Inland Fisheries Service Report

Recreational Fisheries Report

Fisheries Performance Assessment

Technical Report

Arthurs Lake – August 2016

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1 Introduction

Damming the Upper Lake River and flooding the area that originally contained two lakes, Blue Lake and Sand Lake, and the Morass marsh made the present day Arthurs Lake. Arthurs Lake operates as a Hydro Tasmania storage with water from the lake pumped to Great Lake from where it is used to generate hydroelectricity via the Poatina power station. Arthurs Lake is also used as irrigation storage to supply water for the Midlands Irrigation scheme. The scheme has the capacity to supply 38,500ML of water delivered over two periods: 15,812ML during a 150-day summer delivery period (October – February) and 22,688ML during a 215-day winter delivery period (March – September). The irrigation scheme is presently fully allocated. Arthurs Lake is also Tasmania's most popular trout fishery, receiving more angling effort than any other water in the State. Brown trout are the only species of trout recorded at Arthurs Lake, as has been the case since the 1960's although rainbow trout were present in the early days. Arthurs is generally known for its good catch rate of wild brown trout.

The Arthurs Lake trout fishery has until recent years been the mainstay of the lake based fishery. Significant droughts during 1998-2001 and 2005-2009 have impacted on the lake's ecosystem and the fishery, resulting in a substantial change to angler's catch rates and overall harvest of fish. To gain information on the trout population a major survey was proposed, however it was decided to undertake a pilot study in preparation for a future larger scale tagging study. Despite being on a smaller scale, this survey produced some interesting information about the Arthurs Lake trout fishery.

2 FPA Survey Methodology

2.1 In-lake Surveys

In readiness for a small scale capture-mark-recapture population estimate, 1,351 brown trout were double tagged with T-bar tags on each side of the dorsal fin. All fish were captured from the spawning run traps at Tumbledown Creek and Scotch Bobs Creek, no fish were processed from Hydro Creek. The total number of fish tagged and processed (weighed and measured) was below the target level of 2,000 fish. This was due to a large flood event that comprised all three spawning traps, with the Hydro Creek trap destroyed. Of the1,351 fish tagged, 890 were females of which 416 were stripped of eggs; and 461 males of which 220 were stripped of milt (total stripped fish processed 47%). All fish were measured for length to the nearest mm and weighed to the nearest 10 g. The mean weight for fish tagged from the spawning traps was 538 g (median weight 520 g), with a range of 130 – 1,700 g.

After processing, all fish were released downstream of the trap, with very few fish returning to the trap after initial release.

During the period 26-29 September 2016, the Service undertook a trapping survey within Arthurs Lake. The goals and aims of the survey were to:

Goals:

1) To examine the strength and weaknesses of undertaking a larger scale tagging study that would provide a meaningful population estimate for brown trout within Arthurs Lake.
2) To examine the present status of length characteristic of the brown trout population.
3) To establish a meaningful measure of catch per unit effort (CPUE) for Arthurs Lake.

Aims:

- To examine total number of tag returns from a small scale release of 2,000 tagged fish and the quantum of the population estimate and associated confidence limits.
- To examine the mixing of fish within the lake during the recapture of tagged fish.
- To estimate percentage of tag loss.
- To establish the present population structure through length class strength.
- To further examine the efficiency of box traps in establishing a measure of CPUE for Arthurs Lake.

At a number of sites throughout the lake (see appendix A) 80 box traps (see figure 1) were set each day and left to soak overnight for three consecutive nights, totaling 240 box trap sets. Most traps were set around the margins of the lake in a range of habitats, with approximately 30 set in deep water at 3.5-4.5 m on the outer extent of macrophyte beds. Traps were checked and cleared of fish each day with all fish weighed (nearest 10 g), measured (nearest mm) and checked for tags. All fish were assigned as either male or female or unknown for juvenile or undetermined sex.

Figure 1: Typical box trap set showing three co-joined traps.

2.2 Annual Postal Survey

Since 1986, the Service has conducted a postal survey seeking information about anglers' catches. The survey comprises of a form sent to ten percent of all categories of anglers, asking set questions about their angling (catch of trout) for the past season. This information is entered into a database and information on catch per day, harvest and angling effort is extrapolated. This provides a long term overview of individual fishery performance in addition to characterising effort.

3 Survey Results

3.1 In-Lake Survey 2016

During the period 26-29 September 2016, the Service undertook a trapping survey within Arthurs Lake. Each day 80 box traps were set covering a number of sites around the lake (see appendix A). Over the three days, 240 box traps were set resulting in the capture of 277 brown trout.

Brown trout length weight data

Of the 277 brown trout captured, 79 were males, 99 females and 99 were either juveniles or fish where the sex could not easily be determined. In general, the average length and weight for males were greater than females with a number of males growing beyond 1.2 kg (see figure 2 & table 1). Most females averaged around 550 to 750 g, with very few greater than 1 kg. There was a wide spread of immature or juvenile sized fish with most less than 500 g or 350 mm. The average condition factor (k-factor) for all fish was 1.07 k that was slightly low, but consistent with male and female fish in post spawning condition. There were no signs of larger fish being significantly below the average condition factor or having significantly lower weights (see figure 3 & 5). Approximately 73 percent of fish were in fair to excellent condition, with 27 percent categorised as poor. These results are consistent with most lake fisheries where natural recruitment sustains the trout population. Figure 6 below confirms this result with a comparison of length/weight data collected from Little Pine Lagoon during 2000 and 2003 (by electrofishing) and the Arthurs Lake 2016 survey. This comparison displays how similar these fisheries function in relation to growth and fish condition.

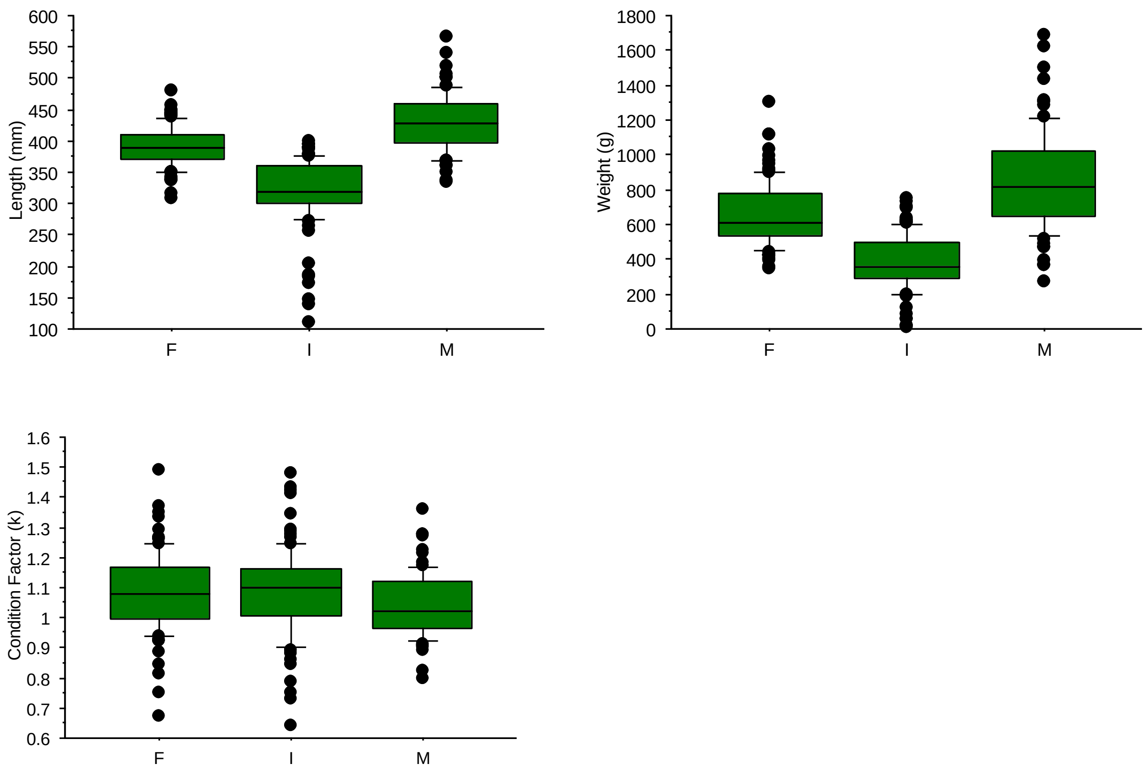


Figure 2: Box plots for brown trout - length, weight & condition factor separated by sex (F=female, M=male & I= immature or undetermined sex).

Grouping	Measurement	Mean	Minimum	Maximum
All brown trout (n=277)	Length (mm)	376	110	567
	Weight (g)	616	10	1,690
	Condition Factor (k)	1.07	0.54	1.49
Female (n=99)	Length (mm)	391	308	480
	Weight (g)	658	350	1,300
	Condition Factor (k)	1.08	0.67	1.49
Male (n=79)	Length (mm)	430	335	567
	Weight (g)	853	270	1,690
	Condition Factor (k)	1.04	0.54	1.36
Unknown sex (n=99)	Length (mm)	319	110	399
	Weight (g)	385	10	750
	Condition Factor (k)	1.09	0.64	1.48

Table 1: Descriptive statistics for brown trout - length, weight & condition factor separated by sex, (Total=all brown trout, F=female, M=male & U= undetermined).

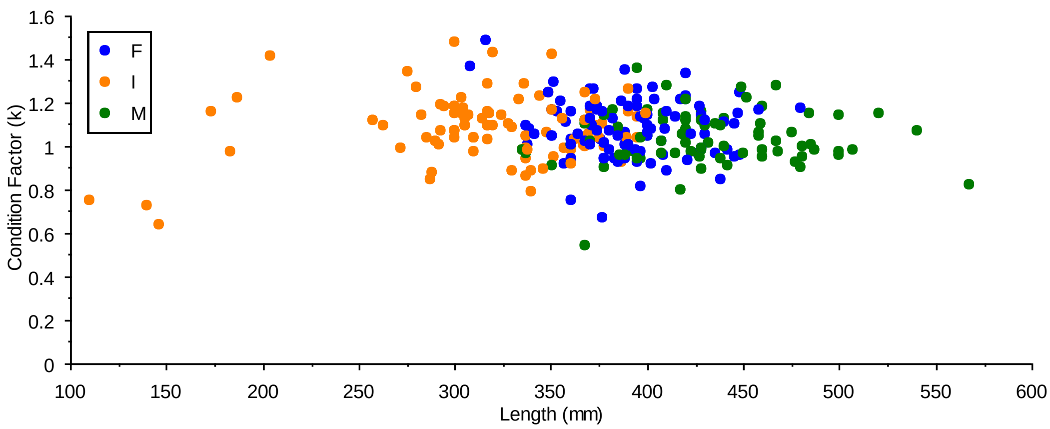


Figure 3: Condition factor by length for all brown trout, seperated by sex (F=female, M=male & I= immature or undetermined sex).

Figure 4: Condition factor category for all brown trout.

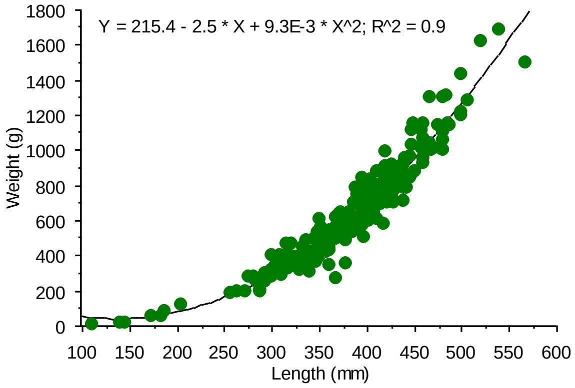


Figure 5: Arthurs Lake length/weight relationship for brown trout.

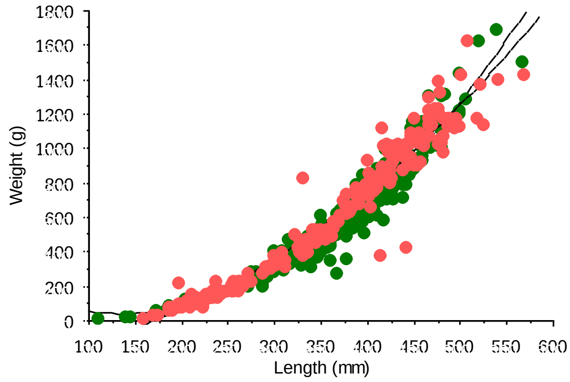


Figure 6: Length/weight relationship comaring Little Pine Lagoon data 2000 & 2003 (red points) with Arthurs Lake survey data 2016 (green points).

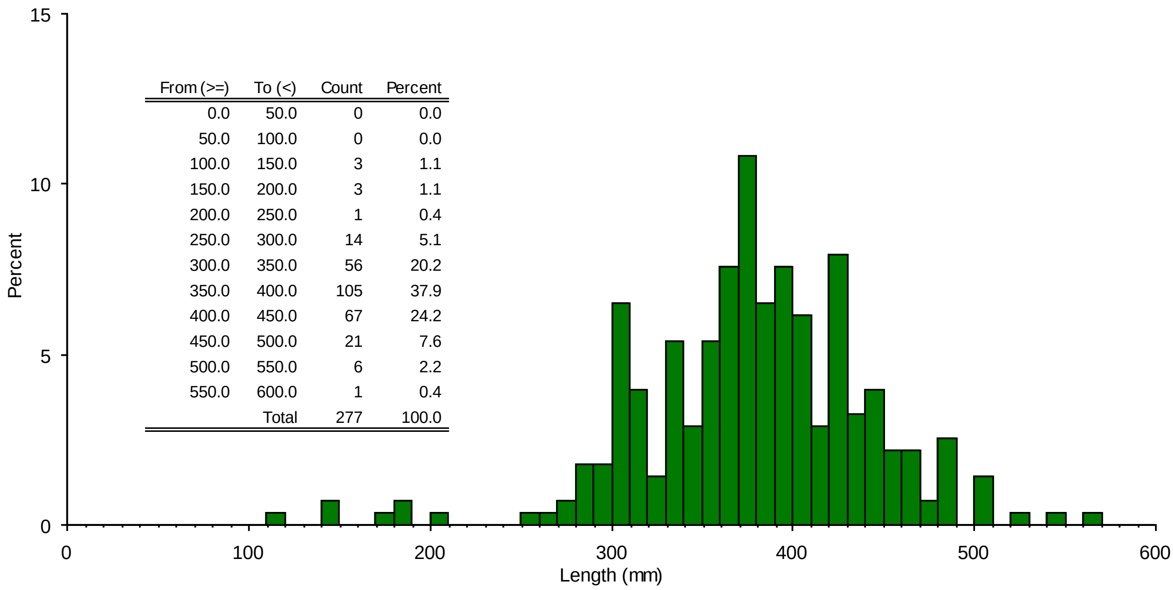


Figure 7: Length frequency for brown trout– Arthurs Lake 2016.

Analysis of the length data for all brown trout measured (n = 277) (see figure 7) shows possibly 5 groupings of fish lengths. The first of these consists of just three fish in the 100 – 160 mm range, representing 1+ yo. The second cohort consisting of 5 fish in the 180 – 260 mm range are 2+ yo fish. The third cohort that contains approximately 61 fish in the 270 - 350 mm range is likely to be 3+ yo, with fish in the 360 - 410 mm length range (approximately 122 fish) likely to consist of 4+ yo. There is another peak at 420 - 430 mm signifying a fifth cohort that most likely encompasses 5+ and 6 + fish.

The growth of these fish however, appears slightly depressed and validation of age at length for the population is required to examine this issue.

3.2 CPUE Information

Generally, the capture of brown trout in box traps was low, with 277 brown trout capture from 80 box traps set over three nights (total 240 sets), with the nets cleared each day. This equates to a mean CPUE of 1.15 brown trout per net. A similar survey conducted in 2013 using a range of gear types that included box traps resulted in a CPUE figure of 3.8 fish per box trap. Based on this comparison it appears the CPUE for 2016 was 70% lower than for the 2013 survey. There are a number of factors that may have influenced this discrepancy and they are highlighted in the discussion section. However, this difference is likely to indicate a real, gross decline in CPUE.

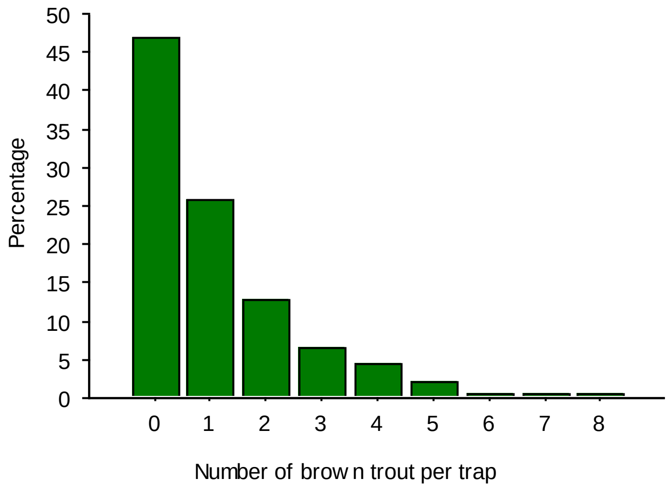


Figure 8: Capture frequencey expressed as a percentage of box traps that caught fish.

Figure 8 shows the percentage of box traps that caught a specified number of brown trout. Forty seven percent of the traps captured no trout, with 26% capturing one, while 13% captured 2 fish. Eleven percent of box traps captured 3-4 fish, with the most captured in a single trap being 8 fish. Box traps captured a wide range of length classes between 110 – 567 mm. The lack juvenile fish captured is most likely attributed to both habitat preference of small fish (heavy cover and rocky habitat) and a sampling bias with box traps not being entirely efficient at catching fish less than 200 mm. There were however, a number of nets set on rocky habitat without success.

3.3 Population Estimate & Tag Returns

During June to July 2016 1,351 brown trout were double tagged with T-bar tags on each side of the dorsal fin. All fish were captured from the spawning run traps at Tumbledown Creek and Scotch Bobs Creek, no fish were processed from Hydro Creek. The total number of fish tagged and processed (weighed and measured) was below the target level of 2,000 fish. This was due to a large flood event that comprised all three spawning traps, with the Hydro Creek trap destroyed. Of the 1,351 fish tagged, 890 were females of which 416 were stripped of eggs; and 461 males of which 220 were stripped of milt (total stripped fish processed 47%).

During the recapture phase 277 brown trout were captured in box traps over a four day period (three nights). Of these fish, just three were tagged (1.1%), all three fish were double tagged. Table 2 shows the parameters for the estimation. The associated estimate of bias was well below 4 (0.75) and implies the estimate is strongly biased. Additionally, the upper and lower limits are grossly inaccurate with the lower limit indicating a negative figure. The implications of this are discussed further in section 5.

Parameter	Result
Total fin clipped released (M)	1,349
Total recaptures (C)	277
Total marked recaptures (R)	3
Population estimate: MC/R = N	124,742
Standard error	71,550
Lower and Upper 95% CI limits	-15,495 – 264,980
Estimate bias level: MC/4N =	0.75 (>4 acceptable bias)

Table 2: Petersen population estimate for brown trout Arthurs Lake 2016.

Of the three tagged fish captured all three had double tags. All fish recaptured were not stripped during the tagging phase. Of the two fish tagged at the Tumbledown Creek trap, one was recaptured at Hydro Bay the other was recaptured at Jonah Bay. The third fish was tagged at Scotch Bobs Creek and recaptured south east bay of Brazendale Island.

3.4 *Comparison of results 2013 and 2016*

A comparison of the 2013 and 2016 survey results shows the general size of brown trout, both length and weight were significantly less for fish captured during 2013 survey. The mean length of trout captured in box traps from the 2013 was 341 mm compared to 376 mm for 2016. The mean weight comparison was 414 g for 2013 and 616 g for 2016 (see figure 10 & table 3).

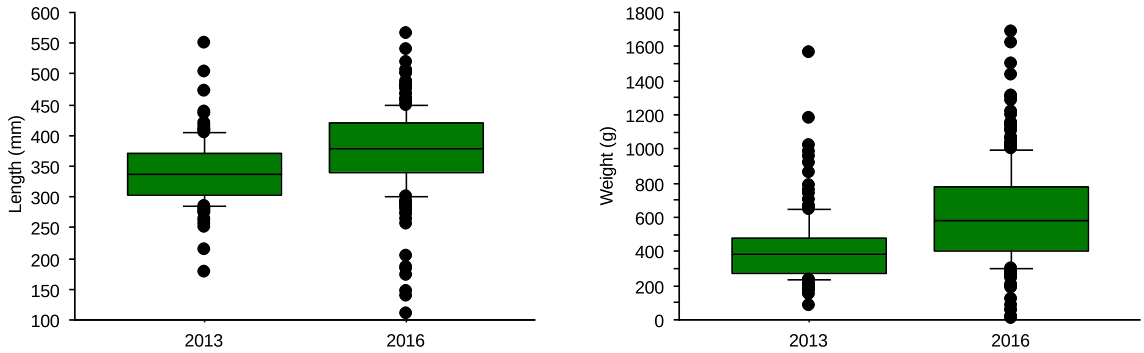


Figure 9: Box plots for length and weight data comparing Arthurs Lake survey results for 2013 & 2016, brown trout.

	Mean	Minimum	Maximum
Length (mm) 2013	341	178	567
Length (mm) 2016	376	110	550
Weight (g) 2013	414	80	1570
Weight (g) 2016	616	10	1690

Table 3: Descriptive statistics for length and weight data comparing Arthurs Lake survey results for 2013 & 2016, brown trout (2013 n=179; 2016 n=277).

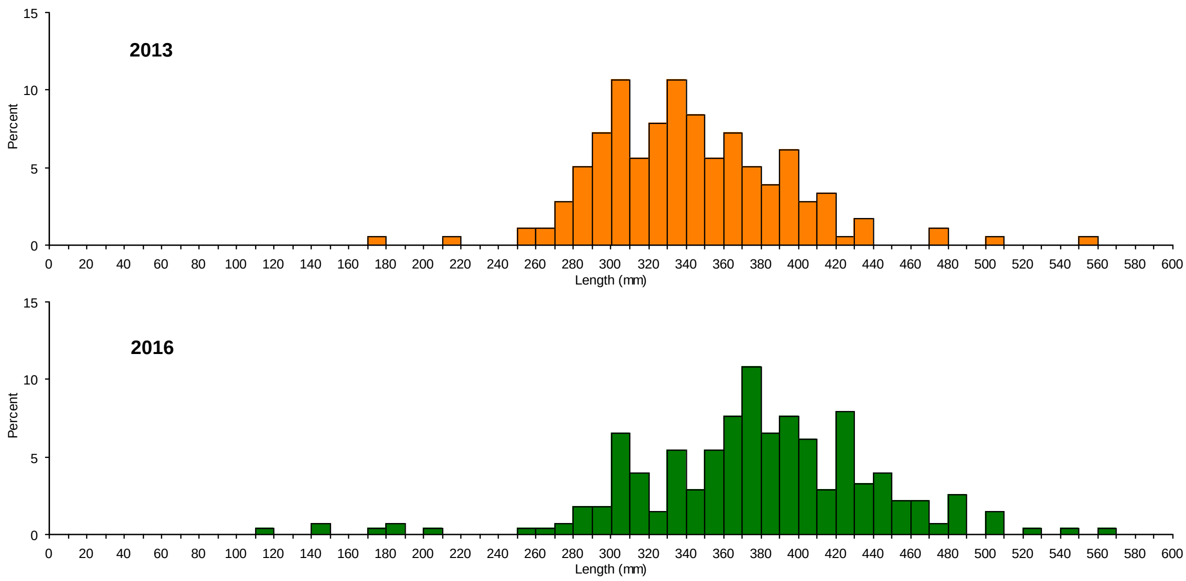


Figure 10: Length frequency graphs for brown trout comparing Arthurs Lake survey results for 2013 (n=179) & 2016 (n=277) in 10 mm increments.

A comparison of length frequency plots for 2013 and 2016 surveys in addition to comparing spawning run monitoring data for the same periods, suggests the 2013 population was strongly biased by the presence of fish in the 3+ and 4+ age classes (280-320 and 330-380 respectively). Approximately 10% of the fish captured during 2013 were 400 mm or greater, this compares to 34% for the 2016 survey. Conversely, the percentage of fish 300 mm or less was 33% in 2013 compared to 8% for the 2016 survey.

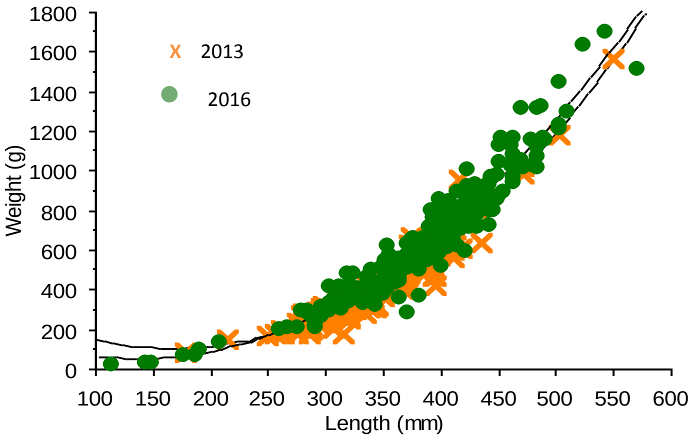


Figure 11: Length/weight regression data for brown trout, comparing Arthurs Lake survey results for 2003 & 2016 (2016 includes clipped and non-clipped fish), (2003: Y = -1187.662 + 5.212 * X; R^2=0 .85 & 2016: Y = -3191.683 + 9.833 * X; R^2 =0.83).

A simple regression plot of comparative lengths and weights for brown trout captured during the 2013 and 2016 surveys (see figure 11) shows the growth rate for fish surveyed in 2016 was marginally better across most lengths, although this difference is not significant. A plot of all fish lengths v weights from spawning and in-lake surveys also displays a similar pattern (see fig 12 & 13).

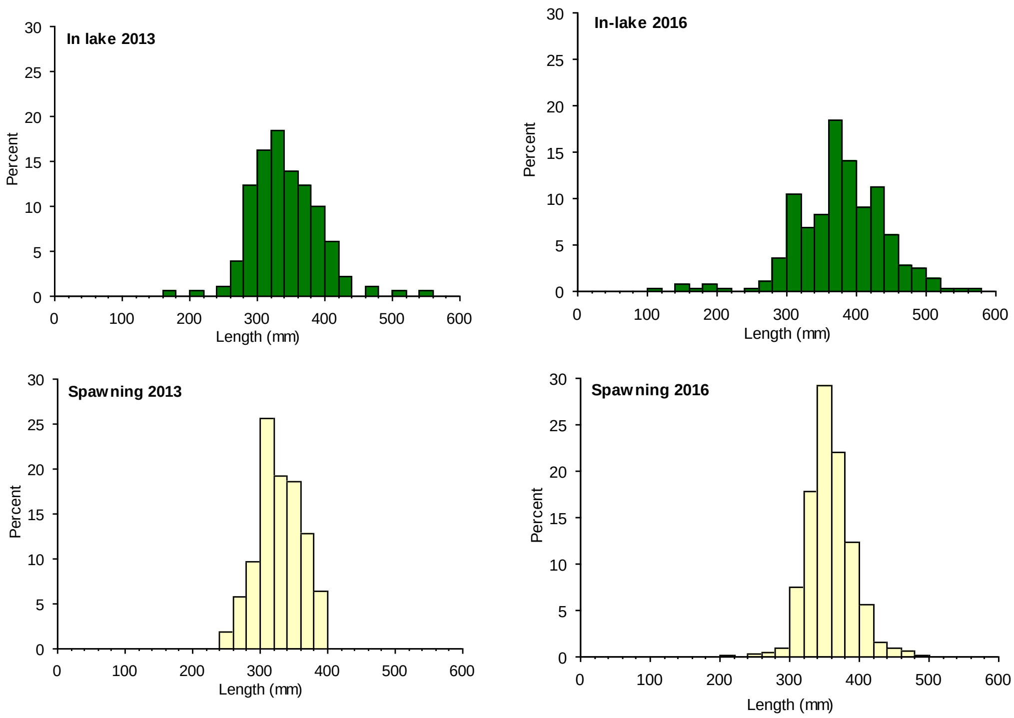


Figure12: Comparison of length frequency for spawning run and in-llake survey data for 2013 & 2016.

A comparison of the lengths of spawning fish collected in June-July for 2013 & 2016, and fish captured during the respective years (September 2013 & 2016), shows that spawning runs are dominated by three and four year old fish in the 300-400 mm size range. The dominance of these cohorts are particularly strong during 2013. The 2016 spawning data shows a small percentage of fish were over 400 mm.

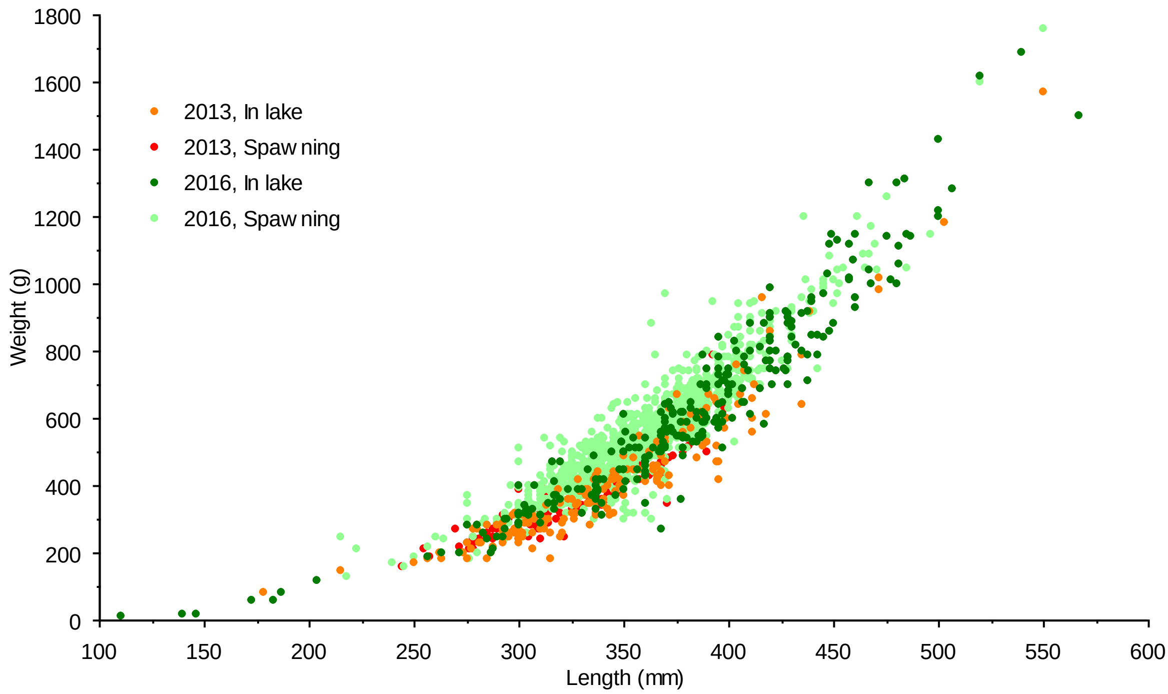
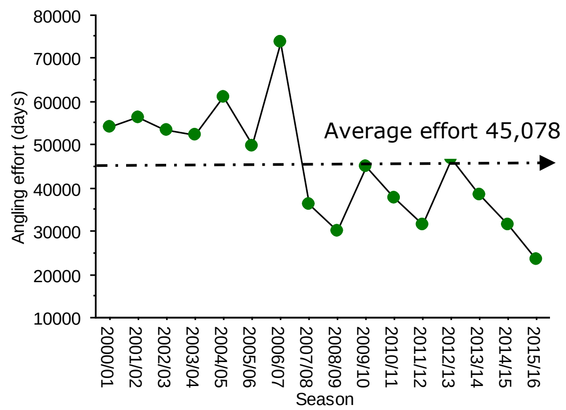
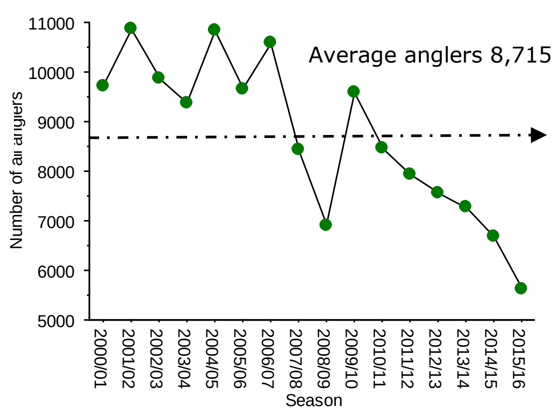


Figure 13: Comparison of length weight data for 2013 &2016 in-lake surveys and 2013 & 2016 spawing run data.

4 Angler Postal Survey





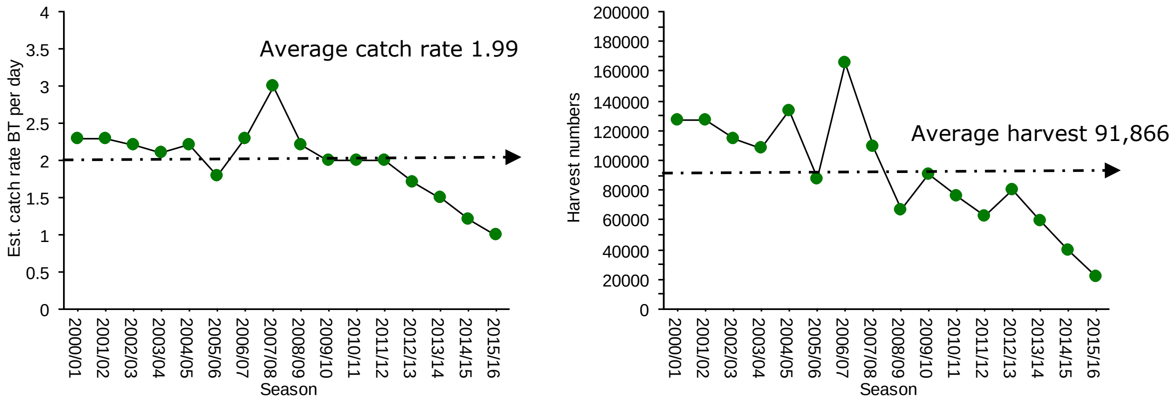


Figure 14: Angler Postal Survey results for angling effort, angler numbers, and daily catch rate for brown and rainbow trout Tooms Lake, 1995-2015.

Comparing the number of anglers fishing Arthurs Lake pre and post 2008 there was a decrease of around 30% post the 2007/08 season. This equated to a 38% percent decrease in angling effort comparing the same periods, falling from a mean of 57,217 to 35,536 angling days per season (see figure 14). The long term average catch rate of around two fish per day has decrease to one fish per day for the 2015/16 season. The harvest number for brown trout for 2015/16 season was just 13% of the estimated maximum of 166,022 fish for the 2006/07 season and 25% of the long term average of 91,866 fish.

The decline in angler participation figures (ie number of anglers and angling effort post the 2006/07 season), was mostly driven by the effects of low lake levels because of on-going drought conditions and to a lesser degree the consequence of continuing high harvest pre 2007/08. These factors lead to a decline in overall productivity due to the loss of large areas of macrophytes and poor recruitment of fish.

5 Discussion

The results of the 2016 survey indicate that Arthurs Lake at the time of the survey contained a relatively low to moderate population of brown trout with an average weight of around 0.62 kg, with 10% of fish weighing over 1 kg. Brown trout exhibited a 49% increase in mean weight since the last in-lake survey during 2013, were the mean weight was just 414 g. This increase in weight can be attributed to the higher proportion of fish in the larger length range. During the 2016 survey, 35% of fish were greater than 400 mm, compared to just 10% for the 2013 survey. This difference was due to the presence two larger size cohorts. These cohorts were almost absent during 2013, as evident in both the spawning run and in-lake survey data. This suggests that survival of larger fish was poor and there was a substantial deficiency in recruitment stemming from 2007-09. These results fit with the peak in drought conditions, with the lake level falling more than 4 m during the period November 2005 to March 2009. Additionally, the dry period was followed by a substantial wet period with the lake level increasing almost 3 m in just 6 months (see appendix C).

The impact of the drought resulted in large areas of productive macrophytes being exposed and dying, and the substrate removed by wind and wave action (see appendix D). The low lake levels resulted in elevated total turbidity, (although relative to most waters this was not high ie 3-5 NTU) and the loss of productive areas of the lake to approximately 3.5 metres depth. The loss of macrophyte beds and the rapid increase in lake level late 2009, restricted the productive zone to a narrow band and lead to a decline in overall productivity of the system. Also during this time there were signs of poor recruitment and most probable, high mortality from elevated harvest levels and later the effects of reduced productivity on older fish.

The decline in angler participation figures (ie number of anglers and angling effort post 2006/07 season), was also driven by the effects of low lake levels and to a lesser degree the consequence of high harvest pre 2007/08 and low recruitment (2007-09).

The impacts of the drought and subsequent low lake levels and poor recruitment have had long term implications for the fishery, that have lasted almost ten years. There are however, some very positive signs with a range of length cohorts now present. The size and general condition of fish has increased, and during the 2016/17 season most anglers consistently reported better catch rates. This situation will need to be monitored once the data from the annual postal survey is available post 2016/17.

In addition, over the last three years, there has been a change in stocking policy and a move toward using adult brown trout captured in spawning traps for stocking other waters. This has meant an increased number of fish have been removed from the spawning runs at Arthurs Lake (see appendix E). A total of 22,545 adult brown trout have been removed across all three traps over a three year period (2014-2016). The impact on the total population and annual recruitment is likely to be small, even at low population numbers. However, a policy to ensure on-going recruitment would be prudent.

In relation to future studies involving estimation of the population size, analysis of CPUE and length at age structure, a number of issues arose out of the survey.

In order to achieve a meaningful population estimate, the tagging/marking of small numbers of fish as undertaken in this survey was inadequate. The estimate produced is likely to have low accuracy and the confidence limits great. The estimate is considered as generally indicative only. If a future estimate is carry out, the smallest number of fish to tag to produce a meaningful estimate (+/- 25% accuracy) with an alpha level of 0.05 is between 12,000 – 15,000 fish, with a recapture of at least 1,000 fish. Trade off positions to produce a similar result is to tag 5,000 fish with a total recapture of approximately 3,000 fish. Or tag 8,000 fish with a recapture of 2,000. These figures are based on the estimated population being between 200 – 300 thousand fish.

During the recapture phase, only three tagged fish were captured, however, all were caught well away from the initial tagging sites, therefore indication good mixing within the population. Tag loss was unable to be estimated due to the low recapture numbers (only three fish). However, during the spawning run at Tumbledown and Scotch Bobs creek traps during 2017, approximately 50 double tagged fish were rechecked with no fish losing either tag.

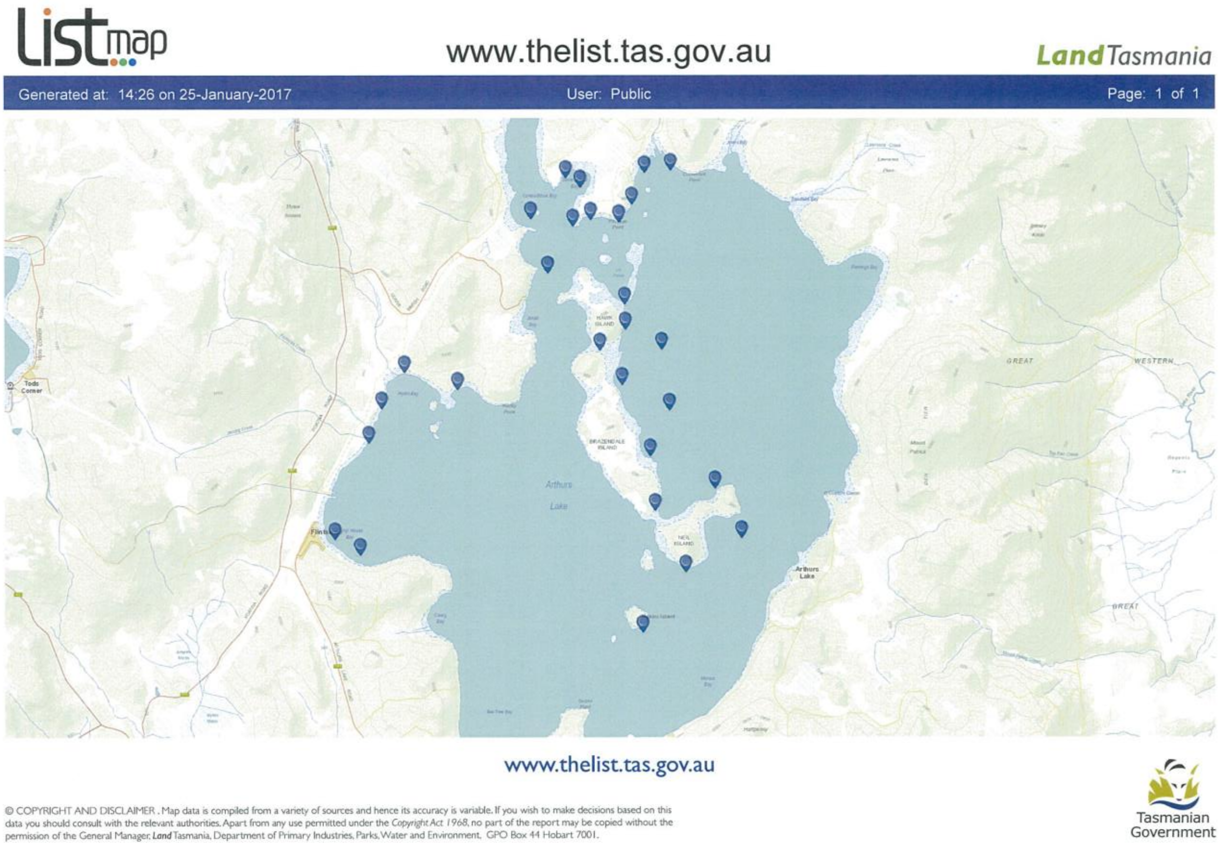
Analysis of the length structure of those brown trout captured showed a number of defined cohorts. However, the relationship between length and probable age, even for small fish ie 320 mm, was problematic. Further analysis of the population should include analysis of actual age structure through the assessments of otolith structure to provide meaningful length at age data.

6 Recommendations

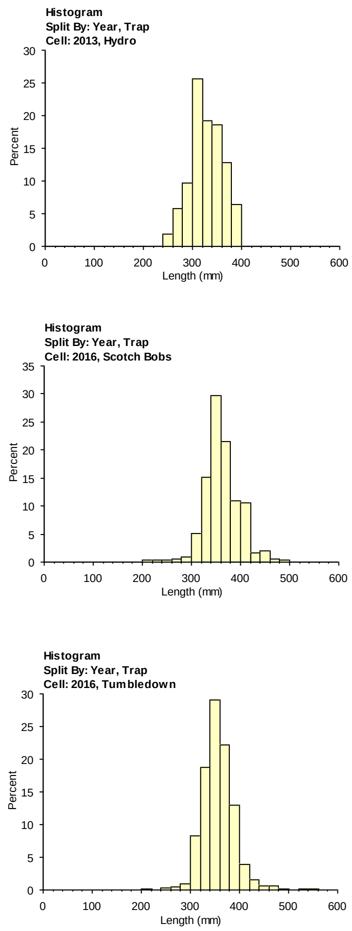
If a program to understand the Arthurs Lake brown trout population is established, it will need generally broad in scope and be adequately resourced. This will need to include:

- an initial robust estimate of the population size,
- assessment of length at age and population age structure,
- assessment of the spawning run;
  - an annual weigh and measure of a representative sample,
  - an annual record of the total number of fish present in spawning traps, the spawning run and of fish transferred, and an assessment of the number of fish returning to spawn each year.
- Monitoring of angling effort, catch rate and annual harvest, and validation of this information in context of the Arthurs Lake fishery.
- Review of regulatory structure applicable to the long-term sustainability of the fishery, that meets the expectation of anglers for Arthurs Lake.
- Development of a recruitment and spawning run management plan to ensure the values of the fishery are maintained.

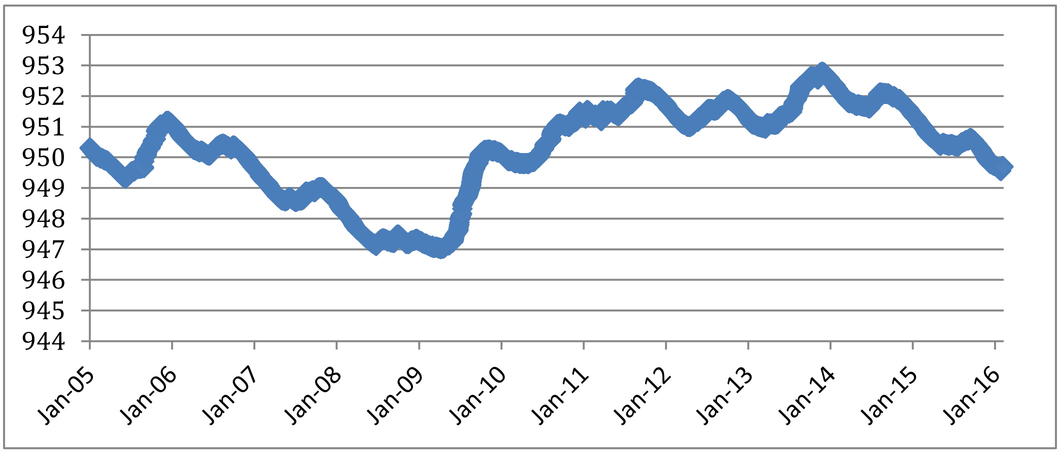
7 Appendix



A) Net set locations Arthurs Lake August 2016



B) Spawning run length frequency plots for each spawning trap 2016 (2013 Hydro Ck)



C) Arthurs Lake – lake level plot 2005 - 2016

D) Arthurs Lake, Cowpaddock Bay low lake level January 2009 left and high lake level October 2009.

Year	Number
2014	16,950
2015	5,110
2016	485
Total	22,545

E) Arthurs Lake, brown trout transferred from spawning traps 2014-2016 (2016 effected by major flood event).