weight (g)	530.3	223.3	42%
Hematocrit (%)	45.5	10.0	22%
Leucocrit (%)	0.6	0.4	70%
Plasma protein (wt%)	5.5	1.2	22%
Condition factor	1.22	0.12	10%
LSI	0.9	0.1	17%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N** 100	**0** 57	**A** 100	**B**	**0** 100	**N** 100	**0** 14	**0** 100	**0** 71
B1	**1**	**1**	**F**	**S**	**1** 43	**B**	**R** 100	**1**	**S**	**1** 72	**1**	**1** 29
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G**	**2**	**M**	**2** 14	**2**	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3**	**3**
E2			**P**	**I**		**E**	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	100	57	100	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	0.42	xxxx	xxxx	0.00	xxxx	1.00	0.00	0.29

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	21.0	xxxx	xxxx	0.0	xxxx	25.0	0.0	9.7

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 95.7	**Severity Index**: 5.2	**Feeding Index**:100.0

Sex (%)	**M**: 36	**F**: 64	**U**:	**Stage (%)**	**1**: 43	**2**: 50	**3**: 7	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: A few shagworms

Sores: None

Gonads:

Other: Pseudobranchs probably swollen from drowning in gill nets so these graded as normal

SUMMARY OF FISH HEALTH PROFILE

Location: Kaikorai Stream	Site:
Species: Brown trout	
Autopsy date: 03, 04, 06/03/97	Sample size: 10
Capture method: Baited fyke and EFM	Reason for autopsy: MFE70209
Remarks: Big size range 174–553 mm.	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	309.6	146.8	47%
Weight (g)	656.3	854.2	130%
Hematocrit (%)	45.4	6.1	14%
Leucocrit (%)	0.4	0.3	81%
Plasma protein (wt%)	7.2	1.8	25%
Condition factor	1.25	0.13	10%
LSI	1.0	0.4	36%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N** 100	**0** 90	**A** 40	**B**	**0** 100	**N** 100	**0**	**0** 50	**0** 100
B1	**1**	**1**	**F**	**S**	**1** 10	**B** 20	**R** 80	**1**	**S**	**1** 20	**1** 40	**1**
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G** 20	**2**	**M**	**2** 50	**2**	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 30	**3** 10	**3**
E2			**P**	**I**		**E** 40	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	100	90	60	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	0.10	xxxx	xxxx	0.00	xxxx	2.20	0.80	0.00

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	5.0	xxxx	xxxx	0.0	xxxx	55.0	26.7	0.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 95.0	**Severity Index**: 1.3	**Feeding Index**: 73.3

Sex (%)	**M**: 40	**F**: 60	**U**:	**Stage (%)**	**1**: 40	**2**:	**3**: 60	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: None

Sores: None

Gonads:

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Tokomairiro River	Site:
Species: Brown trout	
Autopsy date: 06, 07/03/97	Sample size: 14
Capture method: EFM	Reason for autopsy: MFE70209
Remarks: Most fish quite small.	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	182.0	49.9	27%
Weight (g)	77.5	79.5	103%
Hematocrit (%)	45.4	6.4	14%
Leucocrit (%)	0.3	0.4	149%
Plasma protein (wt%)	5.3	0.7	13%
Condition factor	1.04	0.05	10%
LSI	0.6	0.1	18%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N** 100	**0** 100	**A** 79	**B**	**0** 100	**N** 100	**0** 14	**0** 50	**0** 100
B1	**1**	**1**	**F**	**S**	**1**	**B** 21	**R** 57	**1**	**S**	**1** 43	**1** 50	**1**
B2	**2**	**2**	**C**	**L**	**2**	**C**	**G** 43	**2**	**M**	**2** 43	**2**	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3**	**3**
E2			**P**	**I**		**E**	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	100	100	100	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	0.00	xxxx	xxxx	0.00	xxxx	1.29	0.50	0.00

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	0.0	xxxx	xxxx	0.0	xxxx	32.3	16.7	0.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 100.0	**Severity Index**: 0.0	**Feeding Index**: 83.3

Sex (%)	**M**: 71	**F**: 29	**U**:	**Stage (%)**	**1**: 64	**2**: 8	**3**: 28	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: None

Sores: None

Gonads: Mostly immature

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Kaikorai Stream	Site:
Species: Common bully	
Autopsy date: 04/03/97	Sample size: 12
Capture method: GMT	Reason for autopsy: MFE70209
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	70.4	5.1	7%
Weight (g)	4.3	1.0	24%
Hematocrit (%)	39.1	9.5	24%
Leucocrit (%)	<0.1	—	—
Plasma protein (wt%)	no data	—	—
Condition factor	1.22	0.09	7%
LSI	3.0	0.9	31%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 25	**N**	**0**	**A** 8	**B**	**0** 100	**N** 100	**0** 75	**0** 17	**0**
B1	**1**	**1**	**F**	**S**	**1**	**B**	**R** 100	**1**	**S**	**1** 8	**1** 17	**1** 58
B2	**2**	**2**	**C**	**L**	**2**	**C** 92	**G**	**2**	**M**	**2** 17	**2** 66	**2** 42
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3**	**3**
E2			**P** 75	**I**		**E**	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	25	—	—	100	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	0.42	1.50	1.42

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	10.5	50.0	47.3

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 90.6				**Severity Index**: 0.0				**Feeding Index**: 50.0		
Sex (%)	**M**: 25	**F**: 75	**U**:	**Stage (%)**	**1**:	**2**:	**3**: 100	**4**:	**5**:	**U**:

GENERAL REMARKS

Parasites: Whitespot

Sores:

Gonads:

Other: Many fish with pale gills

SUMMARY OF FISH HEALTH PROFILE

Location: Lake Maraetai	Site: 2
Species: Common bully	
Autopsy date: 29/03/95	Sample size: 7
Capture method: Fyke net	Reason for autopsy: PPL301
Remarks: Small sample	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	85.3	9.6	11%
Weight (g)	9.3	3.6	39%
Hematocrit (%)	36.6	10.8	30%
Leucocrit (%)	0.7	0.7	90%
Plasma protein (wt%)	7.1	0.2	3%
Condition factor	1.45	0.17	12%
LSI	2.1	0.6	29%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N**	**0**	**A**	**B**	**0** 86	**N** 100	**0** 14	**0** 43	**0** 43
B1	**1**	**1**	**F**	**S**	**1**	**B**	**R** 100	**1** 14	**S**	**1** 29	**1** 29	**1** 29
B2	**2**	**2**	**C**	**L**	**2**	**C** 100	**G**	**2**	**M**	**2** 14	**2** 14	**2** 28
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 43	**3** 14	**3**
E2			**P**	**I**		**E**	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	—	—	100	100	86	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.14	xxxx	1.86	1.14	0.86

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	7.0	xxxx	46.5	38.0	28.7

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 98.3	**Severity Index**: 2.3	**Feeding Index**: 62.0

Sex (%)	**M**: 71	**F**: 29	**U**:	**Stage (%)**	**1**:	**2**:	**3**:	**4**:	**5**:	**U**: 100

GENERAL REMARKS

Parasites: Shagworm infestation probably underestimated

Sores:

Gonads: Gonad stage not assessed

Other: Not a good blood sample — too few fish

SUMMARY OF FISH HEALTH PROFILE

Location: Tarawera River	Site: Upper river
Species: Common bully	
Autopsy date: 31/01 & 19/03/97	Sample size: 7
Capture method: GMT	Reason for autopsy: MFE70209
Remarks: Small sample	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	92.6	23.7	26%
Weight (g)	14.5	12.6	87%
Hematocrit (%)	43.8	7.4	17%
Leucocrit (%)	0.1	0.1	77%
Plasma protein (wt%)	10.0	1.6	16%
Condition factor	1.47	0.18	12%
LSI	2.7	1.0	38%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N**	**0**	**A**	**B**	**0** 100	**N** 100	**0**	**0**	**0** 29
B1	**1**	**1**	**F**	**S**	**1**	**B**	**R** 100	**1**	**S**	**1** 29	**1** 14	**1** 57
B2	**2**	**2**	**C**	**L**	**2**	**C** 100	**G**	**2**	**M**	**2** 14	**2** 72	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 14	**3** 14	**3** 14
E2			**P**	**I**		**E**	**E**		**U**	**4** 43		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	—	—	100	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	2.71	2.00	1.00

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	67.8	66.7	33.3

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 100.0				**Severity Index**: 0.0					**Feeding Index**: 33.3	
Sex (%)	**M**: 29	**F**: 71	**U**:	**Stage (%)**	**1**:	**2**: 14	**3**: 58	**4**: 14	**5**: 14	**U**:

GENERAL REMARKS

Parasites: Most fish infested

Sores: Some

Gonads: All stages, one ripe female

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Mataura River	Site: Lower river
Species: Common bully	
Autopsy date: 11/03/97	Sample size: 5
Capture method: GMT	Reason for autopsy: MFE70209
Remarks: Small sample	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	91.0	26.3	29%
Weight (g)	10.5	11.2	107%
Hematocrit (%)	34.4	8.0	23%
Leucocrit (%)	<0.1	—	—
Plasma protein (wt%)	8.5	0.4	5%
Condition factor	1.04	0.17	16%
LSI	1.3	1.1	82%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 80	**N**	**0**	**A**	**B**	**0** 100	**N** 100	**0**	**0** 20	**0** 80
B1	**1**	**1**	**F**	**S**	**1**	**B**	**R** 100	**1**	**S**	**1**	**1**	**1** 20
B2	**2**	**2**	**C**	**L**	**2**	**C** 100	**G**	**2**	**M**	**2** 60	**2** 80	**2**
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 20	**3**	**3**
E2			**P** 20	**I**		**E**	**E**		**U**	**4** 20		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	80	—	—	100	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	2.60	1.60	0.20

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	65.0	53.3	6.7

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 97.5				**Severity Index**: 0.0				**Feeding Index**: 46.7		
Sex (%)	**M**: 60	**F**: 40	**U**:	**Stage (%)**	**1**:	**2**:	**3**: 100	**4**	**5**:	**U**:

GENERAL REMARKS

Parasites: Almost none

Sores:

Gonads:

Other: Small livers

SUMMARY OF FISH HEALTH PROFILE

Location: Lake Taupo	Site:
Species: Common bully	
Autopsy date: 22, 23/01/97	Sample size: 18
Capture method: GMT	Reason for autopsy: MFE70209
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	84.7	14.9	18%
Weight (g)	10.1	8.5	84%
Hematocrit (%)	38.7	11.1	14%
Leucocrit (%)	<0.1	—	—
Plasma protein (wt%)	11.1	1.7	15%
Condition factor	1.43	0.23	16%
LSI	3.5	0.9	25%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 96	**0** 100	**0** 100	**N** 83	**N**	**0**	**A** 11	**B**	**0** 100	**N** 100	**0** 44	**0** 11	**0**
B1 6	**1**	**1**	**F**	**S**	**1**	**B**	**R** 89	**1**	**S**	**1** 28	**1** 33	**1** 50
B2	**2**	**2**	**C**	**L**	**2**	**C** 89	**G**	**2**	**M**	**2** 11	**2** 22	**2** 44
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 6	**3** 33	**3** 6
E2			**P** 17	**I**		**E**	**E** 11		**U**	**4** 11		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

96	100	100	83	—	—	100	89	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	1.11	1.78	1.56

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	27.7	59.3	52.0

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 96.0				**Severity Index**: 0.0				**Feeding Index**: 40.7		
Sex (%)	**M**: 28	**F**: 66	**U**: 6	**Stage (%)**	**1**:	**2**: 11	**3**: 55	**4**: 28	**5**:	**U**: 6

GENERAL REMARKS

Parasites: Shagworms and whitespot

Sores: Black subcutaneous spots

Gonads: Mostly maturing gonads, but some ripe females

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Waikouaiti River	Site:
Species: Common bully	
Autopsy date: 05/03/97	Sample size: 18
Capture method: GMT	Reason for autopsy: MFE70209
Remarks: All livers bordering on being fatty (C)	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	83.4	10.9	13%
Weight (g)	7.5	3.2	42%
Hematocrit (%)	32.3	8.5	26%
Leucocrit (%)	<0.1	—	—
Plasma protein (wt%)	8.4	1.8	22%
Condition factor	1.23	0.11	9%
LSI	1.7	0.7	40%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 72	**N**	**0**	**A**	**B**	**0** 100	**N** 100	**0** 55	**0** 12	**0**
B1	**1**	**1**	**F**	**S**	**1**	**B** 39	**R** 89	**1**	**S**	**1** 33	**1** 18	**1** 67
B2	**2**	**2**	**C**	**L**	**2**	**C** 61	**G**	**2**	**M**	**2** 6	**2** 64	**2** 33
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 6	**3** 6	**3**
E2			**P** 28	**I**		**E**	**E** 11		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	72	—	—	100	89	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	0.61	1.65	1.33

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	15.3	55.0	44.3

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 95.1				**Severity Index**: 0.0				**Feeding Index**: 45.0		
Sex (%)	**M**: 33	**F**: 67	**U**:	**Stage (%)**	**1**:	**2**:	**3**: 77	**4**: 17	**5**: 6	**U**:

GENERAL REMARKS

Parasites: Shagworms and whitespot

Sores: Few

Gonads: Mature, ripening fish

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Waiau River	Site: Lower river
Species: Common bully	
Autopsy date: 11/03/97	Sample size: 16
Capture method: GMT	Reason for autopsy: MFE70209
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	81.6	7.8	10%
Weight (g)	6.2	2.2	36%
Hematocrit (%)	28.8	8.9	31%
Leucocrit (%)	<0.1	—	—
Plasma protein (wt%)	9.2	1.2	13%
Condition factor	1.10	0.08	7%
LSI	1.8	0.7	40%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N**	**0**	**A** 12	**B**	**0** 100	**N** 100	**0** 12	**0** 12	**0**
B1	**1**	**1**	**F**	**S**	**1**	**B**	**R** 94	**1**	**S**	**1** 6	**1** 12	**1** 94
B2	**2**	**2**	**C**	**L**	**2**	**C** 88	**G**	**2**	**M**	**2** 45	**2** 76	**2** 6
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 12	**3**	**3**
E2			**P**	**I**		**E**	**E** 6		**U**	**4** 25		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	—	—	100	94	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	2.31	1.63	1.06

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	57.8	54.3	35.3

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 99.3				**Severity Index**: 0.0				**Feeding Index**: 45.7		
Sex (%)	**M**: 50	**F**: 50	**U**:	**Stage (%)**	**1**:	**2**:	**3**: 94	**4**:	**5**: 6	**U**:

GENERAL REMARKS

Parasites: Cysts but no shagworms

Sores: None

Gonads: Mature, ripening fish. Fish 4 with deformed gonads

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Waikato River	Site: Between Lakes Ohakuri and Aratiatia
Species: Common bully	
Autopsy date: 03/12/96	Sample size: 18
Capture method: GMT	Reason for autopsy: COE70203
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	86.5	10.0	11%
Weight (g)	9.5	3.9	41%
Hematocrit (%)	40.6	10.3	25%
Leucocrit (%)	0.3	0.3	118%
Plasma protein (wt%)	7.5	1.7	23%
Condition factor	1.40	0.15	11%
LSI	2.9	1.5	53%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 95	**0** 100	**N** 100	**N**	**0**	**A** 5	**B**	**0** 100	**N** 100	**0** 67	**0** 66	**0** 5
B1	**1** 5	**1**	**F**	**S**	**1**	**B** 5	**R** 100	**1**	**S**	**1** 11	**1** 17	**1** 39
B2	**2**	**2**	**C**	**L**	**2**	**C** 90	**G**	**2**	**M**	**2** 17	**2** 17	**2** 28
E1			**M**	**S&L**		**D**	**NO**		**G**	**3** 5	**3**	**3** 28
E2			**P**	**I**		**E**	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	95	100	100	—	—	100	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.06	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	0.61	0.50	1.78

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	3.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	15.3	16.7	59.3

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 99.4				**Severity Index**: 1.0					**Feeding Index**: 83.3	
Sex (%)	**M**: 39	**F**: 61	**U**:	**Stage (%)**	**1**:	**2**: 44	**3**: 39	**4**: 17	**5**: 5	**U**:

GENERAL REMARKS

Parasites: Shagworms present in most fish

Sores: Some parasitic cysts present on tails

Gonads: Bully 2 with grey gonads

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Whakapipi Stream	Site:
Species: Common bully	
Autopsy date: 17/04/97	Sample size: 10
Capture method: GMT	Reason for autopsy: MFE70209
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	95.2	8.9	9%
Weight (g)	11.5	4.3	37%
Hematocrit (%)	29.5	8.7	30%
Leucocrit (%)	<0.1	—	—
Plasma protein (wt%)	7.5	0.9	12%
Condition factor	1.27	0.14	11%
LSI	1.7	0.4	25%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 100	**0** 100	**0** 100	**N** 100	**N**	**0**	**A**	**B**	**0** 100	**N** 100	**0** 50	**0** 60	**0**
B1	**1**	**1**	**F**	**S**	**1**	**B**	**R** 100	**1**	**S**	**1** 30	**1** 10	**1** 30
B2	**2**	**2**	**C**	**L**	**2**	**C** 100	**G**	**2**	**M**	**2** 20	**2** 30	**2** 70
E1			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3**	**3**
E2			**P**	**I**		**E**	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

100	100	100	100	—	—	100	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	0.70	0.70	1.70

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	17.5	23.3	56.7

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 100.0				**Severity Index**: 0.0				**Feeding Index**: 76.7		
Sex (%)	**M**: 70	**F**: 30	**U**:	**Stage (%)**	**1**: 10	**2**: 20	**3**: 60	**4**: 10	**5**:	**U**:

GENERAL REMARKS

Parasites: No shagworms

Sores:

Gonads: Still mature fish, lots of males

Other:

SUMMARY OF FISH HEALTH PROFILE

Location: Lake Whakamaru	Site:
Species: Common bully	
Autopsy date: 07/04/95	Sample size: 20
Capture method: Fyke net	Reason for autopsy: PPL301
Remarks:	

HEALTH FACTOR	MEAN VALUE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Length (mm)	77.9	9.0	12%
Weight (g)	6.1	2.6	43%
Hematocrit (%)	39.4	11.8	30%
Leucocrit (%)	0.3	0.2	88%
Plasma protein (wt%)	7.4	1.5	21%
Condition factor	1.23	0.16	13%
LSI	2.4	1.2	52%

VALUES AS PERCENTAGE OF TOTAL SAMPLE

EYE	FIN	OPL	GILL	PBR	THY	LIV	SPL	HGUT	KID	FAT	BILE	PARA
N 95	**0** 100	**0** 100	**N** 85	**N**	**0**	**A** 10	**B**	**0** 100	**N** 100	**0** 20	**0** 30	**0** 15
B1	**1**	**1**	**F**	**S**	**1**	**B** 5	**R** 100	**1**	**S**	**1** 45	**1** 55	**1** 30
B2	**2**	**2**	**C**	**L**	**2**	**C** 85	**G**	**2**	**M**	**2** 35	**2** 15	**2** 55
E1 5			**M**	**S&L**		**D**	**NO**		**G**	**3**	**3**	**3**
E2			**P** 15	**I**		**E**	**E**		**U**	**4**		
H1			**OT**	**OT**		**F**	**OT**		**OT**			
H2						**OT**						
M1												
M2												
OT												

SUMMARY OF NORMALS (%)

95	100	100	85	—	—	100	100	100	100	xxxx	xxxx	xxxx

SUMMARY OF MEANS

xxxx	0.00	0.00	xxxx	xxxx	—	xxxx	xxxx	0.00	xxxx	1.15	0.85	2.35

SUMMARY OF SPECIFIC PERCENTAGE INDICES

xxxx	0.0	0.0	xxxx	xxxx	—	xxxx	xxxx	0.0	xxxx	28.7	28.3	78.3

SUMMARY OF COMBINED PERCENTAGE INDICES

Normality Index: 97.5				**Severity Index**: 0.0					**Feeding Index**: 71.7	
Sex (%)	**M**: 35	**F**: 65	**U**:	**Stage (%)**	**1**:	**2**:	**3**:	**4**:	**5**:	**U**: 100

GENERAL REMARKS

Parasites: Many fish with heavy shagworm infestation

Sores: None

Gonads: Gonad stage not assessed

Other:

Colour plates

Available as hard copy only.