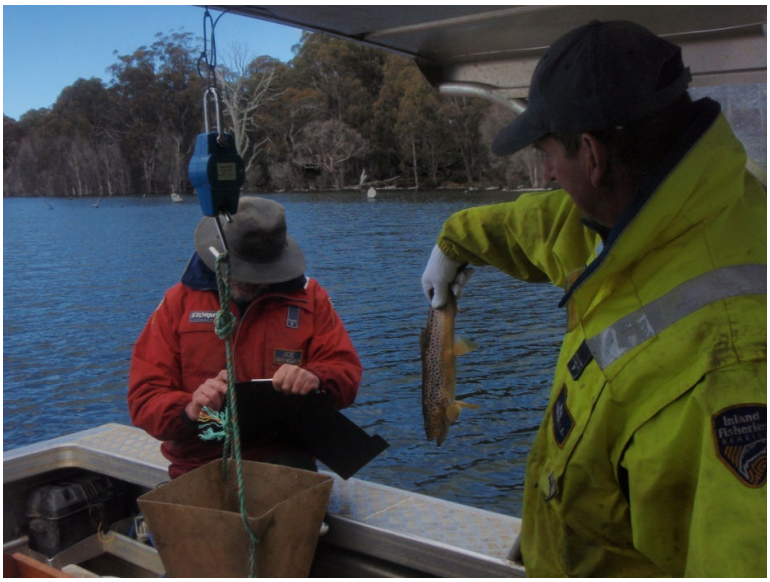
Technical Report

Arthurs Lake Baseline Assessment Survey 2013



Prepared by T Farrell

Inland Fisheries Service

V. 23 December 2013

Introduction

Since the inception of the Angler Postal Survey (APS) by the Inland Fisheries in 1985 Arthurs Lake has ranked in the top three most visited trout fisheries in Tasmania. For the majority of these years it has been the most visited trout fishery.

Since the mid 1960's Arthurs Lake has had a large self sustaining population of brown trout (*Salmo trutta*). There has been no active management of stocks other than through fishing regulations. The bag limit of 12 fish per day and a minimum size takeable size of 220 mm have been in place for many decades and no stocking has taken place since before 1950.

In the absence of in-lake surveys the monitoring of the performance of Arthurs Lake as a fishery and the status of the trout population has been through the APS and the annual sampling of the spawning run at Hydro creek respectively.

Monitoring of the spawning run at Hydro Creek on the western side of the lake has been conducted by Inland Fisheries since 1977 (see figure 1.).

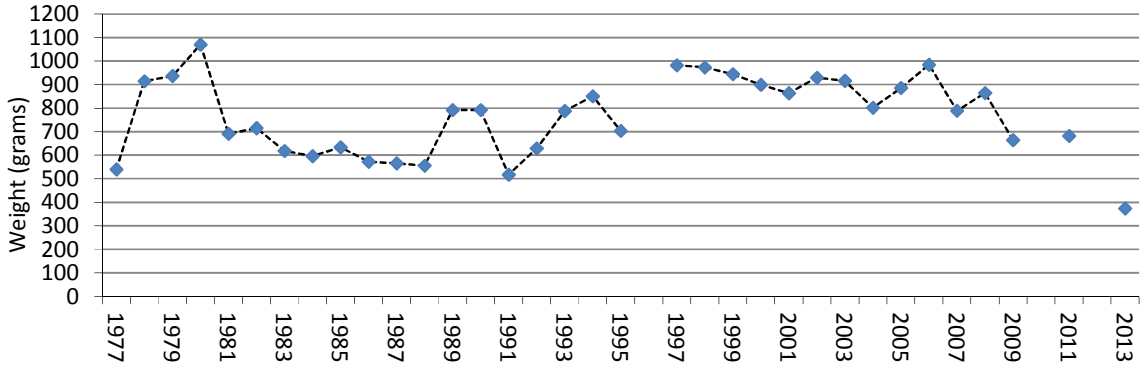


Figure 1. *The average weight (grams) of spawning trout at Hydro Creek, Arthurs Lake 1977 – 2013.*

The range of sizes during the period of monitoring has fluctuated greatly, from a high in 1980 of 1070 grams to a low in 2013 of 374 grams.

The APS results for Arthurs Lake show a fluctuation in catch rates over the years the survey has been conducted as seen in figure 2.

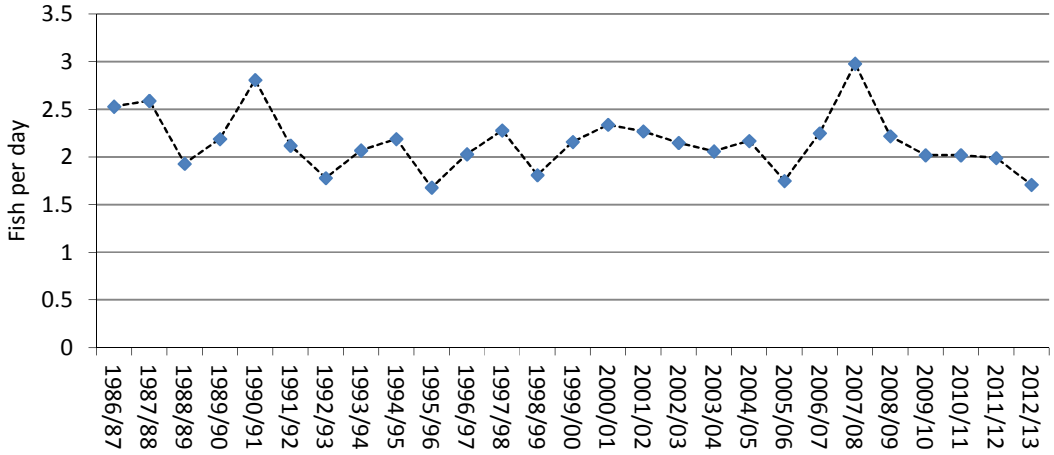


Figure 2. *Catch rate (fish per day) for Arthurs Lake as calculated from APS from 1986/1987 season to 2012/2013 season.*

The APS results for the 2012/2013 angling season show the catch rate has declined to 1.71 fish per day, the second lowest recorded for the 27 years duration of the APS. This downward trend in catch rate occurred after the peak reached during the 2007/2008 season at 2.98 fish per day.

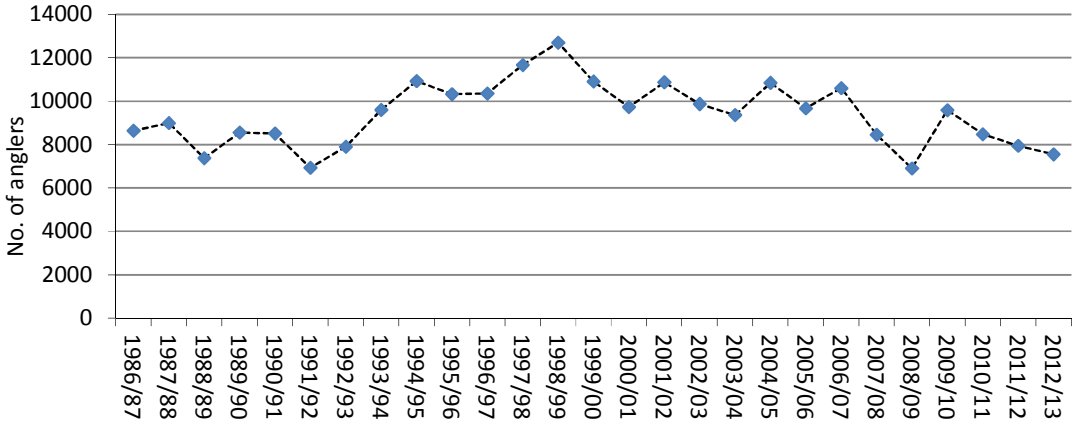


Figure 3. *Total number of anglers fishing Arthurs Lake as calculated from APS from 1986/1987 season to 2012/2013 season.*

Participation in the Arthurs Lake fishery as calculated from the APS shows that the number of anglers fishing there has varied from a peak of 12,695 during the 1998/1999 season to a low of 6,901 during the 2008/2009 season. A significant rise in participation at the fishery occurred during the 2009/2010 season at 9,586 anglers but this has declined progressively to 7,551 for the 2012/2013 season.

Purpose of the 2013 netting and electrofishing survey

The IFS is embarking on a project to manage, by construction of upstream migration barriers, most of the major spawning creeks. Construction of side channels and trapping facilities on the will occur at three of these creeks. This work is scheduled to commence in autumn 2014.

The aim of this project is to control access of brown trout to spawning habitat. The construction of traps on some of these creeks will also allow the removal of spawners as an additional population control measure.

The potential outcomes are twofold, firstly to manipulate the size of the Arthurs Lake brown trout population in order to improve the average size of fish taken by anglers and secondly to trap and transfer adult brown trout to fisheries that are unsustained by natural recruitment.

The purpose of the 2013 netting and electrofishing survey has been to assess the current population structure and catch rate of the fishery prior to any manipulation of the lake's population of brown trout. This survey will provide a baseline to reference for further assessment post construction of spawning creek barriers and trapping facilities.

Survey methods

Arthurs Lake is a large body of water that contains a variety of habitat. The population of brown trout at Arthurs Lake is believed to be very large and trout of all sizes occupy the range of available habitat. It was therefore important to sample all habitat types to gauge the structure of the brown trout population of the lake.

The initial part of the survey involved four days of netting from 23 September to 26 September using two teams of four staff and two IFS vessels (5.5 m aluminium catamarans), 59 fyke nets, 47 box traps and two 250 metre gill nets (75 mm mesh). All of the fyke nets and box traps were deployed on 23 September with one team setting half of the gear on the Western side of Arthurs, known as the Blue Lake; the other team deployed the remaining gear on the eastern side of the lake encompassing the Sand Lake and the Morass.

Each morning of 24 and 25 of September was spent checking each net, measuring and weighing the catch. Some nets deemed catching poorly or in some case damaged were pulled from the initial location and reset, or removed if damaged. Each afternoon of 23 to 25 September was spent setting and retrieving gill net sets in various localities on both sides of the lake. Soak time was generally one hour but in a couple of cases only half that time.

On 26 September due to changing weather pattern the decision was made to pull all gear from the lake. The last catches were weighed and measured as the gear was pulled.

The weather throughout the first three days of the netting survey was cool (7-10^0 C air temperature) with moderate to strong winds mostly from the west to northwest averaging 20 knots. A south westerly change was due midday on 26 September. Snowfalls occurred in the morning of 26 September but all nets were pulled before the change had fully occurred. The water temperature was 6-7^0 C and water clarity was good to moderate depending on the location. A high lake water level (200 mm below full supply) was the dominating environmental factor of the survey. High water levels made for difficulties finding good soft ground in which to stake nets.

Two attempts were made at electrofishing component of the survey due to operational difficulties with the IFS electrofishing boat. The first sample date on 7 October 2013 involved half an hour of electrofishing at Jonah Bay before a mechanical failure forced abandonment of the survey. On 22 October 2013 the electrofishing boat was used to survey Seven Pound Bay, the Morass and Hydro Bay for a total of three hours shock time. On both sampling periods the weather was fine and conditions for electrofishing were optimal.

Analysis of the data from fish captured forms the basis of this report. Measurements of weight and length for the fish captured give parameters of the fish size in the population such as range and means. Length frequency distribution gives a guide to cohorts (age classes) but it is not a validated method of determining exact size of a fish at any given age.

For precise determination of the size parameters of fish within a cohort such as age at length keys there would need to be collection of hard parts (e.g. otoliths or scales) of a reasonable sample size of the fish captured. The collection of otoliths of 100 or more fish caught would be required to develop a validated age structure of the population. Due to time constraints and to allow easier repetition of the survey in future years the decision was made not to collect otoliths for ageing. Cohort analysis within the results of this report is a guide only rather than a specific determination of the age classes of the fish within the Arthurs Lake brown trout population.

Results and interpretation

For the week of the netting survey a total of 525 brown trout were captured. Of these 246 were caught in fyke nets (FN), 179 in box traps (BT) and 100 in gill nets (GN3). The 59 fyke nets were set for a total of 4038.13 hours the 47 BTs were set for a total of 3261.37 hours and eight GN3 net shots occurred for a total of 7.28 hours soak time.

During the two electrofishing surveys 47 brown trout were captured, 10 on the first occasion and 37 on the second. The 47 fish were captured in a total of 3.5 hours of boat operation, 10 in 0.5 hours and 37 in 3.0 hours.

Table 1 below shows the breakdown of fish caught, number of nets used and the total hours set for each net type. For electrofishing the total hours under operation and number runs are shown. The total catch rate is shown as fish per hour and is an accumulation of catch rates for each individual net or electrofishing run. The average catch rate is a division of the total catch rate by the number of nets/runs used.

The calculated catch rates, total and average; will be used for comparisons with future surveys. It is important to note that any comparison of catch rate needs to be with the same gear types. It is also important to note that the catch efficiency of some gear types will be affected by size selectivity. The selectivity of the gear type towards certain sized fish can be shown by a plot of the length frequency distribution of the catch.

Gear type	Number of fish caught	Number of hours set	Number of nets/set/runs	Total catch rate (fish per hour)	Average catch rate per net/run
Fyke net	246	4038.13	59	10.68	0.181
Box trap	179	3261.37	47	9.28	0.198
250 m gill net (75 mm)	100	7.28	8	123.48	15.430
Electrofishing boat	47	3.50	2	32.3	16.150

Table 1: *The catch per unit effort (CPUE) for each gear type.*

For each method or gear type all fish captured had the length (mm) and weight (grams) recorded. Condition factor (K) was calculated using the formula $\mathbf{K = (10^5 \times weight)/length^3}$, where weight is in grams and length is in millimetres, for each fish captured. The results are shown in Tables 2 -4 with each table showing the difference in physical parameters of fish for each gear type used in the survey.

The lengths of fish caught shown in Table 2 shows the greatest range in those caught in the box traps (BT). The smallest range of lengths is shown for the fish caught using the 250 m gill nets with 75 mm mesh size (GN3). These results show that size selectivity in BTs is minimal whilst size selectivity in GN3 sets is high and indicative of exclusion at both the lower and upper size ranges i.e. <295 mm and >444 mm.

A plot of length frequency distribution is shown in Figure 2 for all fish caught. Very few fish in the 1^+ age class (fish resulting from the 2012 spawning period) were caught. This age class could be expected to be between 120 and 180 mm in length at the time the survey was conducted. These fish are underrepresented in the catches of the survey due to in part to gear selectivity and possibly due to habitat partitioning. The first year of life habitat for trout differs from that inhabited by older fish. The one year old fish show a stronger preference for cover such as rocks and thick aquatic vegetation. This preference for cover means they are unlikely to be caught by the netting methods that rely on fish movement for capture. Their small size also makes them difficult to detect

electrofishing which relies on visual detection by the fishers, particularly when using boat mounted electrofishing.

The length frequency distribution indicates that there are possibly four dominant cohorts (age classes) in the range of lengths from 230 mm to 430 mm. The fish captured that in the length range 430 to 550 mm probably represent three or more cohorts but this is difficult to determine with the low numbers captured.

Fishing method	Number caught	Mean length (mm)	Minimum length (mm)	Maximum length (mm)
All methods	572	336	178	550
Box traps	179	341	178	550
Fyke nets	246	325	225	520
250 m gill nets (75 mm)	100	362	295	444
Electrofishing boat	47	321	210	450

Table 2: *The descriptive statistics of length (mm) for all trout captured in each gear type.*

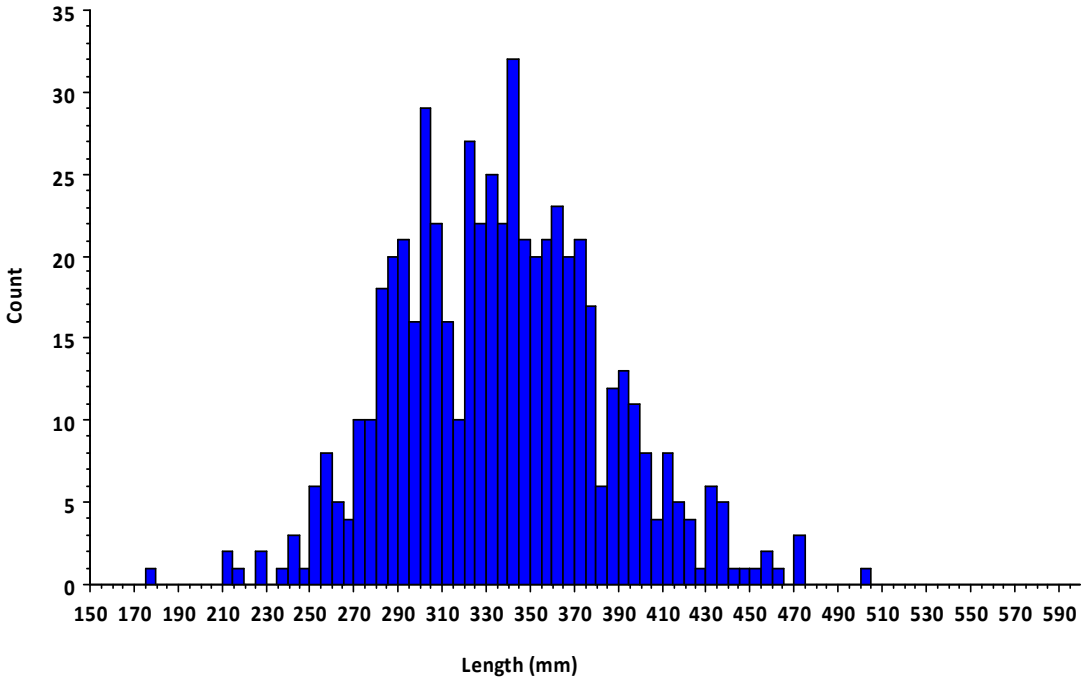


Figure 2. *Length frequency distribution of trout captured in all gear types for the 2013 survey.*

Examination of the weights in the catches shows a similar distribution for each gear type to that shown with the lengths. With the fish caught in BTs showing the greatest range of weights and those caught in GN3 sets showing the smallest range. Average weight of all fish caught overall was closest to the average shown for captures in BTs. These results are shown in Table 3. The similarity in distribution of weights and lengths of captured fish for each gear type is to be expected given the linear relationship between length and weight as shown in Figure 3.

The average weight of fish caught in all gear types for the survey is 411 grams. This is a greater average weight than the fish sampled in the spawning run at Hydro Creek for 2013 which was 374 grams but a much larger sample size at 572 fish compared to 156. The average weight in the survey

would be a better indicator of change in average size of the fish in the Arthurs Lake fishery than that of the spawning run.

In Figures 4 and 5 the spread of lengths and weights respectively for the entire survey are shown with the means for each and the bounds of the fish within the 25 and 75 percentile. For length 50% of fish are within a range of 275 mm to 400 mm. For weight 50% of fish are within the range 250 to 600 grams. This will be an important bench mark against which future surveys can be assessed for change.

Fishing method	Number caught	Mean weight (grams)	Minimum weight (grams)	Maximum weight (grams)
All methods	572	411	80	1570
Box traps	179	414	80	1570
Fyke nets	246	381	120	1510
Gill nets (3")	100	488	300	1010
Electrofishing boat	47	399	130	1280

Table 3: *The descriptive statistics of weight (grams) for all trout captured in each gear type*

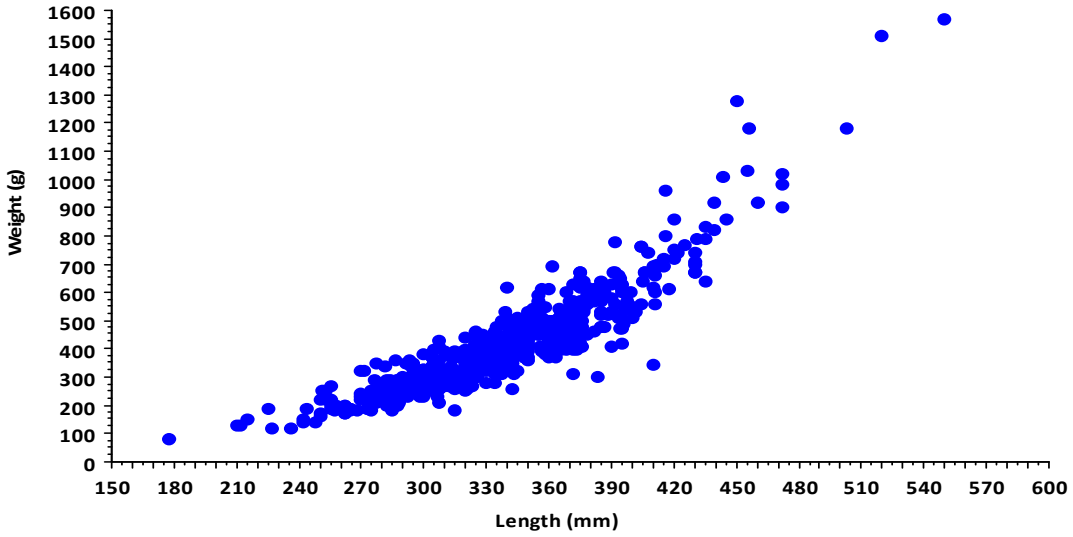
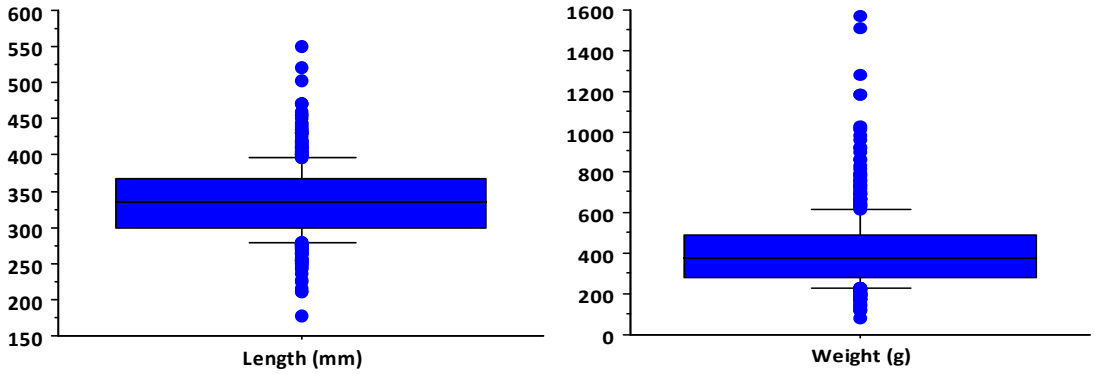


Figure 3. *Length (mm) vs. weight (grams) regression for trout captured in all gear types during 2013 survey*



Figures 4 and 5. *Box plots showing distribution of length (mm) and weight (g) with means for all gear types.*

The condition of the fish captured during the survey expressed as the index K or condition factor is calculated from the weight and length of the fish using the formula **$K = (10^5 \times \text{weight})/\text{length}^3$**, where weight is in grams and length is in millimetres. For trout, if K is less than 0.9 then it is categorised as very poor, if K is greater than 0.9 and less than 1.1 it is considered "poor", if K is greater than 1.1 and less than 1.3 it is considered "fair", if K is greater than 1.3 and less than 1.5 it is considered "good" and if K is greater than 1.5 it is considered "excellent".

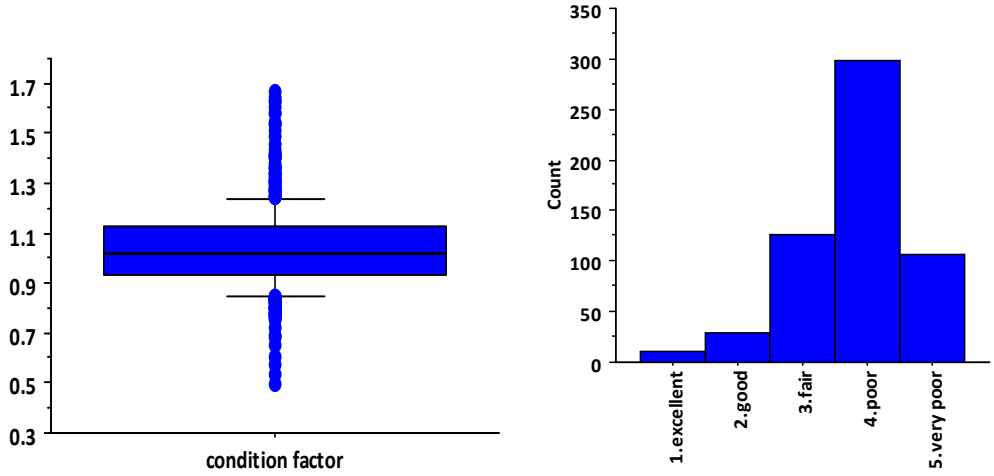
Overall the average K value of fish captured during the survey was 1.04 which puts it in the poor category for condition factor. The average K value for fish captured in all the netting methods was less than 1.1 which means the average category of condition factor for netting was poor. Fish captured during electrofishing averaged a K value of 1.15 which places the average in the fair category.

Figure 6 shows the spread of K in all catches with the mean and 25 to 75 percentiles lying between 0.85 and 1.25. The majority of the fish caught in the survey were in poor to fair condition. The category distribution histogram in Figure 7 gives a better visual representation of this.

Figure 8 shows the spread of K for all the lengths of fish captured. As is expected with young fish, particularly those in the 1^+ age class, the condition factor (K) is higher on average than that of older cohorts. A general trend of decline in K can be seen as fish length, hence age, increases. The fish captured during the survey show the strongest decline in K value in lengths of fish that are possibly the three to five year old age classes.

Fishing method	Number caught	Mean condition factor (K)	Minimum condition factor (K)	Maximum condition factor (K)
All methods	572	1.04	0.50	1.67
Box traps	179	0.99	0.58	1.51
Fyke nets	246	1.06	0.60	1.67
Gill nets (3")	100	1.02	0.50	1.36
Electrofishing boat	47	1.15	0.53	1.58

Table 4: *The descriptive statistics of condition factor (K) for all trout captured in each gear type*



Figures 6-7: *Box plot for condition factor (K) and distribution of condition factor (K) categories where very poor=<0.9, poor=>0.9 -<1.1, fair=>1.1-<1.3, good=>1.3-<1.5 and excellent=>1.5.*

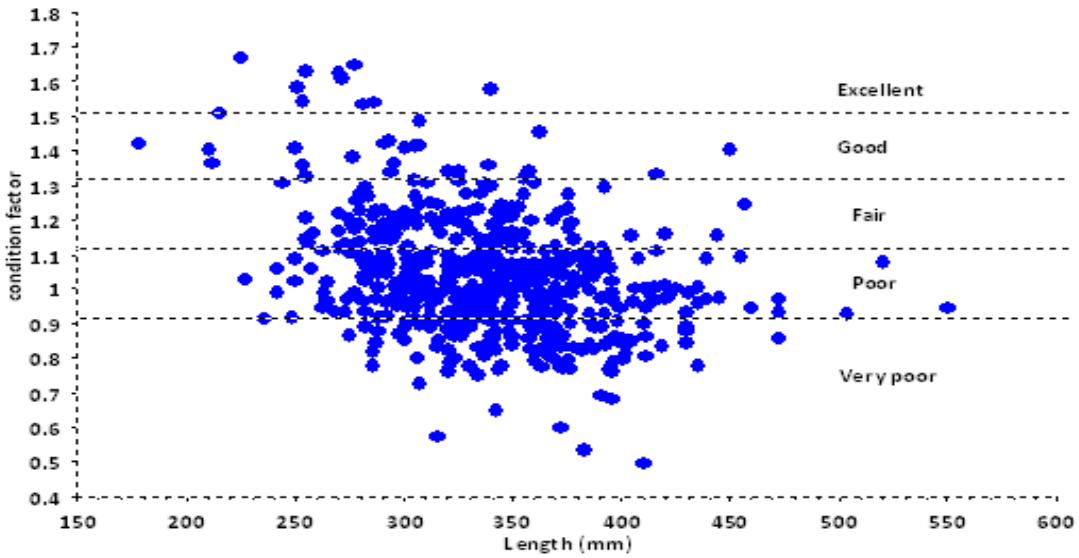


Figure 8: *A scatter plot of length vs. condition factor (K) for all fish caught during the survey and their position relative to condition factor categories.*

Examination of the selectivity of gear type used during the survey, as discussed previously in relation to the length of captured fish, was an important component to this baseline survey. Figures 9 to 12 below show the frequency distribution of lengths for each of the gear types used.

The most selective gear type is clearly the 250 m (75 mm) gill net. This is to be expected as it is the only gear type that allow for escape due to mesh size. Smaller fish (<295 mm) would be able to "swim through" without getting caught due to the mesh being larger than the girth of their head, larger fish evade capture as their head exceeds the mesh diameter thus preventing the mesh catching on their operculum (gill covers) as they attempt to swim through the net.

Electrofishing did show a smaller range of lengths for fish captured, however the overall number captured does not give confidence to conclusions about any selectivity of this method. As mentioned previously in this report there is a reliance on visual detection with this gear type which can alter efficiency depending on water clarity and ambient light conditions whilst under operation. The least

selective gear type in this survey was the box traps (BT). Fyke nets (FN) were also relatively unselective but did not capture as great a range of fish lengths. The explanation of the efficacy in capture of fish of smaller length for BTs over FNs may be the multi aperture design of the BTs compared to the single aperture of the FNs. If fish in the 1^{+} age class tend to move only small distances then they have more chance of finding an entrance to BT than with an FN.

The number of small fish captured was however not significantly greater for BT over FN and both methods proved efficient at capture of a representative range of the population. These two methods alone are useful for rapid assessment of changes to the population post management strategies. The limitations of these gear types for standalone assessment tools would be the restriction to shore line or shallow water sets. Gill nets and electrofishing, whilst being size selective, do allow assessment of off shore or deeper water habitats.

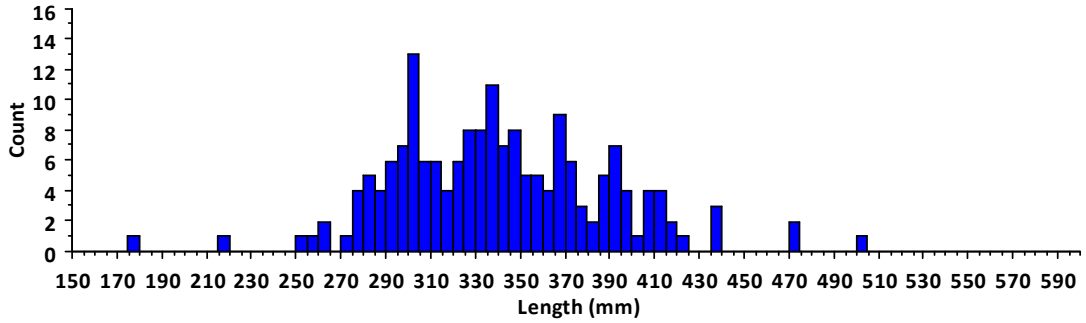


Figure 9. *Length frequency distribution of trout captured in box traps for the 2013 survey.*

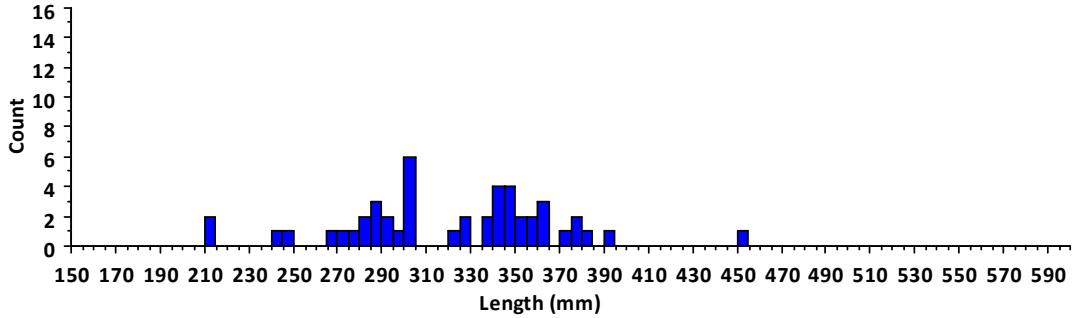


Figure 10. *Length frequency distribution of trout captured by electrofishing boat for the 2013 survey.*

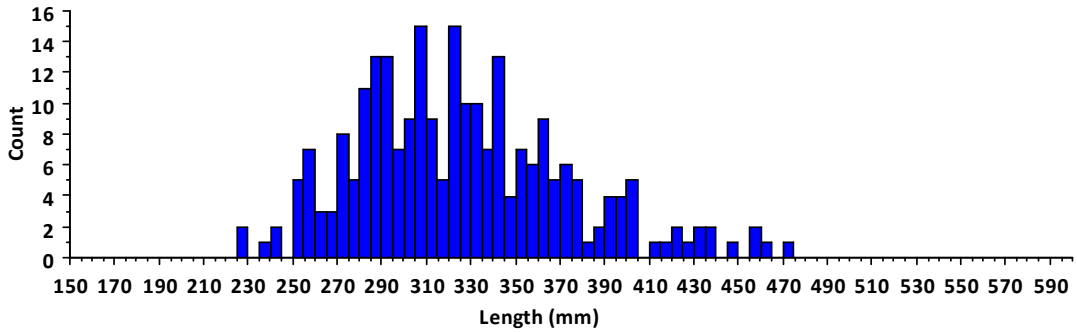


Figure 11. *Length frequency distribution of trout captured by fyke net for the 2013 survey.*

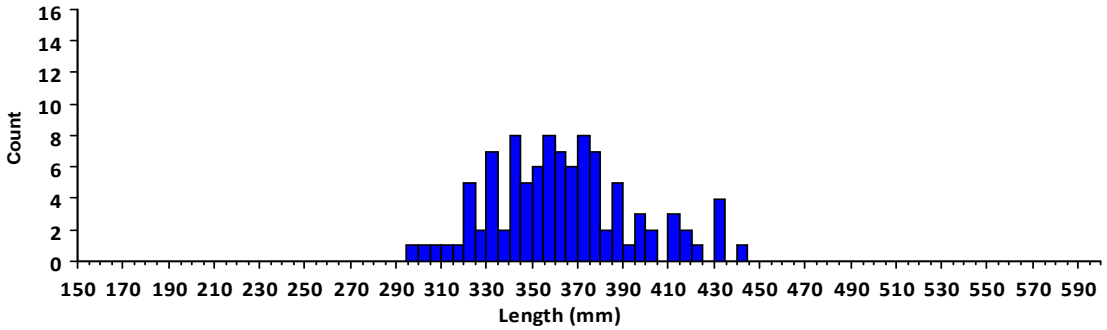


Figure 12. *Length frequency distribution of trout captured by 250 m gill net (75 mm) for the 2013 survey.*

Conclusions and recommendations

The average size of this fish at Arthurs Lake has been as shown a trend of decline over the last seven years from spawning run monitoring at Hydro Creek. The results of this survey indicate that there has been good recruitment to the fishery over the last five years from the relative strength of cohorts that appear to be of five year of age and less. Indications from examination of condition factor are that there is a high level of competition within these younger cohorts for food and habitat showing as relatively poor condition in these age classes.

To 2013 there have been five years of consistently good flow conducive to successful recruitment in the creeks that feed Arthurs Lake.The result of these conditions has produced five years of strong recruitment which in turn has lead to a suppression of the average size and condition of the fish that make up the majority of the lake's brown trout population. If there were no actions to manage or control recruitment to the fishery then the population will remain high and he average size of fish will continue to be low.

The electrofishing boat was used in this survey to target 1^{+} age class fish. These proved relatively scarce during the survey using all gear types and electrofishing proved no more fruitful in their capture. The addition of back pack mounted electrofishing may be a better gear type to find the one year old fish. The opportunity to include this method during the2013 survey was limited in part due to time constraints but also due to the very high water level of the lake.

The survey should be repeated on an annual basis to track changes in the brown trout population post introduction of the proposed new spawning barriers and trapping facilities. For relative comparisons to be drawn from future surveys the methodology should remain consistent. The addition of extra gear types such as other gill net mesh sizes and back pack electrofishing should be done as an adjunct and analysed separately to a survey using the methodologies of the 2013 survey so as true comparisons can be made. Change in population structure and average fish size would be best served by a complete replication of the 2013 survey.