Inland Fisheries Service

Fisheries Performance Assessment
Technical Report

Arthurs Lake – April 2023

Inland Fisheries Service

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Introduction

Arthurs Lake is consistently in the top two most popular inland recreational fisheries in the State. The lake is generally known for its good catch rate of wild brown trout and is managed as a Wild and Naturally Recruiting fishery under the Tasmanian Inland Recreational Fishery Management Plan 2018-28. This means it is sustained through natural recruitment and unlikely to be overfished by anglers. It is regulated through a 12 fish daily bag limit, with a minimum size of 300 mm and an open season from the first Saturday in August to the Sunday nearest the end of April.

The millennium drought saw the lake go to low levels in the period from 1998 to 2009. The Arthurs Lake fishery performed exceptionally well during this period with high catch rates peaking as the lake approached its lowest level. The average fish size was also high during this period.

The breaking of the drought in October 2009 with consistent spring rainfall increased flows in all the creeks draining into Arthurs Lake. This resulted in the lakes rapid rise and consistently high lake levels for the next four years. The change to wetter conditions resulted in good spawning and recruitment of trout and decline in productivity and water quality. A significant contributing factor to reduced productivity in the trout population is thought to be less light reaching large areas of the lakebed and consequently less primary production. The fishery in turn declined from 2014 with lower catch rates and angler participation.

By 2019 the Arthurs Lake fishery had recovered from the drought to flood cycle of ten years prior. The catch rate began to increase and the condition of trout in the spawning runs improved. The La Niña climatic event from 2020-23 resulted in high lakes levels and further good trout recruitment.

A Fisheries Performance Assessment (FPA) was commenced to establish the current age structure and status of the lake's brown trout population. In early December 2022, the population was sampled by electrofishing (boat mounted and backpack units). The otoliths of these fish were sent to Fish Ageing Services (FAS) in Victoria. In April 2023 the lake was surveyed using box traps. The catch per unit effort (CPUE) was measured with fish length, weight and sex determined. No fish were retained for this part of the assessment.

FPA Survey Methodology

In-lake Surveys

Electrofishing survey

To assess the age composition of the lake's brown trout population, an electrofishing survey was conducted during 19 and 20 December 2022. The objective of this survey was to take a sample of 200 trout to collect otoliths for ageing. A sample of young of the year (YOY) brown trout was taken to assist with age validation.

The IFS Smith-Root electrofishing boat was launched at Pumphouse Bay. With three staff on board, the boat was driven over the route shown in Figure 1. The generator was activated intermittently to capture as many brown trout as possible over the two-day period. Time of sample, shock time and the number of fish captured were recorded.

Using a Smith-Root backpack mounted electrofishing unit a sample of 'young of the year' brown trout was taken from the mouth of Hydro Creek.

All larger fish captured were processed at the Inland Fisheries Service (IFS) New Norfolk laboratory during 21 and 22 December 2022. Fish were measured, fork length (mm), weight (g), sexed and otoliths removed. Dr Peter Coulson extracted the otoliths of the YOY at the Institute of Marine and Antarctic Studies (IMAS) and all otoliths were sent for ageing to FAS in Victoria.

Trapping survey

To assess the brown trout population structure, a trapping survey was conducted during 3 - 5 April 2023. Two teams set a total of 81 box traps as 25 sets of three and three sets of two (Figure 2). Figure 3 shows how the box traps are set.

The traps were set for two consecutive nights, totalling 162 sets. Most traps were set around the margins of the lake in a range of habitats, with 10 set in deep water. The deep-water sets were trialled using an escape tube for bycatch.

Traps were checked and cleared of fish each day. Up to 160 of the fish caught were weighed, measured, and sexed each day with additional fish only counted.

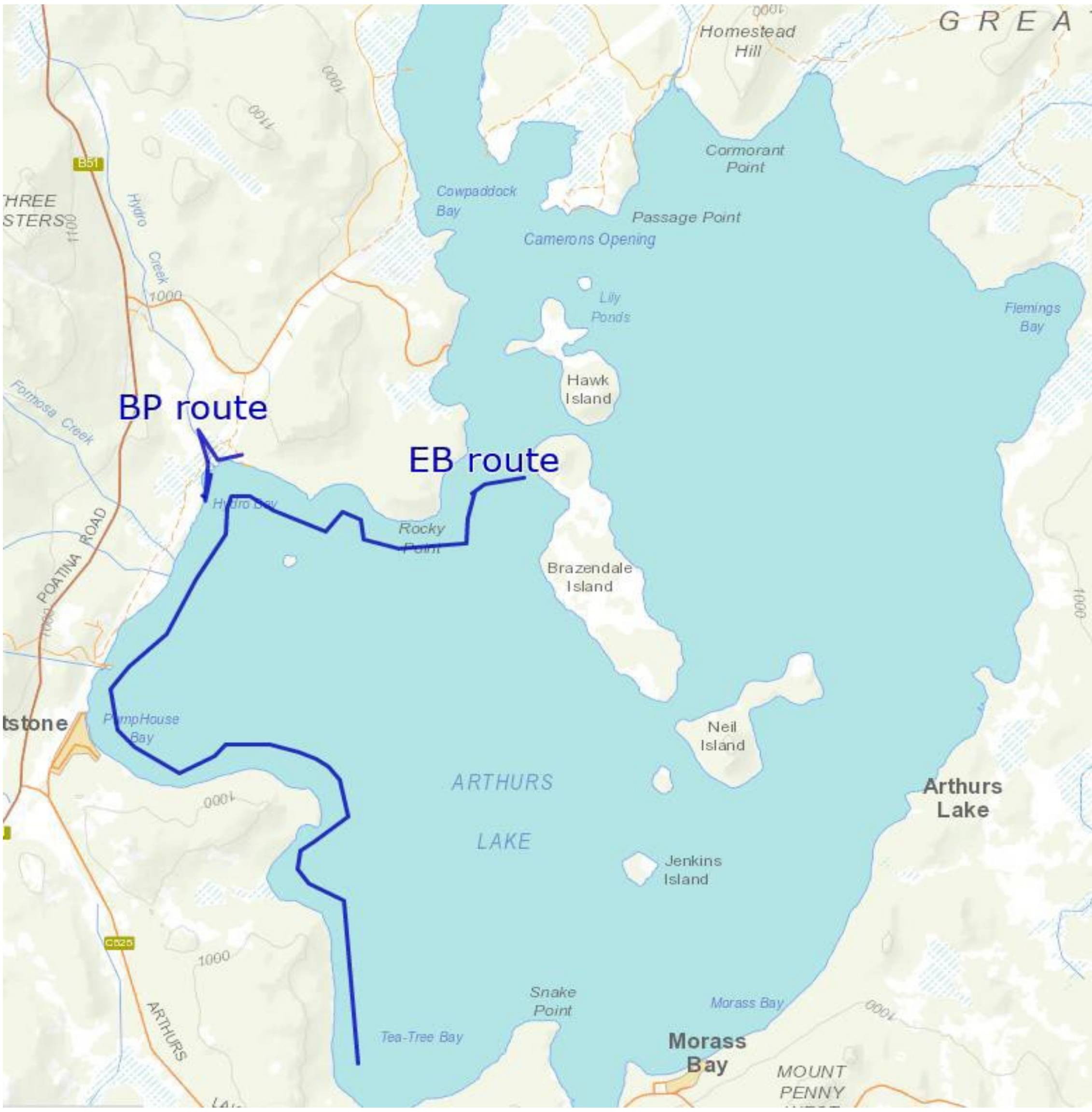


Figure 1. Route of backpack (BP) electrofishing and electrofishing boat (EB) 19 and 20 December 2022

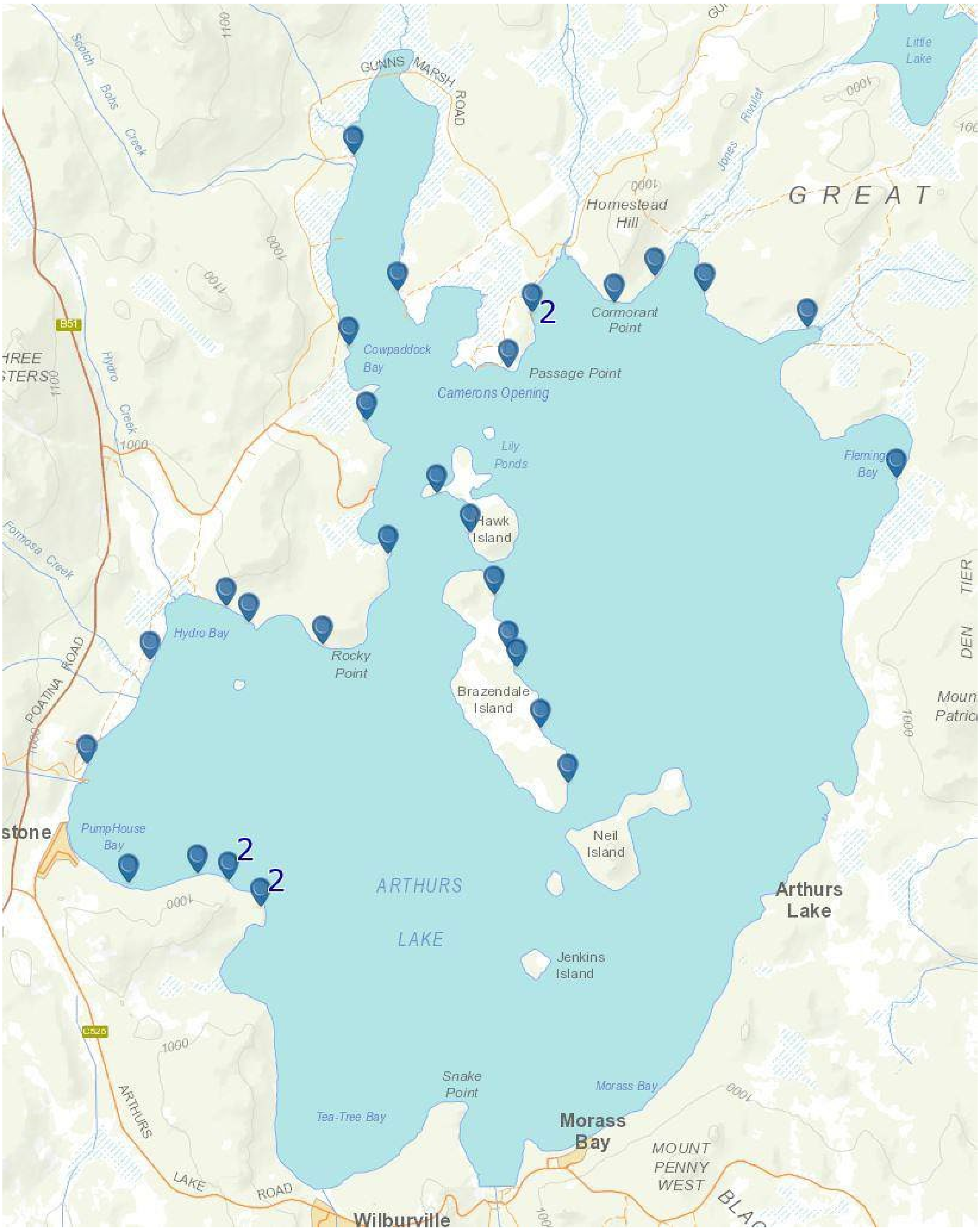


Figure 2. Location of the box trap sets; all the sets were of three traps except where indicated.

Figure 3: Typical box trap set showing three co-joined traps.

Annual Postal Survey

Since 1986, the IFS has conducted a postal survey seeking information about anglers' catches. The survey comprises of a form sent to a subset 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. The results of all years for Arthurs Lake up to and including the 2022-23 season are shown in Appendix D.

Survey Results

In-lake Surveys

Electrofishing survey – December 2022

On 19 and 20 December Arthurs Lake was surveyed using boat and backpack mounted electrofishing units (Figure 1).

On 19 December, the boat covered approximately 12.2 km over five hours 14 minutes with 11,038 seconds of shock time (the time the electrofishing unit is active) for 132 brown trout.

On 20 December, the boat covered approximately 12.2 km over four hours and 57 minutes with 12,235 seconds of shock time for 80 brown trout.

On 20 December, Hydro Creek and around where it enters the lake was backpack electrofished, covering 400 m over one hour and 30 minutes with 4,800 seconds of shock time for eight YOY brown trout.

The CPUE of this survey was measured in the number of fish caught per hour of shock time. The CPUE for each of the five sessions of fishing varied considerably (Table 1). There are no comparable data sets from Arthurs Lake or other fisheries in Tasmania to assess relative change of CPUE.

Table 1. Fishing effort using the boat mounted electrofishing unit for 19 and 20 December 2022 otolith collection survey. # Fishing effort using backpack mounted electrofishing unit YOY sample.

Date	Start time	End time	Survey time (h:m:s)	Shock time (s)	Distance covered (km)	Fish caught	CPUE fish/h
19/12/2022	11:00:00 AM	12:49:00 PM	1:49:00	2,694	2.5	29	3.88
19/12/2022	1:15:00 PM	3:10:00 PM	1:55:00	1,510	3.0	53	12.64
19/12/2022	3:15:00 PM	5:45:00 PM	2:30:00	6,834	6.7	50	2.63
20/12/2022	10:00:00 AM	1:00:00 PM	3:00:00	6,145	6.2	23	1.35
20/12/2022	1:30:00 PM	3:27:00 PM	1:57:00	6,090	6.0	57	3.37
#20/12/2022	12:00:00 PM	1:30:00 PM	1:30:00	4,800	0.4	8	0.60

Brown trout length weight data

A total of 220 brown trout were caught, eight of these were YOY (2022 spawning). The YOY are treated separately in the following weight and length summary. Of the remaining 212, there were 199 weighed, measured and processed for otolith removal.

Of the 199 brown trout processed, 38 were males, 59 females and 102 indeterminate.

A summary of the biological parameters is shown in Table 2.

The fish classed as indeterminate did not show visible gonad growth when dissected and were therefore immature. These fish measured less than 375 mm and weighed less than 568 g. On average these fish had a higher Condition Factor (k) than the other two groups. There is a general decline in condition with length and therefore age (Figure 4).

The largest fish was a male at 514 mm and 1,620 g. Males were larger overall but showed a lower average Condition Factor (k) at 1.08 compared to indeterminates at 1.24 and females at 1.12. The smallest fish (excluding the YOY sampled) was 111 mm and 15 g.

Over half the fish (54%) were categorised as 'fair', having k values between 0.90 and 1.10. Forty percent of fish were categorized as 'good', k is greater than or equal to 1.20 but less than 1.60. The distribution of these categories is shown in Figure 5.

Table 2: Descriptive statistics for brown trout processed from the 19 and 20 December 2022 catch - length, weight and condition factor separated by sex.

Grouping	Measurement	Mean	Minimum	Maximum
All brown trout (n=199)	Length (mm)	279	111	514
	Weight (g)	353	15	1,620
	Condition Factor (k)	1.17	0.83	1.65
Female (n=59)	Length (mm)	348	265	483
	Weight (g)	499	215	1,175
	Condition Factor (k)	1.12	0.94	1.38
Male (n=38)	Length (mm)	414	295	514
	Weight (g)	786	285	1,620
	Condition Factor (k)	1.08	0.83	1.45
Indeterminate (n=102)	Length (mm)	189	111	375
	Weight (g)	108	15	565
	Condition Factor (k)	1.24	0.90	1.65
Young of the year (n=8)	Length (mm)	37.5	29	45
	Weight (g)	0.51	0.18	0.88
	Condition Factor (k)	0.86	0.67	1.10

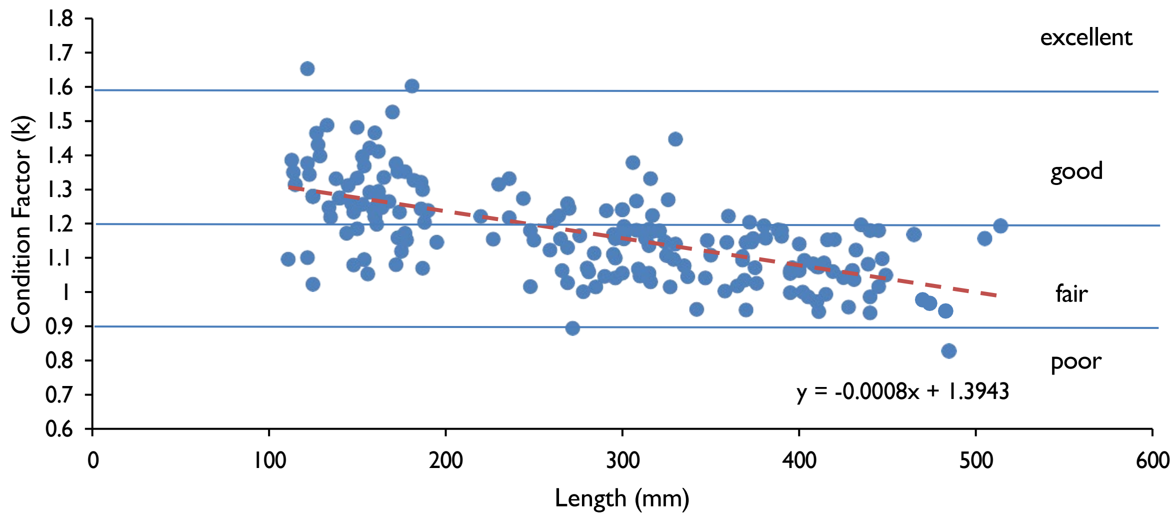


Figure 4: Condition factor at length for all brown trout.

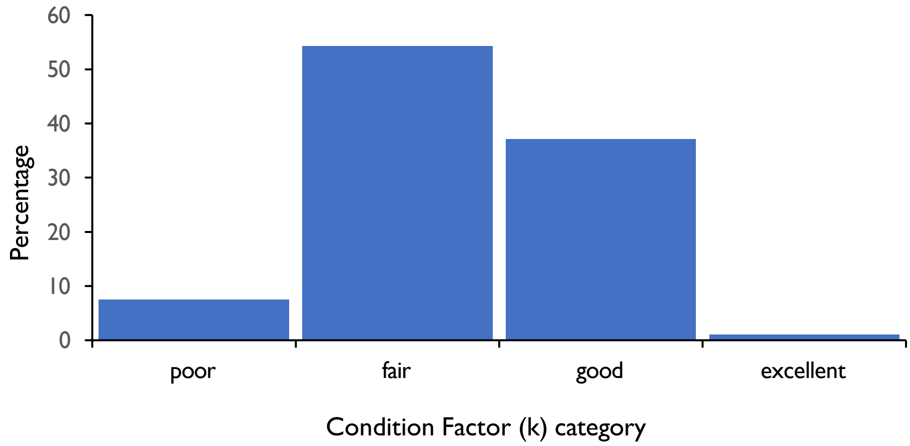


Figure 5. Condition factor category for brown trout processed from the 19 and 20 December 2022 catch.

Ageing results

FAS provided a report at the end of March 2023 on the otoliths collected on 19 and 20 December 2022. By sectioning and reading the annuli (growth rings) they were able to determine the age of the fish that the otoliths were extracted from.

The analysis provided by FAS assumed the "birthdate' for all brown trout was 1 December.

The determination of ages proved to be relatively straight forward for the fish that were four years of age and older. Fish determined to be two and three years old were more difficult to separate. That is, it was unclear with many fish as to whether they were two or three years of age. This was due to the variation in the margin of the second annuli.

The majority (64%), of the fish from the survey were less than three years of age. Fish that were six years of age made up 11 percent of the sample and were the third most common age. The oldest fish were nine years of age, a male (514 mm) and a female (483 mm) (Figure 6).

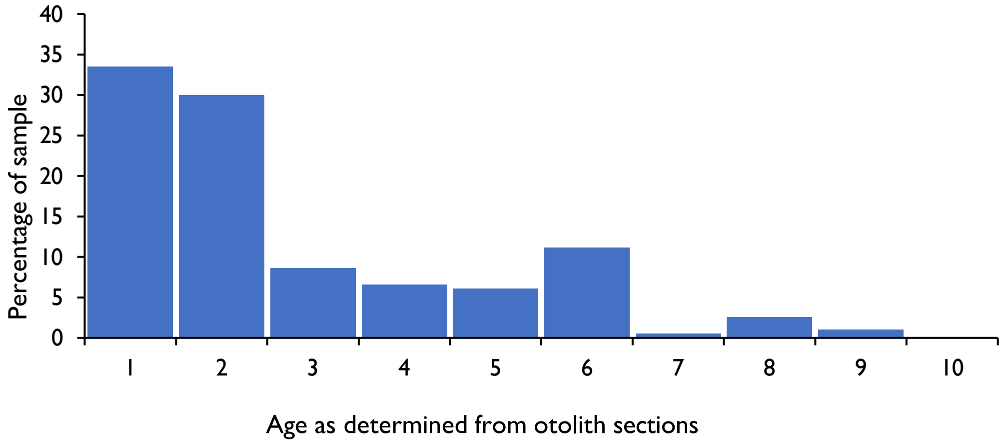


Figure 6. Age frequency distribution of the 199 brown trout examined.

An objective of ageing this sample of fish was to produce an age at length key for Arthurs Lake brown trout.

The results of the otolith preparation and reading by FAS produced the age at length chart shown in Figure 7. These results do not produce a clear key for indicating a discrete length range for any age cohort. The smallest range of length for any cohort is 360 to 430 mm for four-year-old fish. Two-year-old fish have the largest length range of 147 to 374 mm.

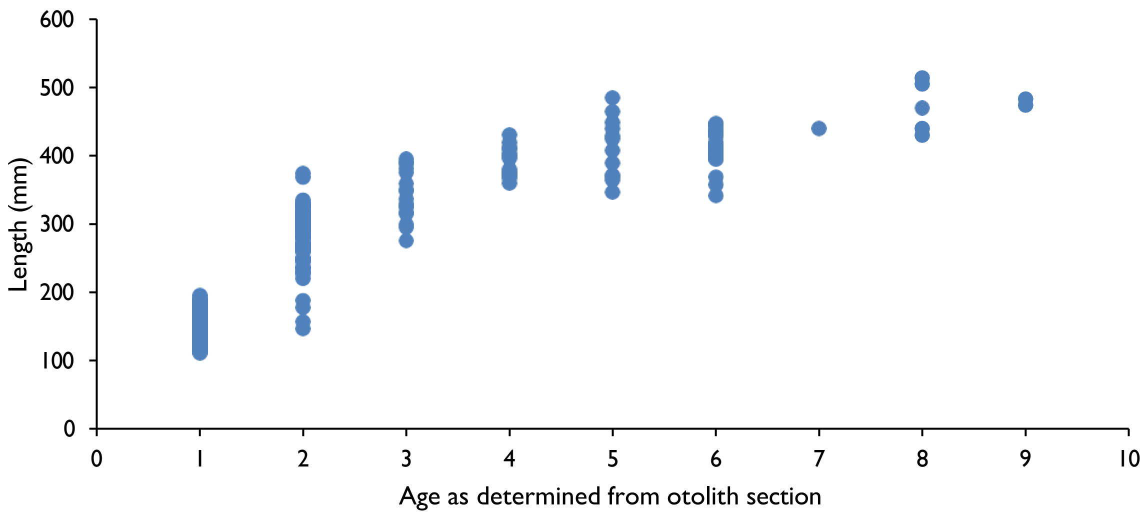


Figure 7. Age at length key for the December 2022 brown trout sample from Arthurs Lake, produced by Fish Ageing Services (n = 199).

To produce a more useable age at length key, the data was split into sex categories. These charts are shown in Appendix A.

None of the charts provide an adequate key for attributing an age to a discrete range of lengths. Variation in length at age is significant through to six years of age. Only one and two data points were available to seven and nine-year-old fish, respectively. The five fish that were determined as eight years of age still varied in length from 430 to 515 mm. It can be assumed that variation in length at age is not restricted to any age class.

FAS indicate that separation of ages 2+ and 3+ fish was difficult. An example of an otolith section is shown in Appendix B.

The relationship between otolith weight and length of fish is more linear than for age determined by reading the sections and length. This relationship gives a better-defined key for age but there is still a significant range of weights and therefore overlap for each age in the key. This is useful for validation only. As otoliths can only be extracted and weighed post-mortem, the key cannot be applied to non-lethal sampling.

Assessment of a length frequency plot for the survey (Figure 8), suggests that two age cohorts are present in the sample that are less than 200 mm in length: YOY (29 to 45 mm) and 1+ (111 to 195 mm). The ageing data does suggest that some fish aged 2+ overlap with the upper length range of 1+ age. The normal distribution of length shown within this range would suggest it represents a distinct 1+ age cohort.

The fish greater than 220 mm and less than 450 mm in length represent numerous age cohorts. At least five age cohorts are apparent within this length range. There are numerous peaks in frequency but only the one in the range of 290 to 330 mm resembles a “normal” distribution that could be confidently assigned as an age cohort, this is most likely 3+. There are large overlaps in length for each age class as indicated from the otoliths analysis. This makes it difficult to identify length ranges for age in a length frequency distribution as well.

The following is a suggested age/size structure of the population:

> 0+: 20 – 50 mm, 1+: 110 – 190 mm, 2+: 220 – 280mm, 3+: 290 – 310 mm,
> 4+: 320 – 350 mm, 5+: 360 -380 mm, 6+: 390 – 410 mm, 7+: 420 – 440 mm,
> 8+: 460 – 480 mm and 9 +: 490 – 510 mm.

Note that the breakdown of age cohorts into length classes as above does not match the suggested length at age from the otolith analysis rather nor is it intended to. This is an interpretation based on the length frequency alone. The ranges suggested are median values at best.

Importantly the 1+ and 2+ age classes represent a large proportion of the sample.

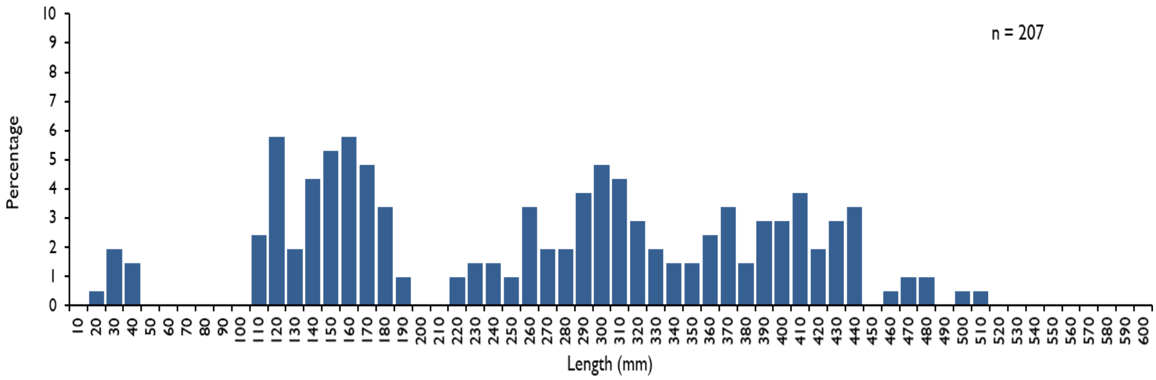


Figure 8. Length frequency distribution of fish caught 19 and 20 December 2022

Box trap survey – April 2023

Over two nights, 3 and 4 April, a total of 435 fish were caught from the 162 box traps set.

There were 204 fish caught for the approximately 24 hours to midday of 4 April from 81 box traps. This is an average of 2.46 fish per trap. The most fish caught was 15, the fewest was one.

There were 231 fish caught for the approximately 24 hours to midday of 5 April from 81 box traps. This is an average of 2.86 fish per trap. The most fish caught was 28, the fewest was one.

Brown trout length weight data

Of the 435 fish caught in box traps, 329 were measured and 315 were weighed. Note it was agreed prior to the survey that only 300 fish would be weighed and measured i.e., 150 per day.

Of the 329 measured, 127 were female, 119 were male and 83 were indeterminate. The summary of the weight, length and Condition Factor (k) is shown in Table 3.

The largest fish caught were males, with 555 mm being the longest. The seven fish over 500 mm in length were male and were in fair to poor condition, with k = 1.07 – 0.82. Weights were 1.5 – 1.09 kg.

The female fish were smaller on average in weight and length but in slightly better condition overall. Average condition was k= 1.00 compared to 0.99 in the males.

Indeterminate fish ranged from 89 to 350 mm in length and 60 to 460 g in weight. They were in better condition than the mature fish, average k = 1.07.

Figure 9 shows k at length for the sample, n = 315, the general decline in condition with size/age is visible but the relationship is not as marked as shown in the December sample.

Overall, the condition of fish captured in this survey is poorer than that shown in the electrofished sample taken in December, k = 1.17 vs 1.01. Normally the reverse of this trend would be expected, i.e., April sample k > December sample k. The April sample should have better condition than the December sample as the fish are closer to their spawning weight which is usually the peak of condition for brown trout. This is in part due to the higher ratio of indeterminate to total catch in the December sample compared to the April sample (0.51 vs 0.25). However, this probably does not entirely explain the apparent decline in condition factor.

Most of the fish (75%) in this sample can be categorised as "fair", 16% as "poor" and 8% as "good" (Figure 10). This emphasises the trend in worsening condition factor (k) from December to April.

Table 3. Descriptive statistics for brown trout - length, weight and condition factor separated by sex for fish sampled during 3 - 5 April 2023.

Grouping	Measurement	Mean	Minimum	Maximum
All brown trout (n=329 length) (n=315 weight & k)	Length (mm)	359	89	555
	Weight (g)	553	60	1,500
	Condition Factor (k)	1.01	0.67	1.48
Female (n=127 length) (n=125 weight & k)	Length (mm)	367	230	473
	Weight (g)	530	160	1,150
	Condition Factor (k)	1.00	0.77	1.40
Male (n=119 length) (n=118 weight & k)	Length (mm)	422	293	555
	Weight (g)	774	250	1,500
	Condition Factor (k)	0.99	0.67	1.29
Indeterminate (n=83 length) (n=72 weight & k)	Length (mm)	251	89	350
	Weight (g)	228	60	460
	Condition Factor (k)	1.07	0.73	1.48

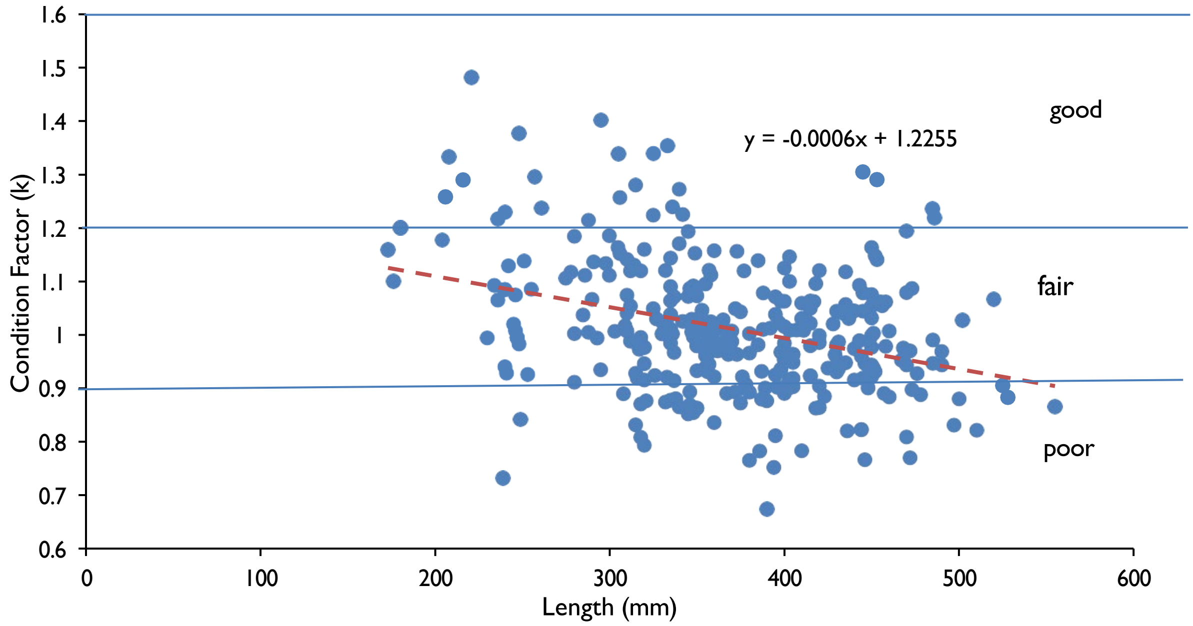


Figure 9: Condition factor by length for all brown trout.

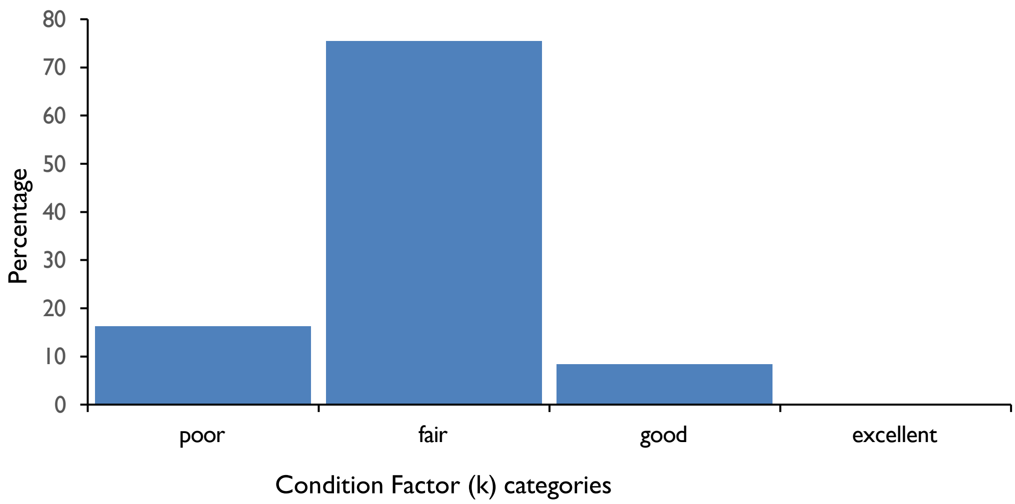


Figure 10: Condition factor category for all brown trout.

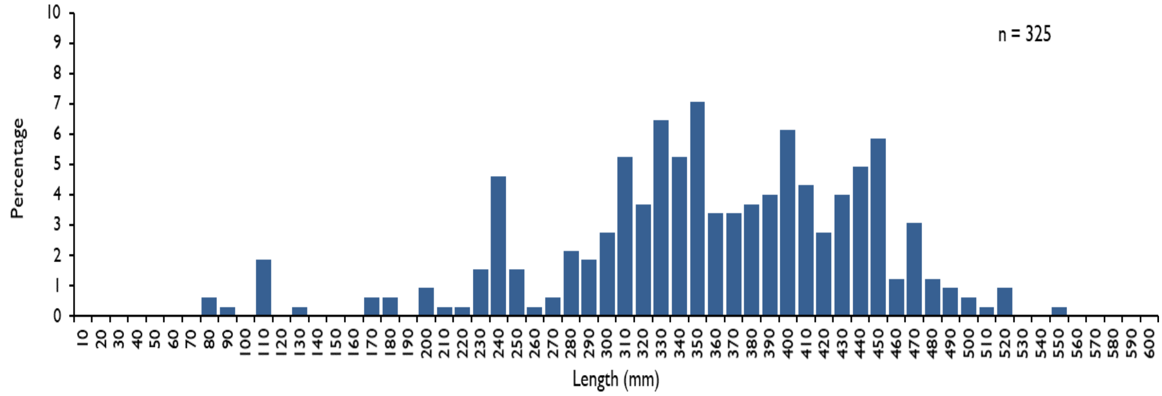


Figure 11. Length frequency for brown trout – Arthurs Lake April 2023.

The length frequency distribution reflects an increase in length of all age cohorts in comparison to the December 2022 sample (Figure 11). The shifts are greater for the younger age cohorts with the difference in growth as expected for that stage of life. The apparent strength of the 1+ and 2+ is not as evident in the April sample. This is likely a result of the size selectivity of the sampling method. It could also be due to the availability of those size classes in the habitat that was fished, rather than overall difference in abundance.

CPUE Information

This survey (April 2023), there were 435 brown trout captured from 162 box trap overnight sets. This equates to a mean CPUE of 2.66 brown trout per trap per night.

In 2016 there were 277 brown trout captured from 240 box trap overnight sets. This equates to a mean CPUE of 1.15 brown trout per trap per night.

Box traps used in a survey in 2013 resulted in a CPUE figure of 3.8 brown trout per box trap per night.

The CPUE for the 2023 survey is 2.3 times that of the 2016 survey but 0.7 that of the 2013 survey. It is likely that this is in part due to abundance of trout. The survey in 2016 followed two years where trout had been removed from the spawning run and only a limited number were allowed to spawn. The survey in 2013 followed at least three good years of recruitment due to good inflows in the spawning creeks. The resulting recruitment would have increased the population and thus abundance of trout in the lake that year.

Comparison of results 2013, 2016, 2022 and 2023

The methodologies of the 2013 and 2022 FPA surveys at Arthurs Lake differ from those of 2016 and 2023 in the way the samples were obtained. Therefore, the comparisons of the trout population structure between the four surveys needs to be treated with caution. The electrofishing survey covered in this report was during December, while the box trap surveys in 2013 and 2016 were in September, and 2023 survey in April.

Table 4. Descriptive statistics of brown trout - length, weight and condition factor for 2013, 2016, 2022 and 2023 surveys.

Grouping	Measurement	Mean	Minimum	Maximum
2013 Box trap, fyke net, gill net and electrofishing survey	Length (mm)	336	178	550
	Weight (g)	411	80	1,570
	Condition Factor (k)	1.04	0.50	1.67
2016 Box trap survey	Length (mm)	376	110	567
	Weight (g)	616	10	1,690
	Condition Factor (k)	1.07	0.54	1.49
2022 Electrofishing survey	Length (mm)	279	111	514
	Weight (g)	353	15	1,620
	Condition Factor (k)	1.17	0.83	1.65
2023 Box trap survey	Length (mm)	360	89	555
	Weight (g)	552	60	1,500
	Condition Factor (k)	1.01	0.67	1.48

Spawning run monitoring

Monitoring of brown trout from spawning creeks at Arthurs Lake has been happening since 1977 (Figure 12). Until 2015 this was a weigh and measure of 200 fish from Hydro Creek. Since 2015, fish have also been sampled from Scotch Bobs and Tumbledown creeks. In 2012 there was no data collected due to the Hydro Creek trap being unserviceable. The results since 2015 reflect an average of the fish sampled from all the creeks. This provides a more consistent data set to monitor changes in fish size through time.

The timing and quantity of water of inflowing creeks plays an important role in the success of recruitment to the brown trout population. A plot of lake level from Hydro Tasmania for the years 2000 to 2023 is shown in Appendix C.

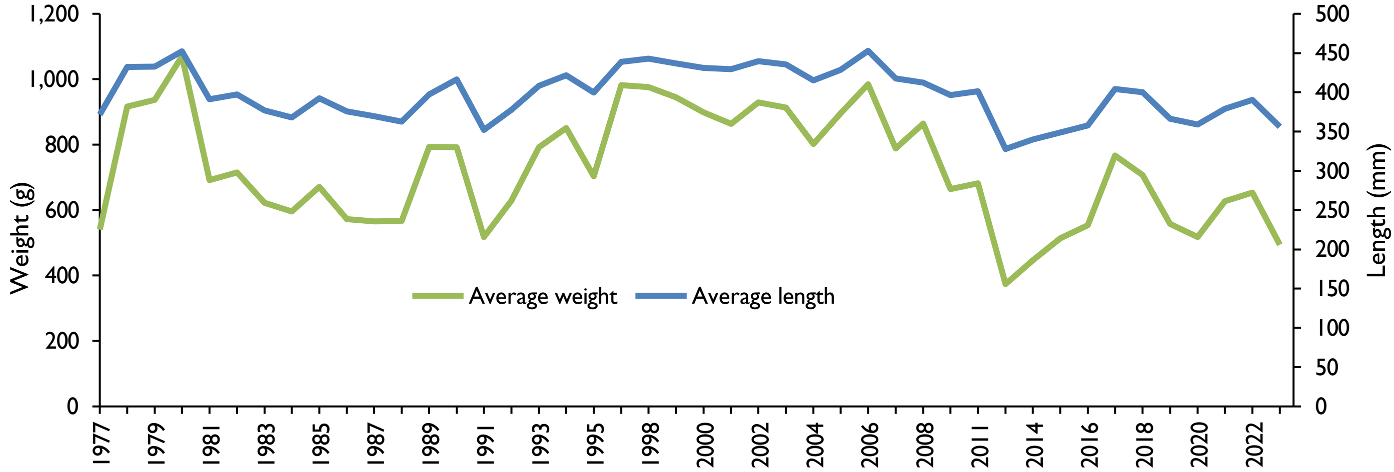


*Figure12. Average weight and length of spawning brown trout at Arthurs Lake 1977 to 2022. *data is missing for 2012.*

There was a sharp fall in length and weight of spawning brown trout from 2011 to 2013. The averages for 2013 were 328 mm and 374 g, the lowest since 1977.

During 2010, 2011 and 2012 consistently good flows in the spawning creeks, resulted in three years of good recruitment. Fish recruited during those years, potentially dominated the spawning run for the first time during 2013. The small average size in the spawning run was validated by similar averages in the catch of the 2013 in-lake survey, at 336 mm and 411 g.

Traps built on Tumbledown and Scotch Bobs creeks were first used in 2014 and complimented the Hydro Creek trap. This enabled the removal of some spawning fish for use in other fisheries, and limited spawning area. The removal of fish from the traps at Arthurs Lake is shown in Table 5. From 2015 the removal of fish was limited to those less than 400 mm in length.

Reduced winter and spring flows combined with the management of traps on three of the four main spawning creeks at Arthurs Lake reduced potential recruitment from the 2014 and 2015 spawning seasons. The spawning run during 2016 was not regulated due to a flooding event midway through the spawning run in June.

Table 5. Arthurs Lake, brown trout transferred from spawning traps to other waters 2014-2023

Year	Number
2014	16,950
2015	5,110
2016	Major flood event, 485
2017	4,507
2018	1,296
2019	Fish tagged for promotion, 5
2020	Fish tagged for promotion, 5
2021	376
2022	1,882
2023	2,832
Total	**33,448**

From 2017 the average size of spawning trout decreases until 2020 followed by increases in 2021 and 2022. The removal of 4,507 and 1,296 spawning trout from the traps during 2017 and 2018 respectively may account for the 2021 and 2022 size increases.

The removal of spawning fish that are less than 400 mm in length may result in an average size increase in subsequent years. By removing spawning fish, the recruitment from that year is potentially reduced and may limit the proportion of young fish in the spawning run three years later.

The results of the 2023 spawning monitoring show a sharp decline from the previous year, when the average weight goes from 653 to 494 g. This occurred after three years of good inflows and the resultant recruitment. The recruits of the 2020 spawning season entered the spawning population at Arthurs Lake during 2023 for the first time reducing the average size in the spawning run.

Angler Postal Survey

The charts showing the Angler Postal Survey (APS) results for each season from 1985-86 to 2022-23 are shown in Appendix D. The primary results of the APS for each year for any water (in this case Arthurs Lake) are four attributes calculated from the questionnaires. These attributes are catch rate (fish per day), harvest (estimated number of fish caught), the number of anglers fishing there and total effort (days fished x anglers). The seasons relevant to this report are from 2009-10 to 2022-23 and these results are discussed below.

Summary of Angler Postal Survey results at Arthurs Lake since 2009-10 angling season

- During the 2009-10 season the millennium drought broke. This marked a slight increase in angler visitation and effort to above the long term average. Catch rate declined slightly possibly because of a “dilution factor” i.e., there was a lower density of fish at high water level. Noting that the change from drought conditions to high water levels occurred within a six month period.

- The 2010-11 season marked the start of the decline in all four APS calculated attributes to below the long-term averages. The high water levels most likely have contributed to ecosystem decline through the loss of weed beds due to the lack of light penetration. For anglers this resulted in fish that were harder to catch and showed poor condition.

- There was a trend of decline in all four APS calculated attributes below long term averages from 2010-11 until 2016-17. A slight increase in these attributes occurred during the 2017-18 season but they again declined in the next two seasons. The number of anglers fishing Arthurs Lake during the 2019-20 season was estimated to be 4,173 anglers, which is 4,200 less than the long term average. This is the lowest recorded at Arthurs Lake in the 36 seasons of APS.

- A slight improvement in catch rate during the 2019-20 saw some anglers return to Arthurs Lake during the next season (2021-22).

- Catch rate has continued to improve and reached 1.27 in the 2022-23 season from 0.66 in 2018-19, the lowest recorded in the 36 seasons of the APS. Whilst there is a slight decline in angler numbers for 2022-23 from 5,525 to 4,812, overall anglers are coming back to the fishery.

Discussion

The summary statistics of the two recent surveys covered by this report show quite different profiles of the Arthurs Lake brown trout population. The fish caught in the December 2022 survey, showed a better Condition Factor overall compared to those caught during April 2023. The April survey only had 8 percent of fish categorised as "good" compared to the December surveys 37 percent.

The expected trend is that trout condition continues to improve towards spawning, late April to June. From December 2022 to April 2023 surveys there was a decrease in overall condition. The average Condition Factor declined from 1.17 to 1.01. The December survey is dominated by younger fish with 64 percent of the sample being one and two-year-old fish. These fish were in better condition and thus boosted the average condition of the sample whilst producing lower than average weight and length.

It is evident the growth rates experienced by younger cohorts are better than older cohorts. The otolith analysis shows that even within cohorts there is also large variation in growth. All cohorts apart from seven and nine-year-old fish (only one and two fish were caught respectively), showed at least 70 mm in variation in length at age. For two-year-old fish the variation was 227 mm. This indicates there is spatial variation in growth for Arthurs Lake brown trout. Fish occupying various trophic niches express varying growth. This might be a function of competition for the more productive areas of the lake. Weed beds provide good food resources but have limitations in the number of trout they support.

Arthurs Lake has undergone large changes in productivity over the last 10 to 13 years. The three years of La Niña climatic conditions experienced during 2009 to 2011 meant the lake had gone from a period of low levels from 2007 to 2010 to a period of very high levels from 2012 to 2015. The previously productive weed beds were inundated and now three to five metres deeper. Less light reaching these now deep weed beds meant they died off. The productivity of the lake was suppressed from this period. Water quality also declined because of dying weed beds.

This change in ecosystem productivity caused a downturn in the Arthurs Lake brown trout fishery. The Angler Postal Survey results showed that from 2009-10 catch rate and harvest (trout caught) started to decline. At the same time anglers started to turn away from the fishery and angling effort declined. The nearby Woods Lake was fishing well at the same time, so effort was diverted to there from Arthurs Lake.

During 2010 to 2013 good recruitment of trout stocks occurred, coincident with declining ecosystem productivity. This resulted in a record low average size fish in the Arthurs Lake spawning runs during 2013. Since that time Arthurs Lake has slowly recovered most likely due to the establishment of new weed beds and an improvement in water quality.

Commencing in 2014, fish were removed from Arthurs Lake with the use of traps on spawning creeks. There was further control of recruitment to the fishery by restricting the number of fish allowed to spawn. The removal of just over 22,000 trout during 2014 and 2015 coincided with an increase in the size of fish in the spawning runs for the next three years to 2017.

There appears to be a relationship between wet winters, the number of fish allowed to spawn and the size of fish in the spawning run two or three years later. The lack of control of the spawning run during 2016, due to a wash out of the trapping facilities, coincides with a drop in the average size of spawning fish during 2018 and a further drop to 2020. The inconsistent removal of spawning fish between 2018 to 2020, varying from five to 1,882 fish, makes this relationship less clear.

From 2020 to 2023 there have been three years of La Niña climatic conditions again. This has resulted in ideal conditions for recruitment for three spawning seasons at Arthurs Lake. As with the early 2010s there has been a large increase in the brown trout population. In comparison to 2022 the average size of trout in the 2023 spawning run has declined by 150 g. This is the first year the recruits from the recent La Niña conditions enter the spawning population.

Most of the fish caught in the 2022 electrofishing survey were juvenile brown trout. This was evident from the ageing results where 64 percent of the fish caught were under three years of age. Even the 6 percent under 200 mm caught in the April box trap survey is unusually high for that size class. It could be assumed that the available habitats are saturated with fish. The mostly "fair" condition of the adult fish caught during the April survey further backs up this theory. Whilst some fish are established in habitats able to sustain moderate growth, many fish were not and consequently showed poor growth. The older fish caught were also exposed to the less productive conditions of Arthurs Lake between 2014 and 2019.

Further rapid inflow events in 2016 and 2022, although smaller than the 2009 event, may have set the ecosystem recovery back by maintaining higher lake levels and depth. The reduction in productivity of Arthurs Lake is still evident in 2023. Overall population indicators (CPUE, spawning run monitoring and APS) showing that apart from high numbers of 1+, 2+ and 3+ fish the population is mostly made up of low numbers of older fish in poor condition. If there is too much recruitment for the limited resources in Arthurs Lake, fish size will go down even if the population remains relatively low.

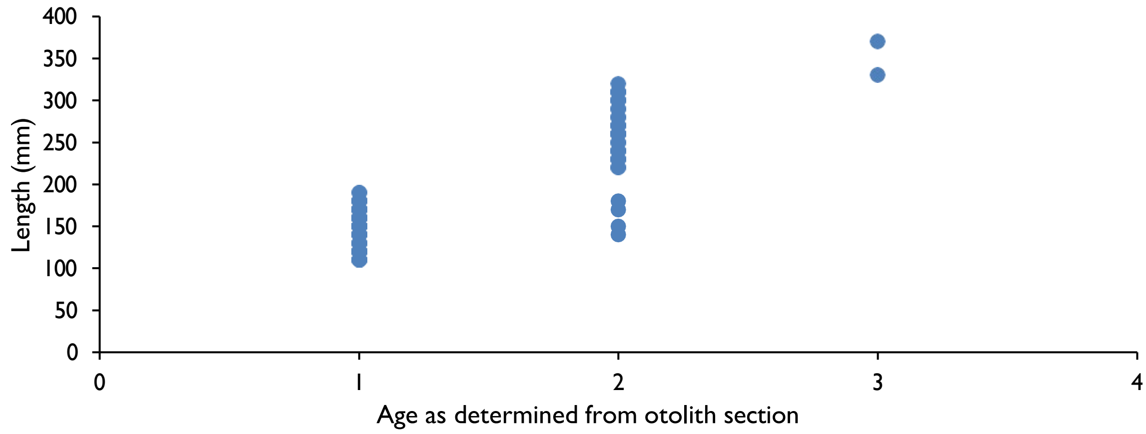
It is likely that over the next two years, without any intervention to control the number of spawning trout, there will be a further drop in average size and condition of Arthurs Lake brown trout. If the population is not reduced, whether through removal of adults by angler harvest or from spawning traps, it is likely there will be a further decline in trout condition. Angler effort at the present day rate is unlikely to have any significant effect on the brown trout population.

Recommendations

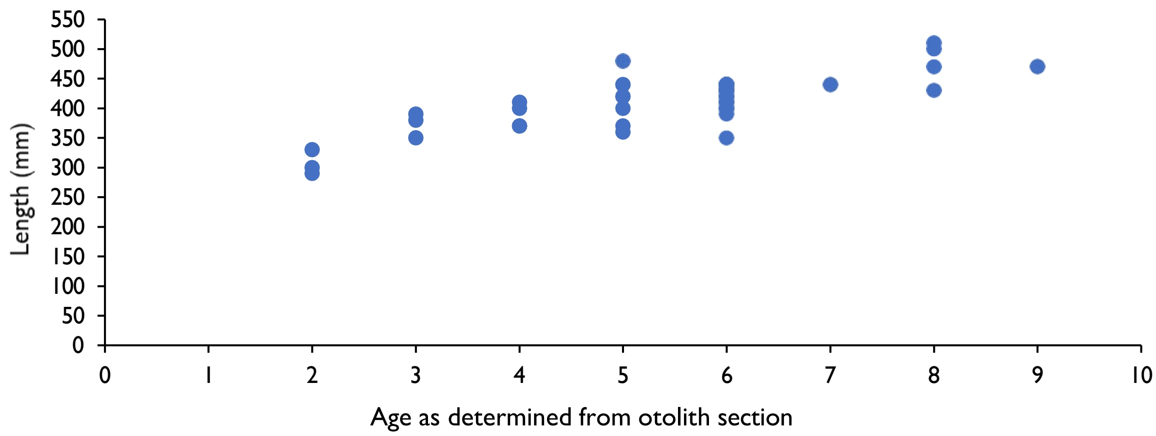
- Consultation with anglers to establish what they want from the fishery in terms of catch rate and fish size.
- Promote the findings of this report so that anglers understand the potential benefits of population control.
- Establish a management plan for Arthurs Lake that provides a guide and protocols for the operation of the spawning traps at Tumbledown, Scotch Bobs and Hydro creeks.
- Use the existing traps to continue to monitor the change in average size of spawning brown trout at Arthurs Lake.
- Consider a method to control the number of spawning brown trout at other creeks that flow into Arthurs Lake e.g., Jones Creek. A serviceable trap may not be practical due to access restriction.
- Conduct a follow up electrofishing survey during December 2023.
- The next FPA needs to be at a specific time and method for comparable results. This would be a box trap survey during April.

Appendices

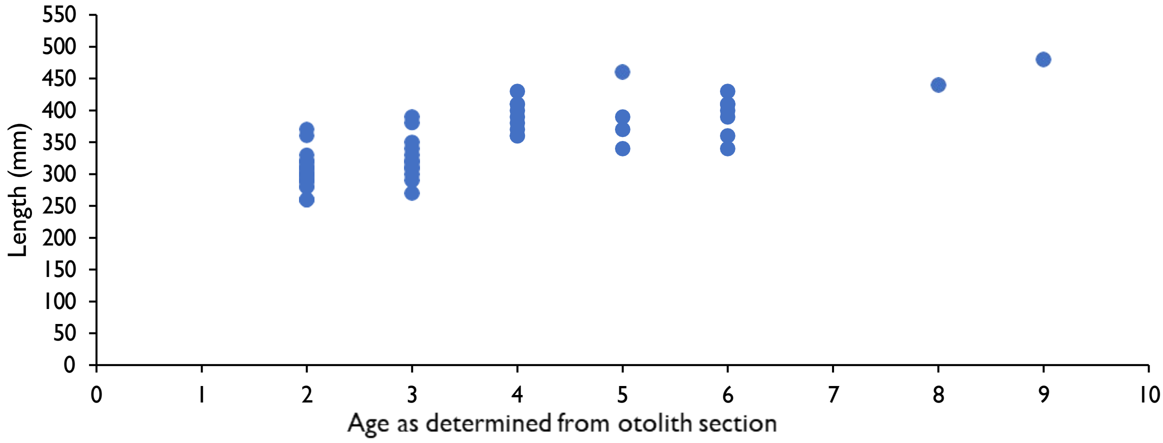
A) Length at age keys split by sex



i) Length at age key for indeterminate fish captured December 2022.



ii) Length at age key for male fish captured December 2022.

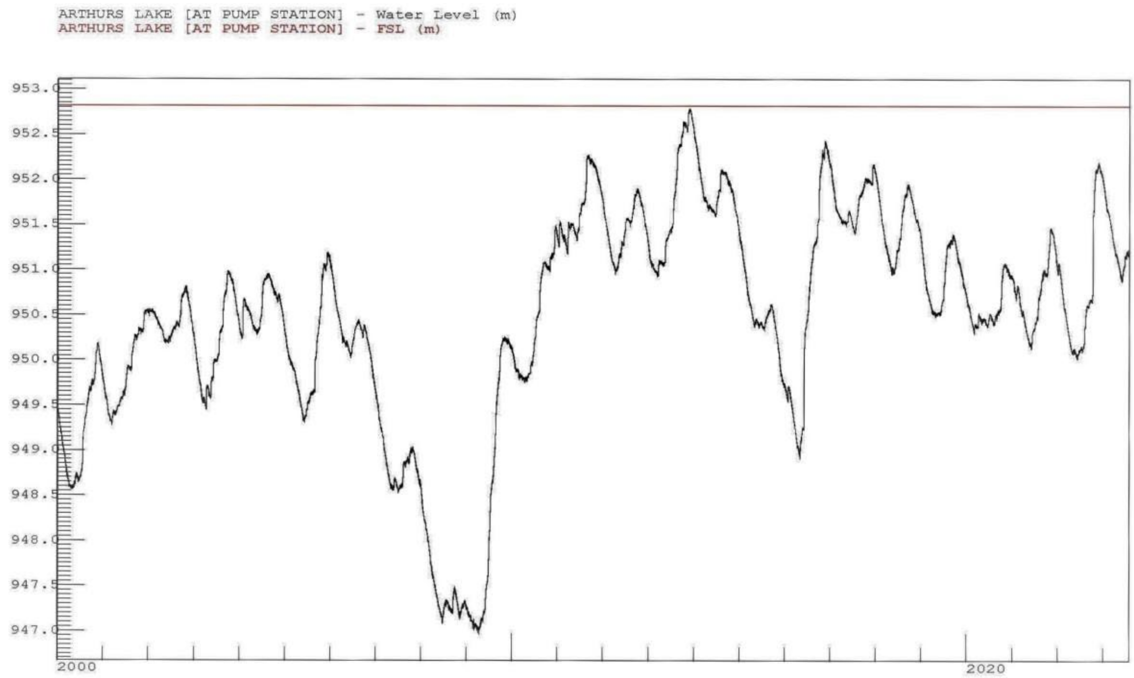


iii) Length at age key for female fish captured December 2022.

B) Example of otolith section

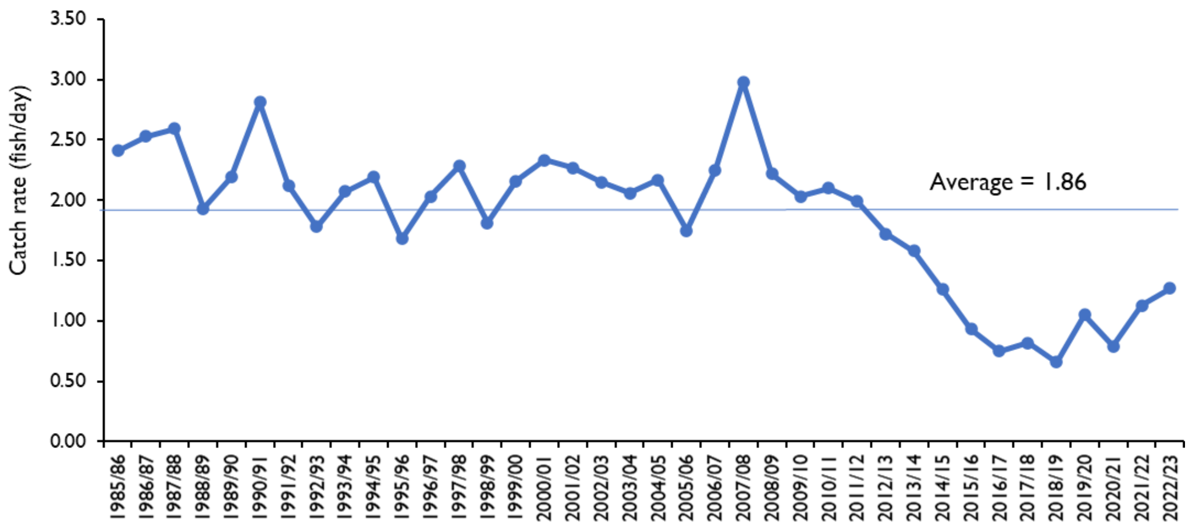
i.) the otolith section of the oldest fish in the sample at 9+ years.

C) Arthurs Lake – lake level plot 2000 – 2023

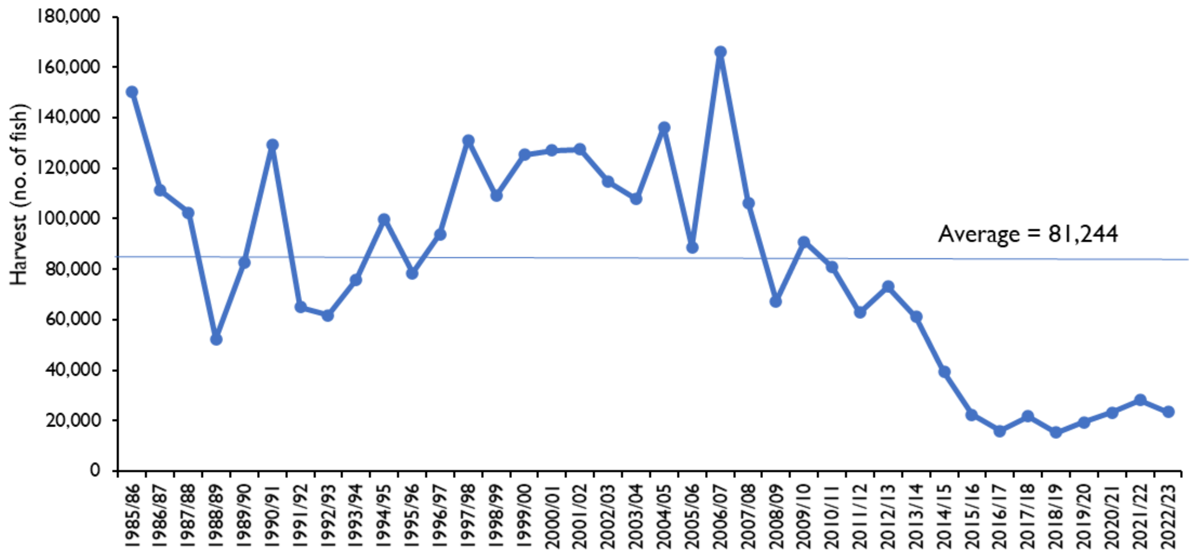


i.) Changes in Arthurs Lake water level (AHD) from 2000 to 2023. Supplied by Hydro Tasmania

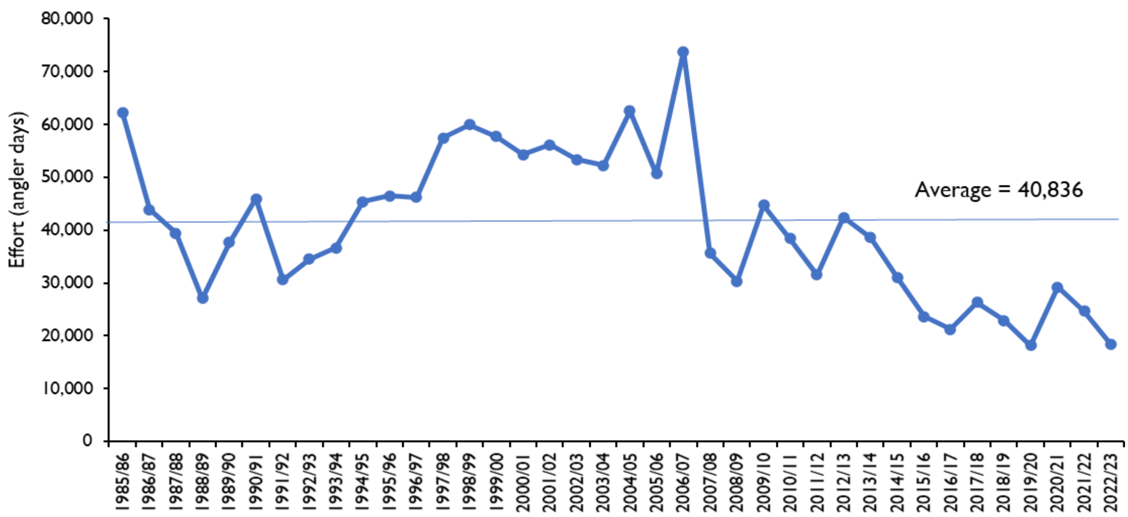
D) Angler Postal Survey results for i.) daily catch rate, ii.) harvest, iii.) angling effort and iv.) angler numbers, and for each season, 1985-86 to 2022-23 season at Arthurs Lake



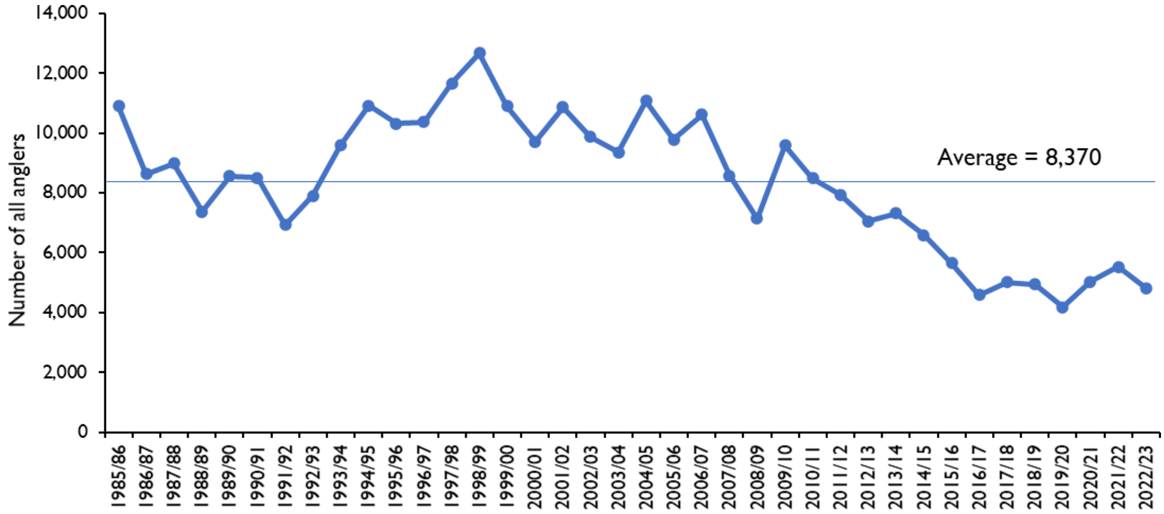
i.) Estimated catch rate (fish per day) at Arthurs Lake from 1985-86 to 2022-23 season



ii.) Estimated harvest (number of fish caught) at Arthurs Lake from 1985-86 to 2022-23 season



iii.) Estimated fishing effort (angler days) at Arthurs Lake from 1985-86 to 2022-23 season



iv.) Estimated number of anglers fishing at Arthurs Lake from 1985-86 to 2022-23 season

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