Patagonia Lake
Fisheries Management Plan
2019-2029

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Approved [X] by Chris Cantrell D. Andrew Clark acting for Date: 9/25/2020
Aquatic Wildlife Branch Chief

Location

Patagonia Lake is located in south central Arizona in game management unit 34A, approximately 10 miles northeast of Nogales in Santa Cruz County. The lake is reached from State Route 82 and west on Lake Patagonia Road (Figure 1).

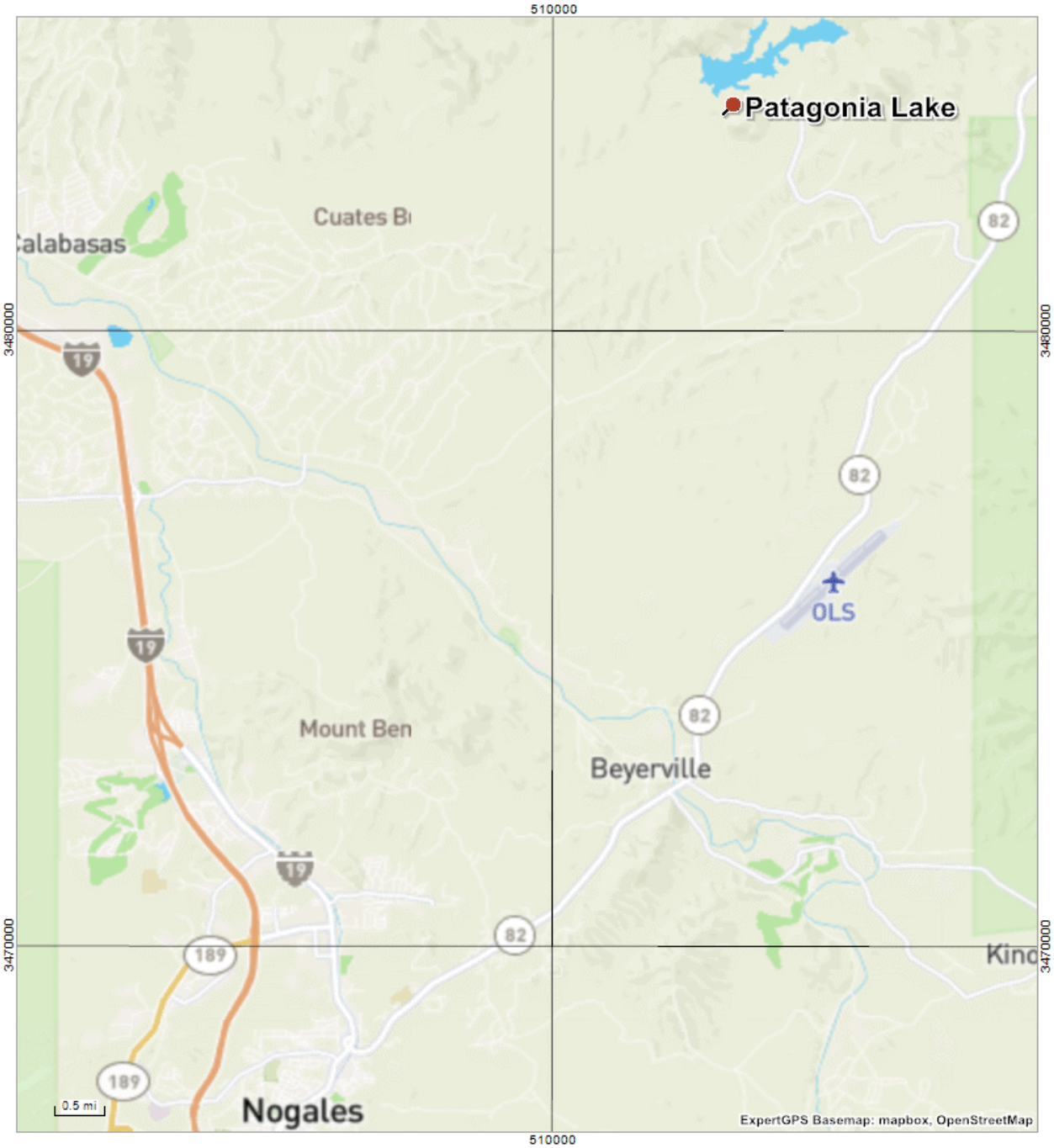

Figure 1. Location map for Patagonia Lake.

Management Prescription

The Arizona Game and Fish Department (Department) has developed approaches for coldwater and warmwater species management in Arizona under a Coldwater Strategic Vision Document (AGFD 2019a) and Warmwater Strategic Vision Document (AGFD 2019b). Using these documents, fisheries management at Patagonia Lake will focus primarily on a High Quality approach for Largemouth Bass *Micropterus salmoides*, Channel Catfish *Ictalurus punctatus* and Flathead Catfish *Pylodictis olivaris* fishery and a General Opportunity approach for Bluegill Sunfish *Lepomis macrochirus* and Redear Sunfish *Lepomis microlophus*. High Quality waters are defined as having conditions for producing Largemouth Bass that reach lengths generally considered of quality size by anglers. During the months of November – March, the lake will be stocked with catchable size Rainbow Trout *Oncorhynchus mykiss* under the Intensive Use strategic approach defined in Coldwater Sportfisheries Strategic Vision Document.

Management objectives and adaptive management strategies have been set under the High Quality, General Opportunity and Intensive Use approaches. Monitoring activities, including community-wide or species-specific fish surveys and angler creel surveys will be used to determine if management objectives are being met. Guidelines to meet objectives are listed in Table 1 below.

Objective 1: Manage the Largemouth Bass population to support High Quality concept standards.

Objective 2: Manage the catfish populations to support High Quality concept standards.

Objective 3: Manage the sunfish populations to support General Opportunity standards.

Objective 4: Maintain a Rainbow Trout stocking program to meet or exceed Intensive Use standards.

Table 1. Patagonia Lake Objectives and Adaptive Management Strategies.

Parameters	**Objective Guideline**	**Trigger point to address unmet objectives**	**Strategies if Objectives are not met**
Objective 1: Manage the Largemouth Bass population to meet or exceed High Quality concept standards.			
Electrofishing Catch Rates	Total spring electrofishing catch per unit effort (CPUE): ≥ 100 Largemouth Bass/Hour	Three consecutive sampling events with a CPUE ≤ 100 Largemouth Bass/hour	● Change daily bag limit and size restriction ● Stocking ● Regulation Change
Mean Relative Weight (Wr)	Mean fall Wr between 90 - 105	Mean fall Wr ≤ 90 for three consecutive sampling events	● Reduce Largemouth Bass in appropriate size classes ● Stock prey

Parameters	Objective Guideline	Trigger point to address unmet objectives	Strategies if Objectives are not met
Proportional Size Distribution (PSD)	PSD = 40 – 70 PSD - P = 10 – 40	Three consecutive sampling events showing population below management guideline	● Reduce Largemouth Bass in appropriate size classes ● Stock prey ● Regulation Change
Angler Catch Rates	CPUE ≥ 0.50 for anglers targeting Largemouth Bass	Largemouth Bass CPUE ≤ 0.50 for two consecutive creel surveys	● Change daily bag limit and size restriction ● Angler education ● Habitat alterations
Objective 2: Manage Flathead and Channel Catfish populations to meet or exceed High Quality concept standards.			
Flathead Catfish Electrofishing CPUE	Mean fall electrofishing CPUE ≥ 15 Flathead Catfish/hour.	Mean CPUE ≤15 Flathead Catfish per hour for three consecutive surveys	● Regulation Changes
Channel Catfish Hoop Net CPUE	Mean summer hoop net CPUE ≥ 1 Channel Catfish/net night	Mean summer hoop net CPUE ≤ 1 Channel Catfish/net night for three consecutive surveys	● Stocking ● Regulation Changes
Angler Catch Rates	CPUE ≥ 0.50 for anglers targeting catfish	CPUE ≤ 0.50 for anglers targeting catfish	● Stocking ● Regulation Changes
Objective 3: Manage the sunfish populations to support General Opportunity standards.			
Size Structure	Multiple age classes present.	Three consecutive sampling events showing population below management guideline	● Stocking ● Regulation Changes
Electrofishing Catch Rates	Total spring electrofishing catch per unit effort (CPUE): ≥ 50 sunfish/hour	Three consecutive sampling events showing population below management guideline	● Stocking ● Regulation Changes

Parameters	Objective Guideline	Trigger point to address unmet objectives	Strategies if Objectives are not met
Angler Catch Rates	CPUE ≥ 0.50 for anglers targeting sunfish.	CPUE ≤ 0.50 for anglers targeting sunfish.	• Stocking • Regulation Changes
Objective 4: Maintain a winter Rainbow Trout stocking program to support Intensive Use approach standards.			
Angler Catch Rates	No less than 0.50 fish per hour.	Angler catch rates drop below 0.50 fish per hour for two consecutive creel surveys.	• Stock larger trout • Regulation changes • Outreach/education

Background

Patagonia Lake is a 265 surface acre man-made lake with a storage right and water right for 11,420 acre-feet for recreation and wildlife uses. Patagonia Lake and the associated recreation facilities were constructed in the late 1960's by a group of citizens incorporated as the Lake Patagonia Recreation Association, Inc. The lake and its facilities became Arizona State Parks (ASP) property in the mid 1970's. Since this time the lake has been managed cooperatively between ASP and the Department. The lake's main water source is rain run-off from Sonoita Creek, and Ash Canyon. Adding to the lake source is an associated increase in the amount treated effluent flowing down Sonoita Creek from the town of Patagonia. This inflow is present during most of the year except during the summer months when it dries up before reaching the lake.

Patagonia Lake is located directly in the channel of Sonoita Creek and the watershed encompasses approximately 146,000 acres. Elevations within the watershed range up to 10,000 feet in the Santa Rita Mountains in the northern part of the watershed down to 3,700 feet at the lake. Vegetation in the watershed ranges from pine forests in the higher elevations to oak woodlands and grasslands in mid elevations to mesquite scrub around the lake itself.

Water Quality & Productivity

Patagonia Lake has never demonstrated problems with its water quality. Normal temperature fluctuations occur seasonally with high temperatures in the mid 80's °F and lower temperatures in the low 50's °F. Annual monitoring of pH shows the lake remains fairly consistent at or near 7.0 to 7.5 but can go higher to over 8.0 during the summer months when little fresh water is flowing into the lake. The specific conductivity typically ranges from 500 to 700 µmhos and again is dependent on precipitation amounts and the amount of fresh water flowing into the lake.

Historically there was some work done on the impacts to zooplankton following the introduction of Threadfin Shad *Dorosoma petenense* in 1979. Ziebell (1986) found that Threadfin Shad populations increased markedly after their introduction in 1979 and apparently caused zooplankton populations to decrease by over 99%. In 1979 at the time of the introduction of Threadfin Shad,

zooplankton studies found 116,860 zooplankton per m^3. In 1981 following a large spawn by the Threadfin Shad that number had dropped to 0 zooplankton per m^3 and remained at or near zero through 1984 (Cashman 1988). Since these studies were completed the Threadfin Shad population has only increased and it is likely that they continue to have negative impacts on the zooplankton population today but the impacts to the fish population are unknown at this time.

It is recommended that a complete study of the zooplankton population at Patagonia Lake be completed to update knowledge and understanding of conditions at the lake.

Forage/Prey

Patagonia has a large and diverse prey base that supports a large and diverse fish population. The prey base at Patagonia Lake consists of three sunfish species (Bluegill, Redear, and Green Sunfish *Lepomis cyanellus*), Threadfin Shad, American Bullfrogs and crayfish.

Monitoring of the sunfish populations as a constituent of the prey base occurs as part of the twice annual electrofishing surveys conducted at Patagonia Lake. These populations are evaluated on their body condition through all size classes and overall length frequencies.

Threadfin Shad are not very cold temperature tolerant and historically Threadfin Shad populations fluctuated in the lake with the rise and fall in water temperature. In recent years however, changes in climate have resulted in water temperatures not falling and remaining at temperatures (low 40's) that are known to be lethal to Threadfin Shad. Incidental observations conducted while electrofishing suggest the population is strong. Beyond these observational surveys there are no other surveys conducted on the Threadfin Shad population.

Additionally, although bullfrogs and crayfish are present at the lake and undoubtedly comprise some portion of the prey base, no surveys are conducted to quantify their populations and it is thought that these species comprise a small portion of the prey base. When available, studies to address questions about forage composition and utilization by sportfish species are needed.

Habitat

In 2015, a study conducted by the Department with side scanning sonar completely mapped the shoreline habitat at the lake. This study confirmed what was already thought to be the case with habitat at the lake. Shoreline habitat consists of sand, boulders, cobble, emergent aquatic vegetation and submergent aquatic vegetation (Figures 2 and 3). This assemblage of habitat provides adequate cover for juvenile fish, ambush habitat for larger adult fish and plenty of spawning habitats to support the current fish assemblage.

Historically Patagonia Lake has not had a problem with submerged aquatic vegetation unlike other lakes in the region. However, in the past few years there has been a noticeable increase in submerged aquatic vegetation in several of the shallower coves, and around the boat ramp in the marina cove. This issue will be watched closely in the future and if needed management actions will be taken to reduce the spread of this vegetation. Occasionally, ASP removes cattails from the marina and other park areas to prevent them from covering entire shorelines.

Species

The species composition at Patagonia Lake consists of Bluegill Sunfish, Redear Sunfish, Green Sunfish, Black Crappie *Pomoxis nigromaculatus*, Channel Catfish, Flathead Catfish and Largemouth Bass. Although the lake is utilized by many anglers without a preference towards a particular species, Largemouth Bass and Channel Catfish are the most sought after species (Mitchell 2017).

During the winter months of November through March the lake is stocked with catchable Rainbow Trout. Nearly 15,000 trout are typically stocked at the lake annually.

Largemouth Bass:

The Largemouth Bass population at Patagonia Lake continues to be the most stable Largemouth Bass population in the region. In spring surveys the past three consecutive years 2017 – 2019, catch per unit of effort for Largemouth Bass was 106, 109 and 110 respectively (Figure 4). This is near the established parameter of ≥ 100 Largemouth Bass per hour of effort for a high quality fishery.

Anderson (1980) reported that Largemouth Bass populations that are in balance with their prey base will express proportional size distribution (PSD) values (fish ≥ 12 inches) in the range of 40 -70% and proportional size distribution – preferred (PSD-P) values (fish ≥ 15 inches) in the range of 10% - 40%. For example, Largemouth Bass ≥ 15 inches should make up 10 – 40% of a sample in a high quality fishery. The Department has adopted these parameters to identify its high quality fishery approach (AGFD 2019b). In looking at these values for Patagonia Lake over a 3 year period 2017 – 2019, values from spring surveys were plotted on a graph fitted with these parameters (Figure 5). Data show values are above the guidelines for fish ≥ 12 inches. In fact, since the year 2000 the mean percentage of fish ≥ 12 inches in spring samples has been 80%. Data show values for PSD-P size fish near the upper end or above the desired range (Figure 5). Since the year 2000 the mean percentage of fish ≥ 15 inches in spring samples has been 42%. Fish in a larger PSD size category, PSD-M (fish ≥ 20 inches) have also been present in spring samples at an average of 5% during the last 20 years.

Anderson (1980) recommended that Largemouth Bass in a balanced population should have a relative weight (Wr) that falls within a range of 95 to 105 (a Wr of 100 represents above average condition). Largemouth Bass require a prey source that is roughly 15 percent of their total length to express a relative weight around 100. Largemouth Bass with a relative weight less than 95 are feeding on prey that are less than 15 percent of the bass's total length while bass with a relative weight greater than 105 are feeding on a prey source that is greater than 15 percent of that fishes total length (Davies 1987). The Department has established a broader management parameter between 90 and 105 for relative weight of a high quality fishery. The Department has adopted standard methods for sampling fish populations (Bonar et al 2009) and it's recommended to sample in the spring season for the greatest CPUE. Spring is also when the Largemouth Bass population is in some form of the reproduction cycle (i.e. pre – spawn, post – spawn, nest guarding, nest building, etc.). These activities can add substantial variability to individual fish weight (Blackwell et al 2000) and as such relative weight data will be gathered in the fall during other management

activities or as spot – check surveys. Figure 6 shows the relative weight within established management guidelines for all three years suggesting there is adequate prey of the appropriate size in the lake to support a high quality Largemouth Bass fishery. When available, studies to address questions about age and growth of Largemouth Bass are needed.

Bluegill Sunfish:

The Bluegill Sunfish population is managed under a general opportunity approach. The catch per unit of effort parameter for Bluegill Sunfish during spring surveys should be ≥ 50 fish per hour during spring electrofishing surveys (Table 1). Figure 4 shows that Bluegill Sunfish far exceed the objective. Length frequency data shows the population is well distributed through many of the length classes, however there are very few individuals larger than 200 mm (8 inches) (Figure 7).

Redear Sunfish:

The Redear Sunfish population is managed under a general opportunity approach. The catch per unit of effort parameter for Redear Sunfish during spring surveys should be ≥ 50 fish per hour during spring electrofishing surveys (Table 1). Figure 4 shows that the catch per unit effort for Redear Sunfish is above management guidelines. Length frequency data shows the population is well distributed through many of the length classes however unlike the Bluegill Sunfish population there are much larger individuals in the population with fish reaching up to 280 mm (11 inches) (Figure 8).

Flathead Catfish:

The Patagonia Lake Flathead Catfish population is the only known recruiting population of this species in regional reservoirs. Management of this species at Patagonia Lake is for a high quality fishery (Table 1). The catch per unit of effort guideline established for Flathead Catfish is ≥ 15 fish/hour. In each of the past three surveys catch per unit effort have been above this established guideline (Figure 4). Length frequency data show the population distributed over several size classes (Figure 9).

In 2011, a study examining age and growth of Flathead Catfish in Patagonia Lake was completed by the Departments Research Branch (Mitchell 2012). Pectoral spines were used to age and back calculate growth of 83 fish ranging in size from 210 – 850 mm (8 – 33 inches). Fish ranged in age from 2 – 15 years and mean annual growth rapidly declined beginning at age five (Figures 10, 11). The cause of this is unknown and diet analysis will be completed when possible.

Through the years 1999 - 2004 and 2010 - 2012, T-bar anchor and passive integrated transponder (PIT) tags were injected into 471 Flathead Catfish in Patagonia Lake to estimate relative abundance, growth and observe movement of Flathead Catfish in Patagonia Lake (Mitchell 2012). Growth rate was rapid in smaller fish and declined with increasing size, validating the age and growth study results.

The locations where a majority of capture and recaptures of fish occurred were dominated by rocky shorelines and greater depth while the locations with few fish tend to be dominated by cattails and shallower in depth (Figures 12, 13). There was some movement of individuals between original

capture and their recapture with an average distance of a half mile. Movements appeared random and are not correlated with seasonal changes.

Data from the 2010 - 2011 survey period was used in the population estimate because these years provided the best quality data for the calculations. During this period 309 flatheads were captured and tagged with only four fish being recaptured for a 1.2% recapture rate. Using the Chapman modified Peterson estimate model, the estimated population with 95% confidence intervals was 1,013 fish ± 720 fish.

Flathead Catfish with PIT tags are still caught today in our surveys and occasionally by anglers. The fish caught during surveys are still scanned and tag info recorded and analyzed for trends in growth and movement.

Channel Catfish:

To better manage the Channel Catfish population as a high quality fishery management guidelines have been established (Table 1). Historically the Department has not focused survey effort on Channel Catfish at Patagonia Lake however given the popularity of the species and newly established management guidelines, future efforts will be made to gain a better understanding of the population. At this time the appropriate data to effectively evaluate the population does not exist so no analysis will be completed at this time.

Black Crappie

Patagonia Lake has historically produced a Black Crappie population capable of trophy size fish (fish > 15 inches) with little management focused on the species. Annual electrofishing surveys do not sample the species with any consistency and other gear types (floating and sinking modified fyke nets) have not sampled enough Black Crappie to be meaningful. Lack of data regarding the Black Crappie population in Patagonia Lake will need to be addressed and more information will be gathered.

Rainbow Trout

Rainbow Trout have been continually stocked during the winter months (November thru March) to provide an Intensive Use Rainbow Trout fishery. Historically, stocking rates were based on the size of the waterbody (Patagonia Lake received approximately 55 Rainbow Trout/acre/year). Figure 14 shows the total number and pounds of Rainbow Trout stocked from 2000 – 2020. Annually the mean total number of fish stocked is 14,450 or 5,500 pounds per season. A new stocking strategy is being implemented using Angler Use Days (AUD) (Coldwater Strategic Vision Document AGFD 2019a) as the guide for stocking rates as well as stocking fewer but larger trout. An AUD is defined as one angler fishing any part of a day. Under the Intensive Use approach the lake should be stocked at a rate of 1 fish/AUD. Creel data gathered in 2016 estimated 7,648 AUD's at Patagonia Lake. Currently the mean fish length is 8 – 12 inches or roughly 2.5 trout per pound. Page Springs State Hatchery (primary fish source) is implementing actions to grow larger fish that will approach 10 – 13 inch fish or 2 trout per pound. Studies have shown that trout stocked at larger sizes return to the creel at a higher rate (Cassinelli 2018). If the angler CPUE is below

0.5 fish per hour for two consecutive creel surveys, more fish may be purchased and stocked as funding allows.

Access

There are two launch ramps at Patagonia Lake. The main ramp is located in Marina Cove near the boat rental facilities and has two ramps. This ramp is the most heavily used ramp at the lake. Some buildup of sediment occurs off the ramp and during lower water, access can be challenging. Dredging may need to be done occasionally. The second boat ramp is located in the main campground and is used heavily during the summer months by visitors staying in the campgrounds. Caution should be used if launching longer boats as this ramp is shorter and drops off rapidly.

To increase and improve shoreline access the Department installed a floating fishing pier near the marina in the mid 1990's and it has been extremely popular with anglers. The pier is currently in good working condition and is not in need of any repairs. Additionally the Department worked with ASP in 2005 to have all of the cattail removed from Marina Cove for angler access. This area is popular during the winter months because the trout are stocked in this cove but the cattails were hampering angler access. ASP has since continued to periodically cut the cattails in this cove to maintain angler access and anglers remain very appreciative of these efforts as it has provided excellent shoreline access. There currently is adequate shoreline access around this lake.

Catch

Catch rate goals established for Patagonia Lake for each species are listed within each objective in Table 1 above. Catch rates throughout the year can be variable and do fluctuate with the season. However, for the large part of the year catch rates do not meet established goals for any species with the exception of Channel Catfish during the month of September and Bluegill Sunfish in June (Figure 15) (Mitchell 2017). Survey data of the fish population shows that there are good numbers of healthy fish in the population (excluding Black Crappie, Channel Catfish and lack of data) however the reasons behind the poor catch rates are not understood at this time. Largemouth Bass catch rates peak in July at 0.27 fish/hour. Concerns are often voiced by Largemouth Bass anglers about the impacts of excessive harvest and the impacts on the population. Data show of the estimated 4,963 Largemouth Bass caught during the 2016 creel survey only 438 were harvested (8.83%) and additional harvest would increase growth rates. The other species are harvested at a much higher rate and may be concerning for both catfish species and Black Crappie (Figure 16).

Satisfaction

An angler satisfaction of 80% is the established goal for this fishery. Angler satisfaction at Patagonia Lake is currently at 51% (Figure 17). The reason for the low satisfaction rate is likely tied to the poor catch rates at the lake. Support for this is shown when angler satisfaction is looked at in regards to angler success. Figure 18 illustrates angler satisfaction scores as it relates to angler success. Not surprisingly from this it is clear that anglers satisfaction is directly tied to catching fish and that the more fish they catch the more satisfied they are.

Literature Cited

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Tables and Figures

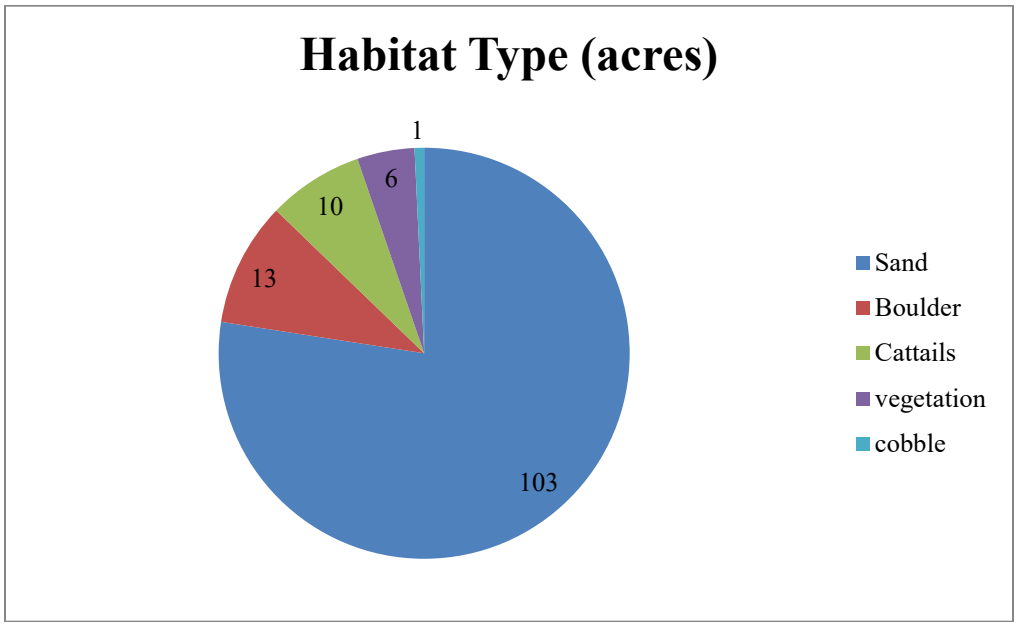

Figure 2. Habitat type in acres found in Patagonia Lake during side scan sonar survey 2015.

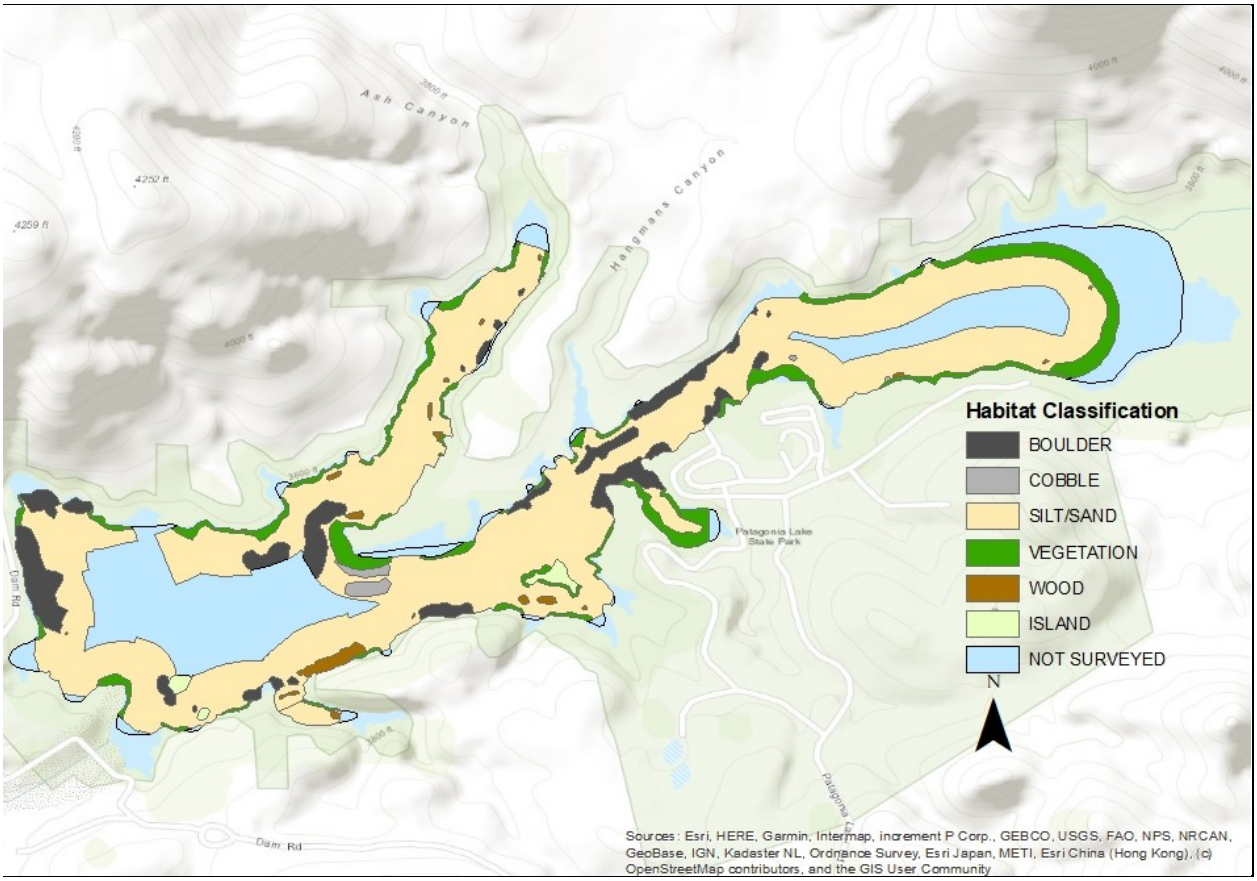

Figure 3. Map of habitat type and location found in Patagonia Lake during side scan sonar survey in 2015.

Year	Catch per unit of effort (fish per hour)				
	Largemouth Bass	Bluegill Sunfish	Redear Sunfish	Flathead Catfish[1]	Channel Catfish
2017	106	109	85	40	18
2018	109	126	111	19	14
2019	110	196	63	n/a	15

[1] Flathead Catfish sampled in the fall with electrofishing boat set to target only Flathead Catfish. Fall 2016 catch per unit effort was 38. No survey was completed in fall 2019.

Figure 4. Catch per unit effort of fish sampled by electrofishing at Patagonia Lake spring 2017 – 2019.

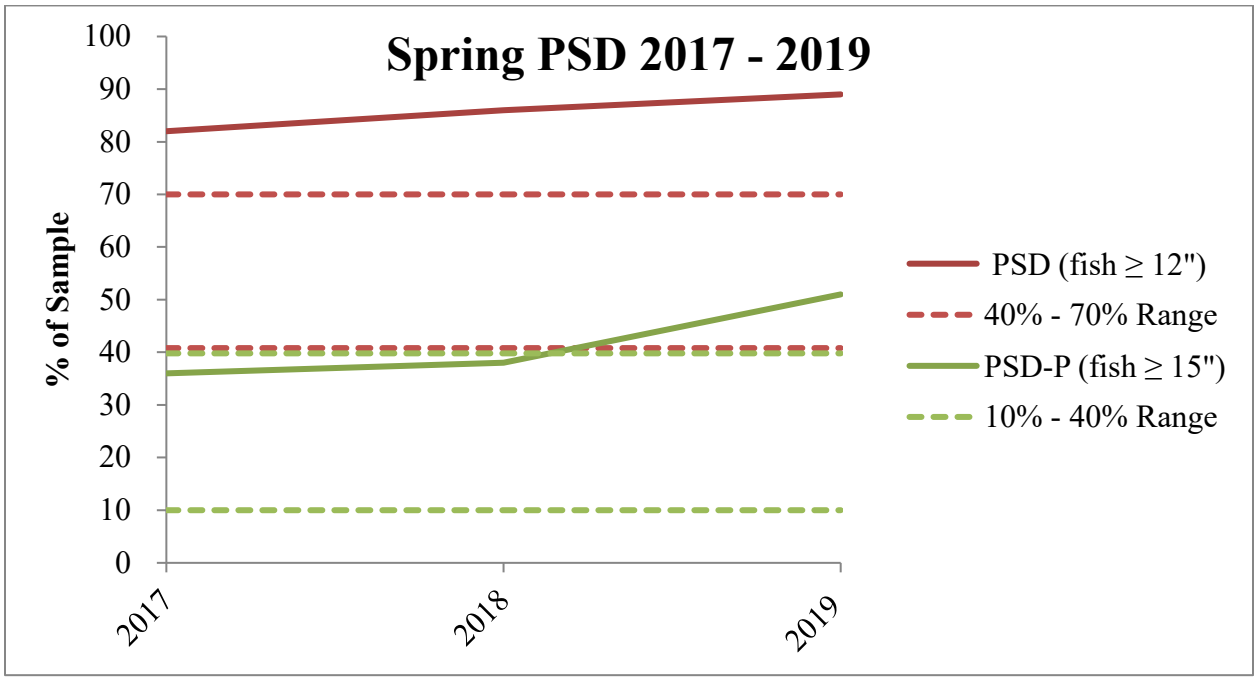

Figure 5. Proportional size distribution values of Largemouth Bass at Patagonia Lake, spring 2017 – 2019 in relation to management objectives for a high quality fishery concept.

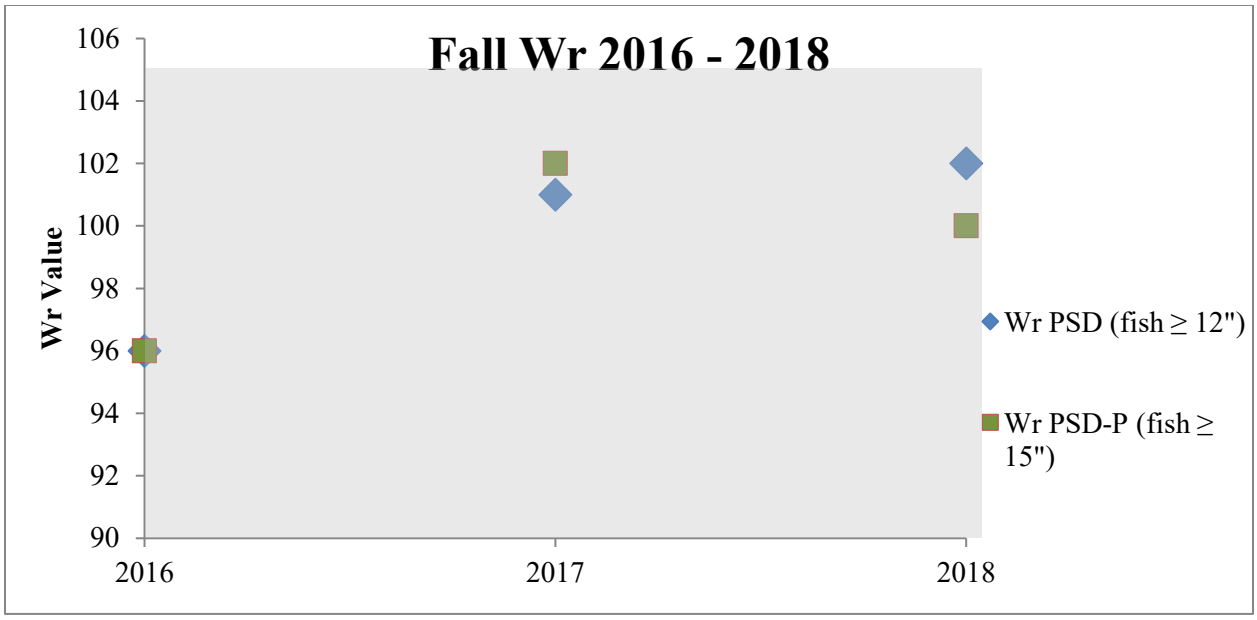

Figure 6. Relative weight of Largemouth Bass at Patagonia Lake fall 2016 – 2018. The shaded area represents the management guideline of 90 – 105.

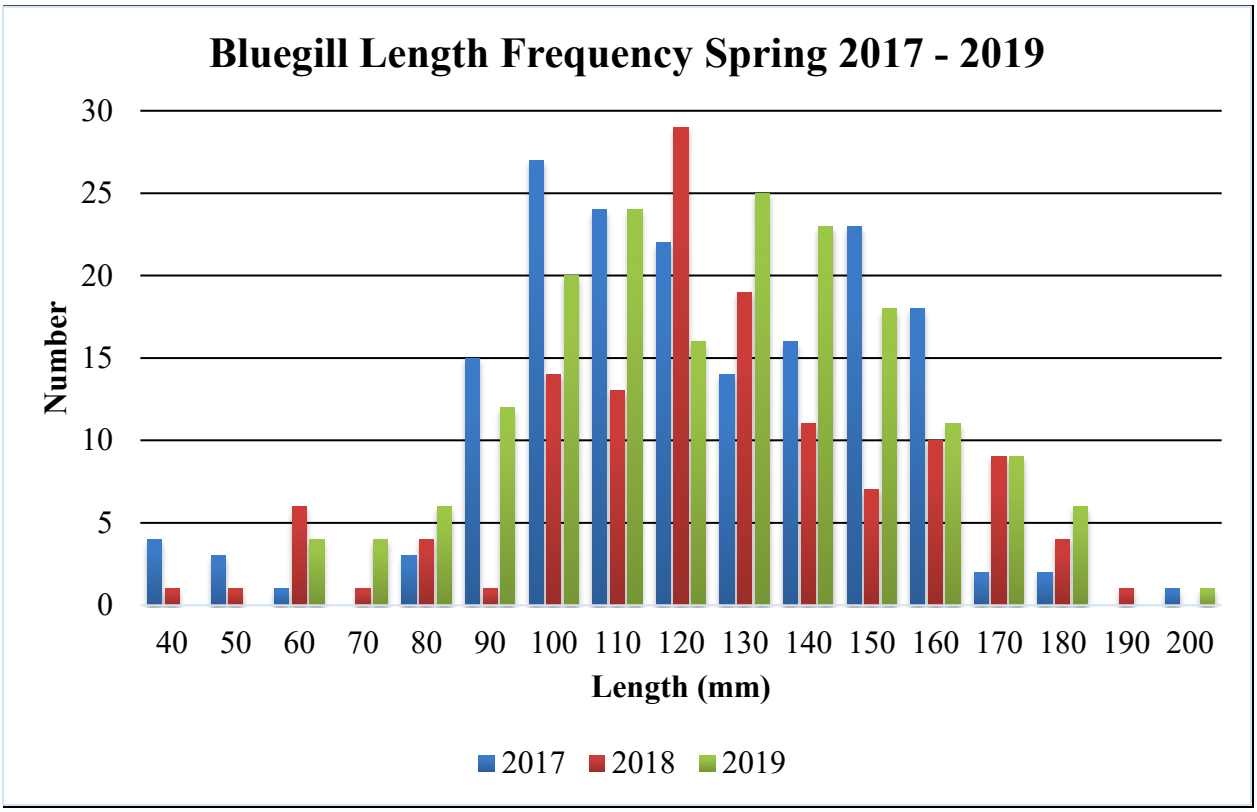

Figure 7. Length frequency values of Bluegill Sunfish at Patagonia Lake, Spring 2017 – 2019.

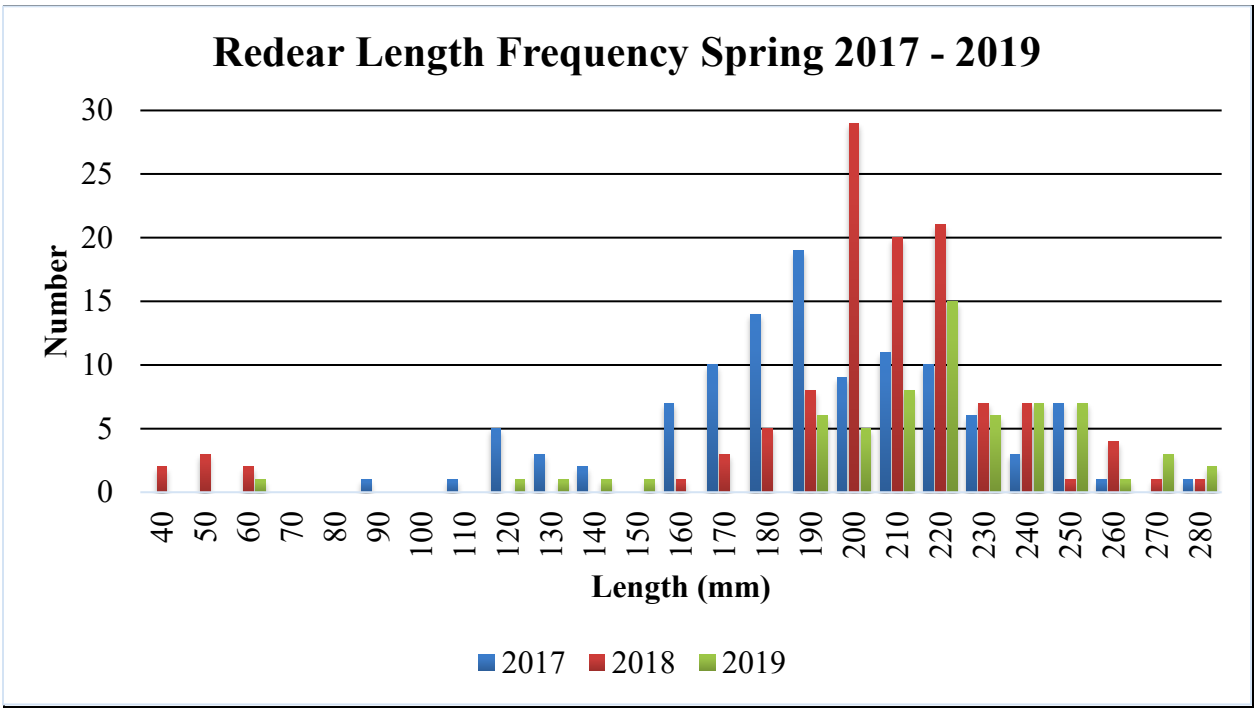

Figure 8. Length frequency values of Redear Sunfish at Patagonia Lake, Spring 2017 – 2019.

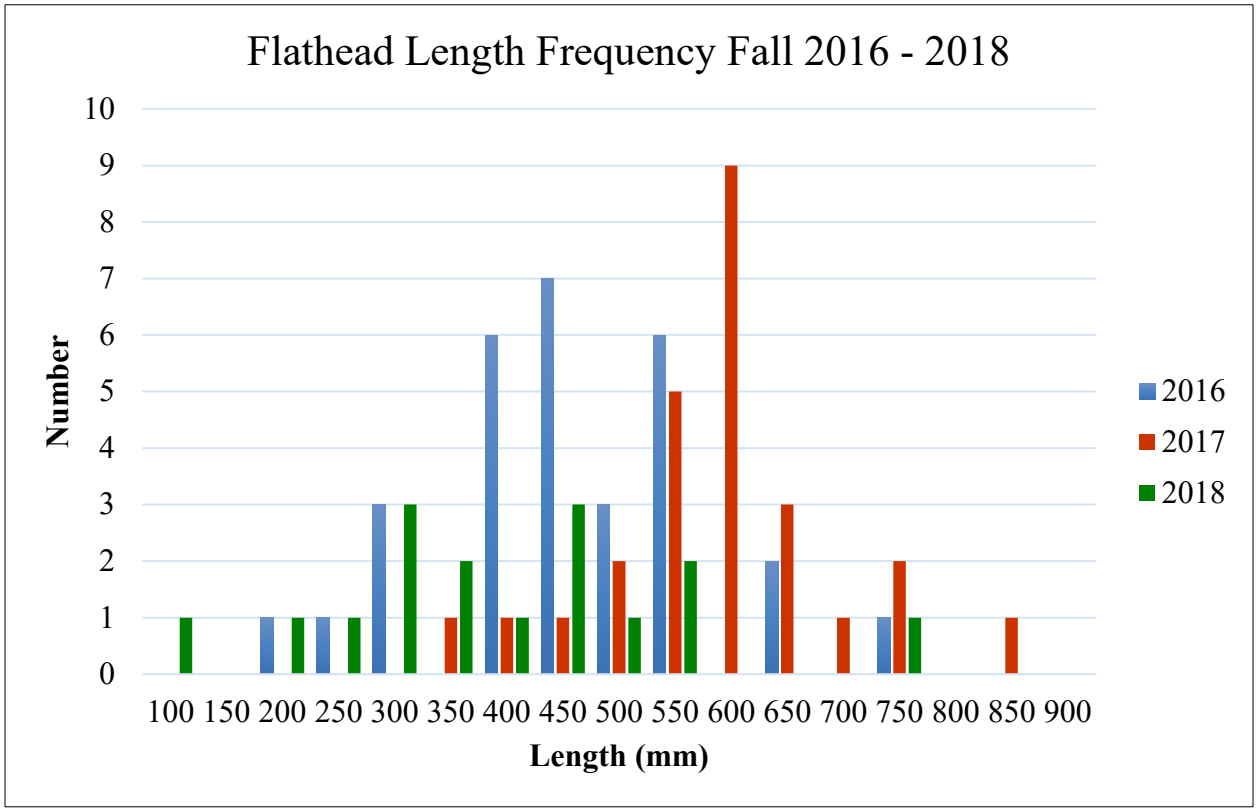

Figure 9. Length frequency values of Flathead Catfish at Patagonia Lake, fall 2016 – 2018.

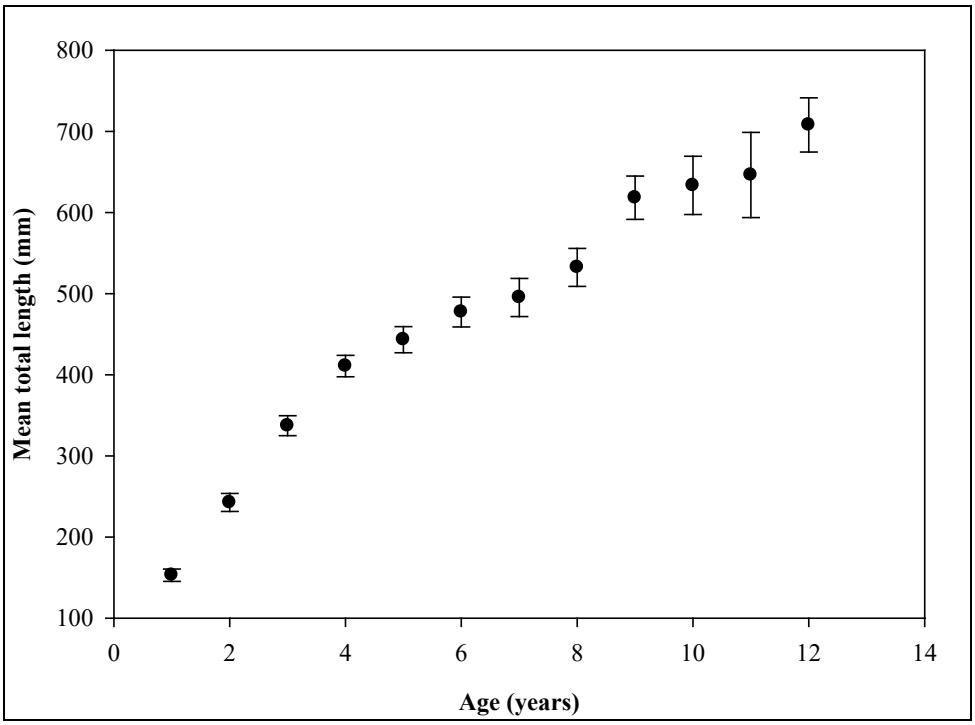

Figure 10. Mean length at age of Flathead Catfish in Patagonia Lake, 2011.

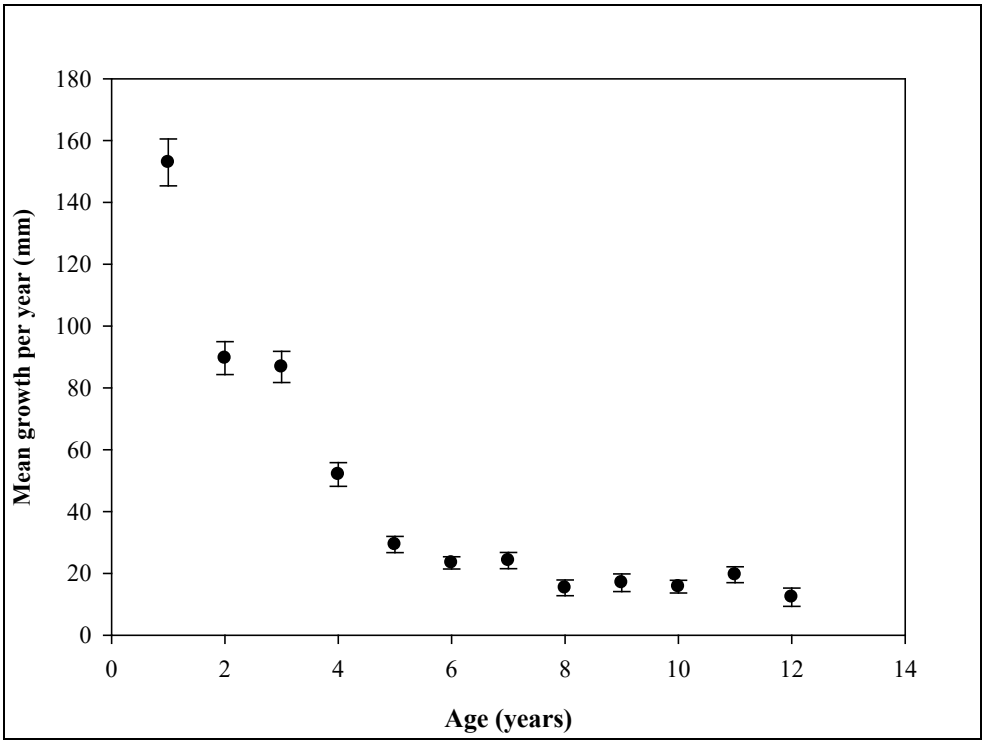

Figure 11. Mean growth per year of Flathead Catfish in Patagonia Lake, 2011.

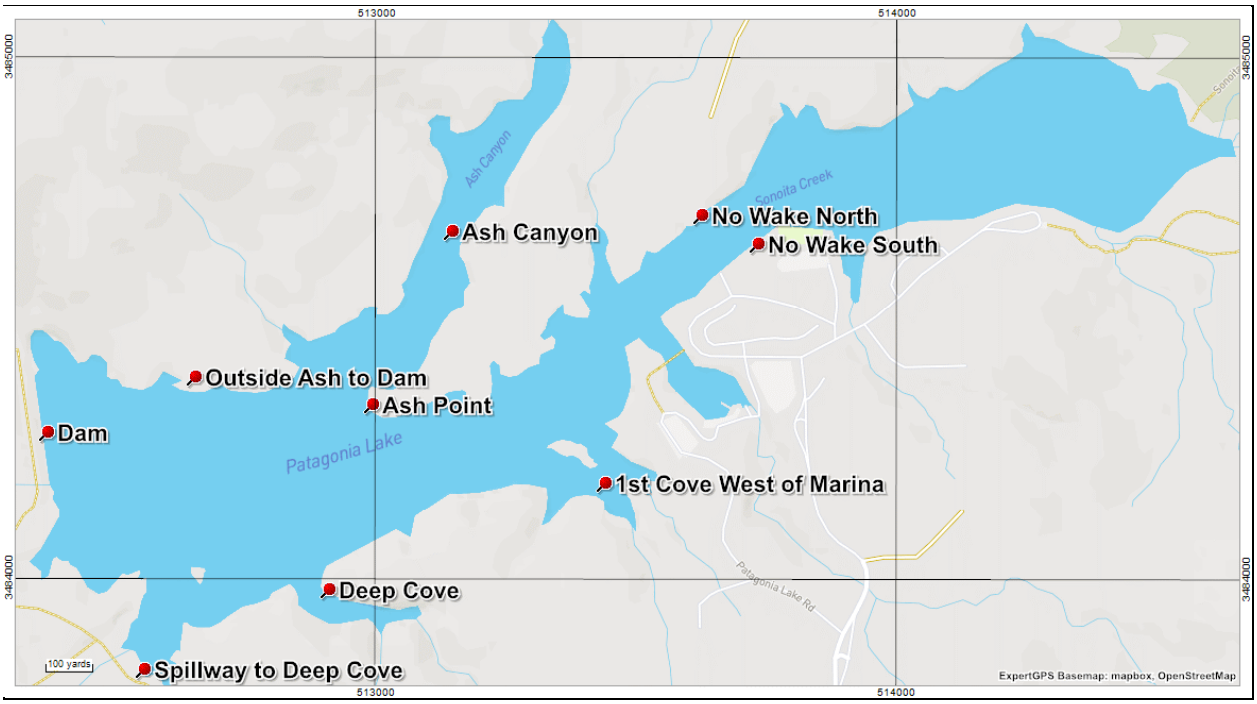

Figure 12. Capture locations of Flathead Catfish at Patagonia Lake, 2012.

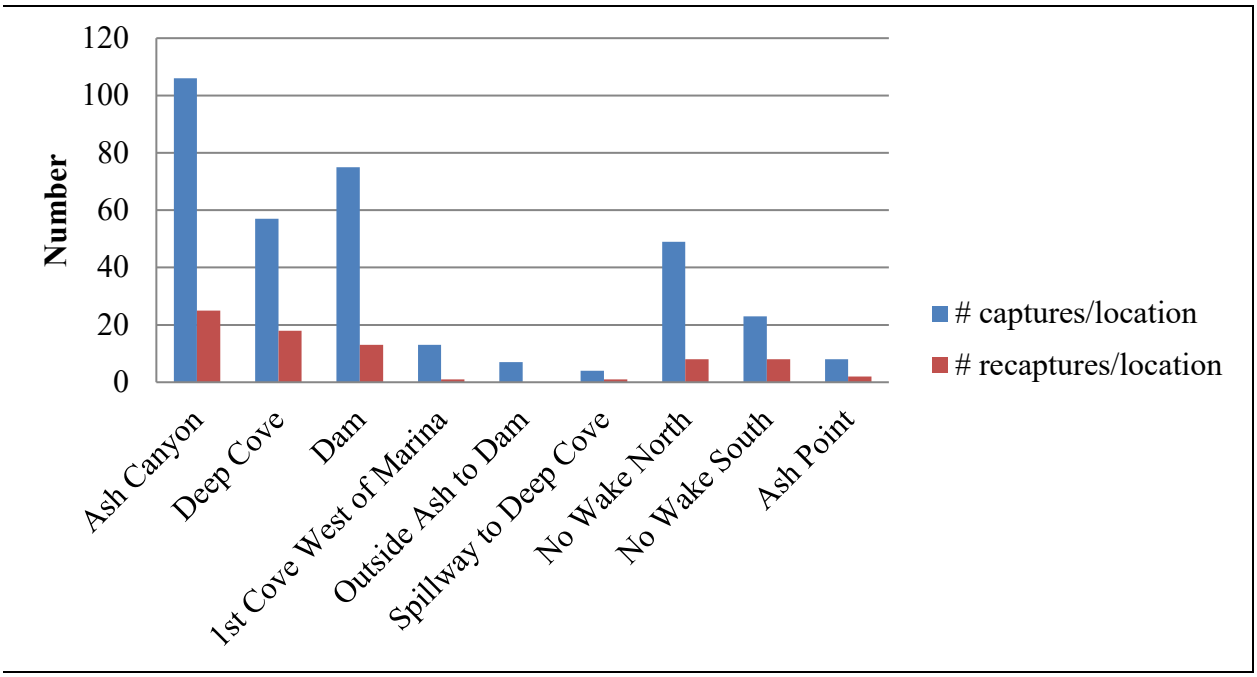

Figure 13. Total number of Flathead Catfish captures by location at Patagonia Lake, 2012.

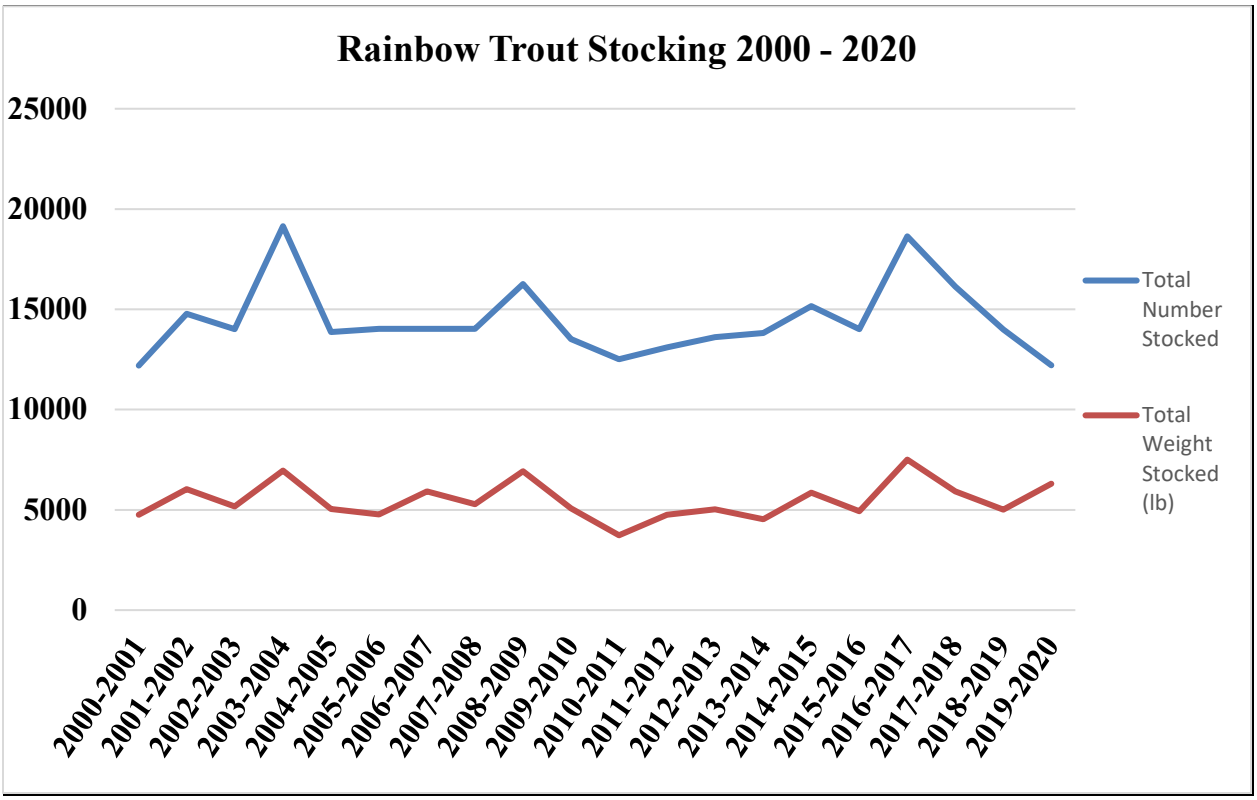

Figure 14. Total number and pounds of Rainbow Trout stocked at Patagonia Lake from 2000 - 2020.

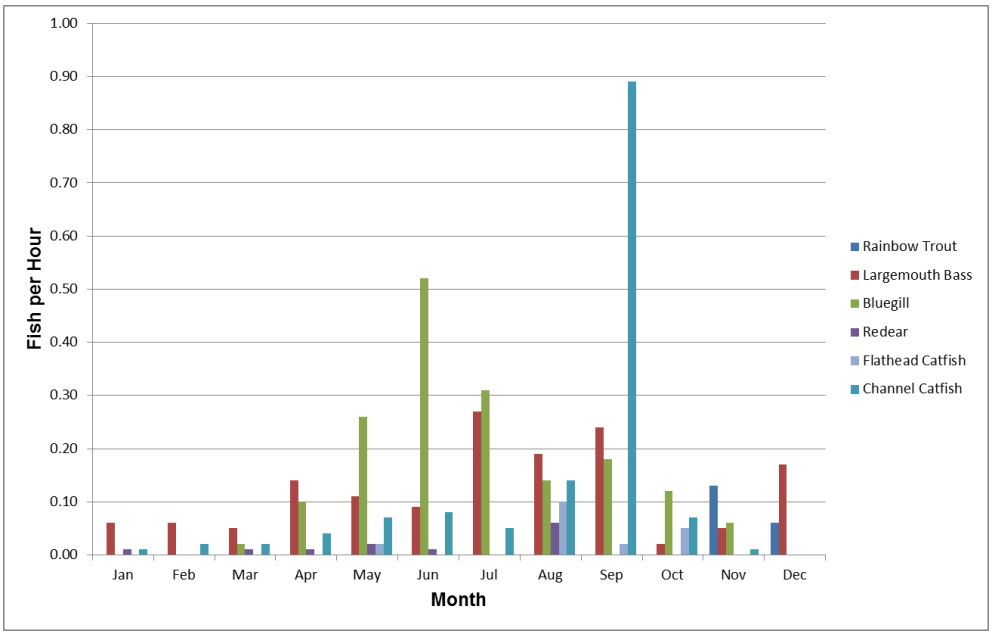

Figure 15. Angler catch per unit of effort of various species by month at Patagonia Lake 2016.

Species	Total Caught	Total Harvest	Percent Harvest
Flathead Catfish	263	207	78.71
Rainbow Trout	593	441	74.37
Black Crappie	1,918	943	49.17
Channel Catfish	5,417	2,329	42.99
Bluegill Sunfish	5,875	2,077	35.35
Redear Sunfish	293	99	33.79
Largemouth Bass	4,963	438	8.83
All Species Total	19,322	6,534	33.82

Figure 16. Estimated total angler catch and harvest at Patagonia Lake 2016.

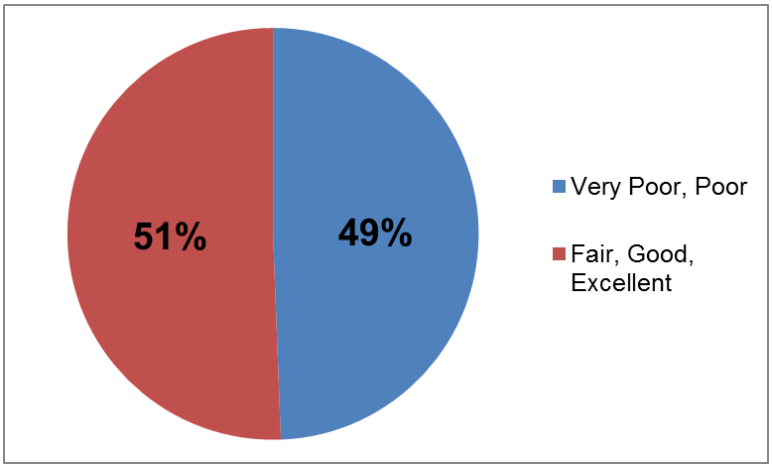

Figure 17. Angler satisfaction at Patagonia Lake 2016.

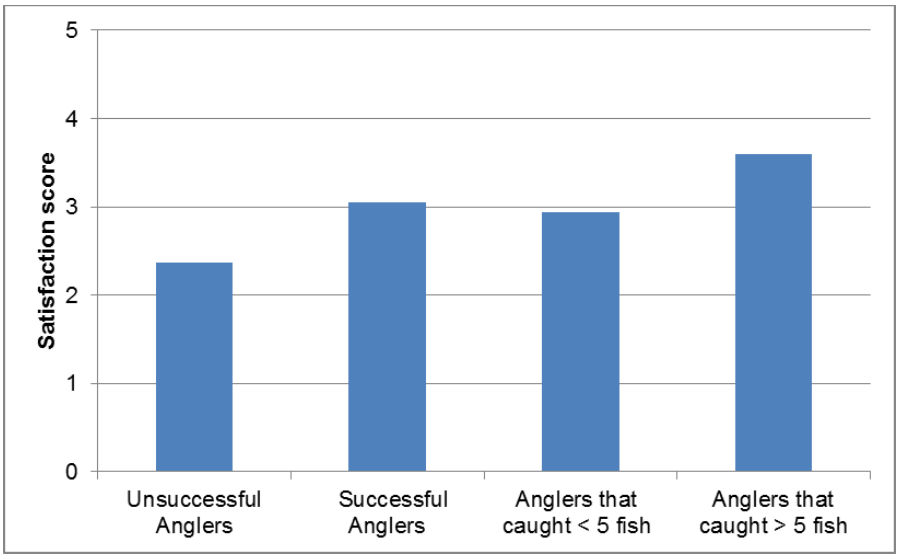

Figure 18. Angler satisfaction as it relates to angler success at Patagonia Lake 2016.