Backwater Analysis

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Known Survival

Known survival analysis uses PIT scanning data to track the number of PIT tagged fish alive in the backwater on any given date. For a fish to be included in the total, it must have been tagged and release prior to the date (x-axis), and it must have been scanned at least once 120 days after it's release date. This avoids including fish that were scanned within a few days of tagging, but died before contributing significantly to the population. For example, a fish tagged and released on January 1, 2019 will be included in the known population total for every day after January 1, 2019 as long as it was scanned once after May 1, 2019. If it was never scanned again after May 5, 2019, then it will be a part of the known population from January 1, 2019 through May 5, 2019, and removed from the population for all subsequent dates.

Figure 1 provides known survival numbers over time for the initial stocking into Yuma Cove backwater on 2013-02-11. The initial stocking was 100 females and 100 males, but only 104 (80 females and 24 males) survived to 120 days post-stocking based on PIT scanning data. The stair step pattern of this graph indicates a dramatic decline in survival over summer months in many years for both sexes. Based on PIT scanning after the most recent spawning season, the known survivors from the initial stocking include 13 females and 4 males. This represents a mean annual survival of 83.4% over 10 years.

Figure 2 provides known survival numbers over time for all PIT tagged fish stocked or captured and tagged into Yuma Cove backwater by sex. New fish are added to the figure once they have been scanned 120 days post-release (stocked or captured). Increases in the known population are therefore due to survival of tagged, naturally recruited fish or fish from supplemental stockings.

Figure 3 provides a clearer picture of the overall known PIT tagged population size over time by combining all sexes.

Table 1 breaks down the current, PIT tagged, known population of 168 fish in Yuma Cove backwater by event in which each fish was initially tagged and the sex it was assigned. Mean TL is the mean total length recorded of all known survivors at tagging.
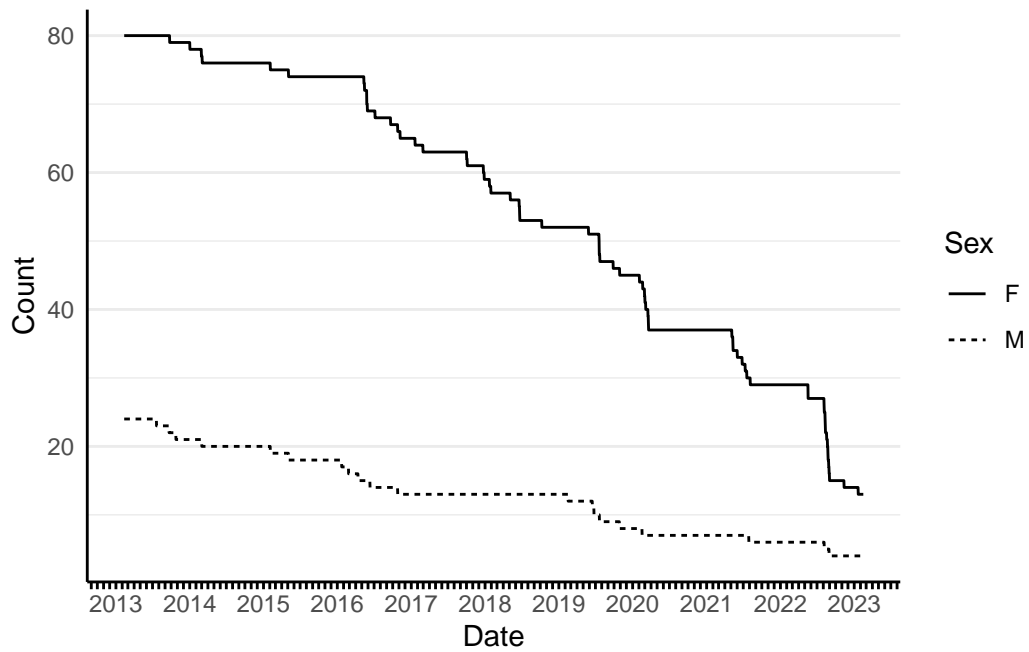
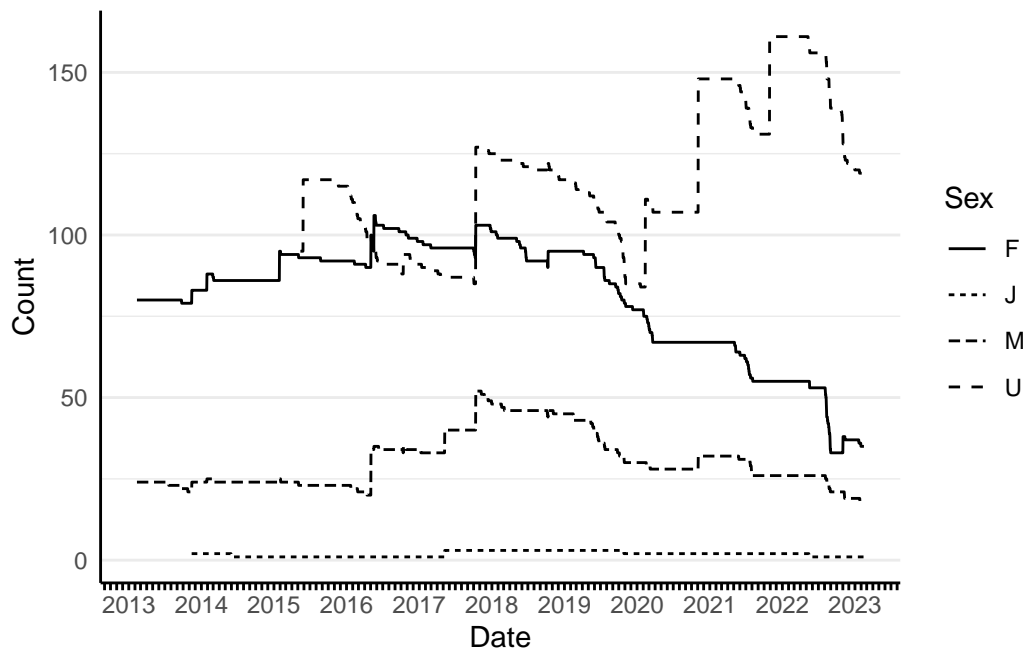Figure 1: Initial stocking survivors over time by sex.

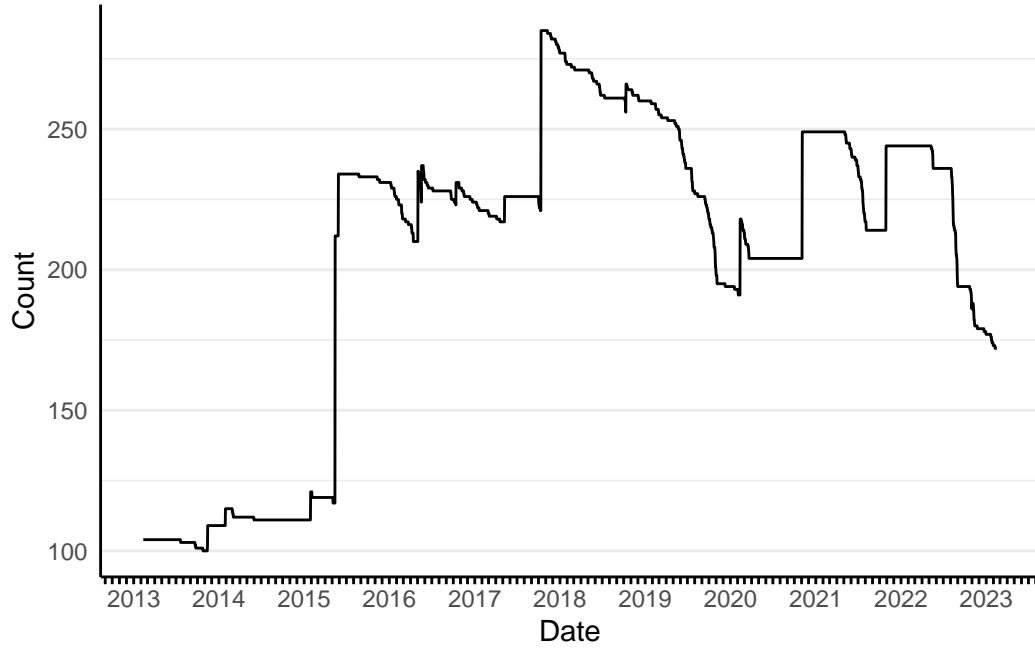Figure 2: Known PIT tagged population over time by sex.

Figure 3: Known PIT tagged population over time.

Table 1: Known PIT tagged population tagging history.

Event	Year	Month	TL (mm)	M	F	U	J
Stocking	2013	February	408	4	0	0	0
Stocking	2013	February	440	0	13	0	0
Stocking	2014	January	360	0	2	0	0
Stocking	2015	January	435	0	1	0	0
Stocking	2020	February	363	0	0	12	0
Capture	2015	May	428	0	0	38	0
Capture	2016	May	480	0	0	1	0
Capture	2016	May	430	4	0	0	0
Capture	2016	May	452	0	9	0	0
Capture	2016	October	475	0	0	1	0
Capture	2016	October	443	1	0	0	0
Capture	2017	May	472	5	0	0	0
Capture	2017	May	272	0	0	0	1
Capture	2017	October	361	0	0	18	0
Capture	2017	October	415	2	0	0	0
Capture	2017	October	518	0	3	0	0
Capture	2018	October	525	0	2	0	0

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Capture	2020	November	478	0	0	24	0
Capture	2020	November	488	2	0	0	0
Capture	2021	October	489	0	0	19	0
Capture	2022	November	143	0	0	1	0
Capture	2022	November	545	0	5	0	0

Backwater Captures and Recaptures

Capture and tagging events in Yuma Cove backwater have resulted in the capture and tagging of 2371 fish. Most fish captured are small and do not survive long enough to contribute to the overall spawning population. To separate the small fish unlikely to contribute to the adult spawning population from the larger subadult to adult fish, all captured fish are broken down into three size classes based on the TL at capture; 1 <350, 2 >=350 and <500, 3 >=500 mm TL.

Table 2 breaks down the size class of tagged fish during capture events in Yuma Cove backwater.

Table 2: Capture summary by size class.

Year	Month	1	2	3
2013	November	48	33	56
2014	January	3	4	6
2014	May	0	15	59
2015	May	0	152	14
2016	May	0	83	17
2016	October	113	23	4
2017	May	3	14	2
2017	October	40	56	35
2018	October	484	24	14
2019	November	10	45	34
2020	November	230	66	46
2021	October	245	30	35
2022	November	284	17	27

Size Class 3 fish are assumed to all be adults, whereas size class 2 fish are likely a mix of subadult and adult fish at the time of capture. Both of these size classes together makeup the entirety of the "spawning population". Although some size class 2 fish are not mature at handling, they have a similar survival profile to size class 3, and are likely to mature a year or two following their capture. The proportion of the spawning adult fish (size class 2+) that are recaptures (captured with a tag) are an indication of the proportion of the total spawning

population that is tagged within the backwater. This proportion can be calculated from all capture events summarized in Table 3.

Table 3: Recapture status for size class 2+.

Year	Month	N	Y	Proportion
2013	November	10	79	0.888
2014	January	1	9	0.900
2014	May	0	74	1.000
2015	May	124	42	0.253
2016	May	56	44	0.440
2016	October	13	14	0.519
2017	May	7	9	0.562
2017	October	55	36	0.396
2018	October	15	23	0.605
2019	November	42	37	0.468
2020	November	56	56	0.500
2021	October	25	40	0.615
2022	November	19	25	0.568

Spawning Adult Population Size

The total population available to spawn is estimated from the recapture proportion for all years when there is a autumn or early winter (after September) capture event. The known population size (Figure 4) for each year as of December 1st is divided by the autumn recapture proportion for the same year. The recapture numbers and total captures that are used to calculate recapture proportion are adjusted for fish that avoid detection or that are harvested during the capture event by removing any fish captured but never scanned after the capture event. Population estimates were made for all years with a autumn sample with more than 10 total captures after adjustment. The 95% confidence intervals are derived from the binomial distribution based on the autumn capture values (trials = total captures, successes = recaptures).

Estimating Biomass

Total length (TL) and mass (g) have been recorded for 1911 fish in Yuma Cove backwater. The length-weight relationship has been well established at this point and can be used to estimate the mass of fish that only have TL recorded. One potential consequence of overcrowding in a backwater and subsequent resource limitation is that the length-weight relationship might change over time. However, this does not appear to be the case in Yuma Cove backwater as the
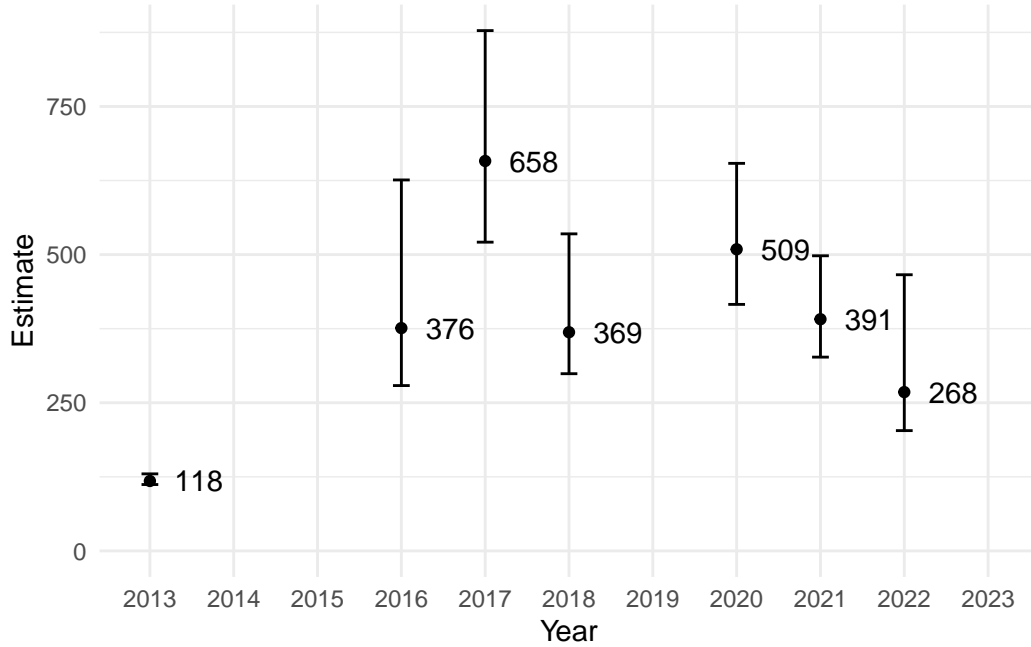
Figure 4: Adult population estimates based on recapture proportion and PIT scanning.

length-weight relationship is consistent regardless of year (Figure 5); most recent measurements in red.

Using the best fit relationship between length and weight, the estimated biomass of the most recent autumn sampling event was estimated in kg. Harvest and mortality have reduced the available biomass post-sampling event, and so the availability of these fish was determined based on recent PIT scanning (contacted at least once in the current year). This surviving spawning biomass is less than half the biomass from the sampling event (Table 4).

Table 4: Biomass estimate from recent autumn sample and surviving biomass from that sample based on PIT scanning.

SizeClass	Mean TL (mm)	Biomass (kg)	Count	Alive	Alive Biomass (kg)
1	137	8.342	284	1	0.030
2	452	16.329	17	0	0.000
3	532	41.407	27	15	24.059

This biomass estimate isn't the total population biomass. The known population in the backwater is 168 fish, and the estimated total population is 268. Most of the known population has been at large for more than 3 years, (105 out of 168 fish, Table 1). It is likely that most if not all of those fish are Size Class 3 adults, and the total spawning biomass would likely be three
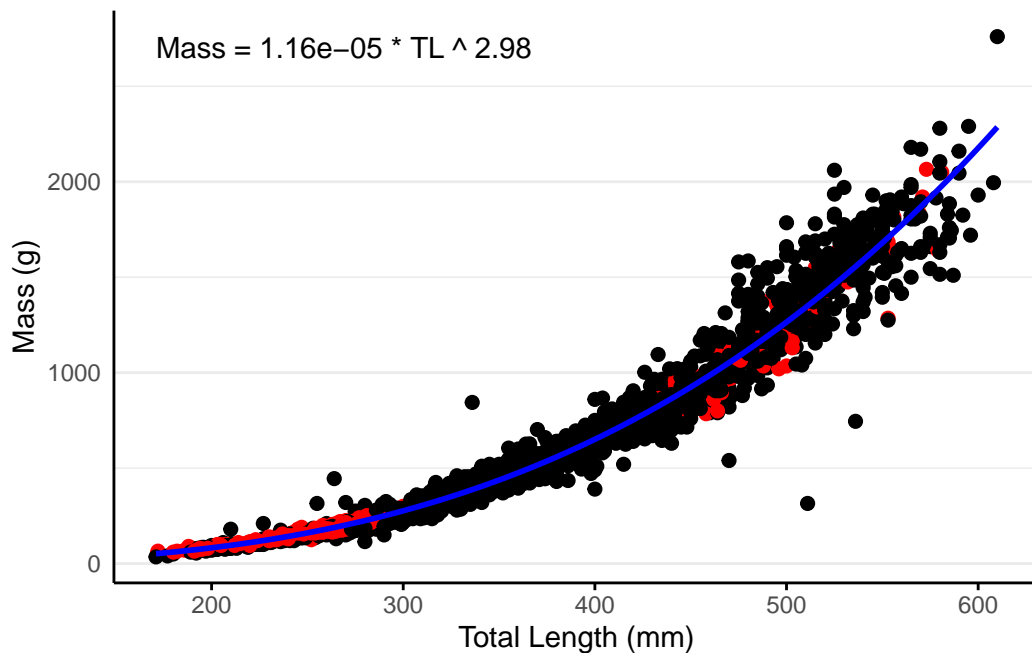
Figure 5: Length-weight relationship based on all capture and release records.

or four times the estimated biomass of the autumn sample. The autumn sample and harvest appears to have reduced the total biomass significantly, but the impact of such a reduction will not be known until the autumn 2023 sample. Survival of size class 1 fish does not seem to have increased significantly after the harvest as only 1 of the 284 size class 1 fish captured and tagged during that autumn harvest-survey has been contacted (PIT scanned) 120 days post-release. Until there is evidence of recruitment in the backwater, harvesting fish out of Yuma Cove backwater does not seem necessary.