



Big Lake Fisheries Management Plan 2020-2030

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Approved [] by Chris Cantrell *D. Andrew Clark* for Date 3/1/2020
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Location

Big Lake is located in game management unit 1 in Apache County at UTM Zone 12S-NAD 83 646202E, 3749902N. It is approximately 75 kilometers southeast of Pinetop-Lakeside, Arizona in the Apache-Sitgreaves National Forests. It can be reached by paved Highways 273 or 261, both originating from Highway 260 between Pinetop-Lakeside and Springerville. (Figure 1).

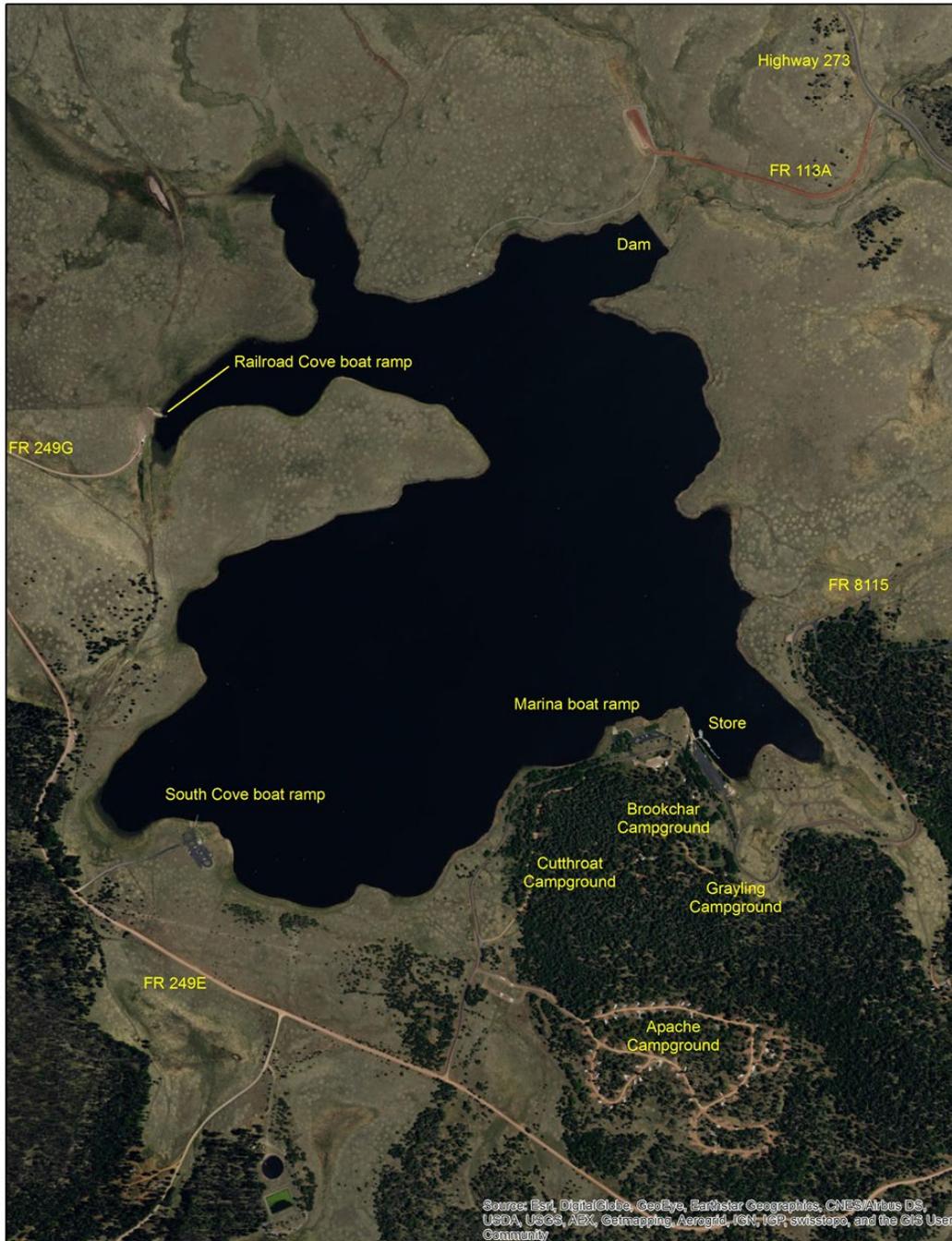


Figure 1. Map of Big Lake, Apache County, Arizona.

Management Prescription

The Arizona Game and Fish Department (Department) has developed strategic management approaches to guide coldwater species management under the Coldwater Sportfisheries Strategic Vision Document (AGFD 2019). The primary and only management emphasis for Big Lake is for a coldwater sport fishery. The coldwater sport fishery emphasis is based on the suitable biological conditions for trout in Big Lake, compatibility of native species management downstream, and the continued high demand for coldwater angling at this lake and the general area. At Big Lake, management goals focus primarily on providing a Basic Yield sport fishery for Rainbow Trout *Oncorhynchus mykiss* and secondarily utilize the Featured Species approach for Cutthroat Trout *Oncorhynchus clarkii* and Brook Trout *Salvelinus fontinalis*. These approaches will be supported by annual stocking of Rainbow Trout, Cutthroat Trout, and Brook Trout.

Fisheries monitoring activities, including gillnetting surveys and/or electrofishing surveys, and angler creel surveys will be used to determine if management objectives are being met. Objective guidelines to meet management objectives are listed in Table 1.

Objective 1. Maintain the Rainbow Trout population to meet or exceed Basic Yield standards.

Objective 2. Maintain the Cutthroat Trout and Brook Trout populations to meet or exceed appropriate Featured Species standards.

Objective 3. Maintain angler satisfaction at 80%.

Table 1. Big Lake Objectives and Adaptive Management Strategies:

<i>Objective 1: Maintain the Rainbow Trout population to meet or exceed Basic Yield Concept standards.</i>			
Parameters	Objective Guideline	Trigger point to address unmet Objectives	Strategies if Objectives are not met
Size structure	50% of Rainbow Trout surveyed \geq 10 inches in length.	Size structure drops below 50% of Rainbow Trout surveyed \geq 10 inches in length for three consecutive surveys.	<ul style="list-style-type: none"> • Stocking size • Stocking frequency • Regulation changes
CPUE ¹	Maintain a minimum CPUE of 10 Rainbow Trout per net night in netting surveys or 10 fish/hour of electrofishing.	CPUE of Rainbow Trout falls below 10/net night in 3 consecutive surveys.	<ul style="list-style-type: none"> • Adjust stocking • Investigate low survival of stocked trout
Angler Catch Rates	Maintain catch rate of 1.0 fish per hour during stocking season or 0.5	Angler catch rates drop below 1.0 fish per hour during	<ul style="list-style-type: none"> • Stocking • Outreach/education • Regulation changes

Objective 1: Maintain the Rainbow Trout population to meet or exceed Basic Yield Concept standards.			
Parameters	Objective Guideline	Trigger point to address unmet Objectives	Strategies if Objectives are not met
	fish per hour from May to September for anglers targeting Rainbow Trout.	stocking season or 0.5 fish per hour during summer months for two consecutive creel surveys.	
Objective 2: Maintain the Cutthroat Trout and Brook Trout populations to meet or exceed appropriate Featured Species Concept standards.			
Size Structure	Multiple age classes captured during sampling events.	Three consecutive sampling events below management guideline.	<ul style="list-style-type: none"> • Stocking • Regulation Changes
Angler Catch Rates	Maintain catch rate of 1.0 fish per hour during stocking season or 0.5 fish per hour from May to September for anglers targeting Cutthroat or Brook Trout.	Angler catch rates drop below 1.0 fish per hour during stocking season or 0.5 fish per hour during summer months for two consecutive creel surveys.	<ul style="list-style-type: none"> • Stocking • Outreach/education • Regulation changes
Objective 3: Maintain angler satisfaction at 80%.			
Angler Satisfaction	Angler satisfaction in creel surveys >80%.	Angler satisfaction drops below 80% for two consecutive creel surveys.	<ul style="list-style-type: none"> • Stock more or larger Cutthroat Trout or Brook Trout • Improve access conditions • Increase outreach/education

¹ CPUE=Catch Per Unit Effort (fish per hour or fish per net night)

Background

Big Lake is located in southwestern Apache County on the Apache-Sitgreaves National Forest at an elevation of 8,985 feet. It was created in the early 1930s by constructing a dam on a tributary of the North Fork of the East Fork Black River. Big Lake was originally developed as a waterfowl project by the U.S. Fish and Wildlife Service and was part of the former Apache National Wildlife Refuge (Novy and Keith 1988). The original dam was 10 feet tall and the lake regularly winterkilled because it was shallow and weedy. The Executive order that created the Apache National Wildlife Refuge was rescinded in 1945 and the Arizona Game and Fish Department assumed full management responsibility. The Department raised the dam 10 feet in 1953 to alleviate winterkill problems. Due to below average precipitation throughout the 1950s, water was

pumped and diverted from Crescent Lake from 1961 to 1964 to complete the filling of Big Lake. The last documented winterkill was in 1960. With the winterkill issue under control, Big Lake became the leading trout fishing lake in the region.

Big Lake is 532 surface acres in size with an average depth of 15.7 feet and a maximum depth of 26 feet. The drainage area to the lake is extremely small, at 1,547 acres of mixed conifer forest and high elevation grassland. The lake rarely spills, with the last recorded spill in the early 1990s. The lake impounds 8,333 acre-feet of water, for which the Arizona Game and Fish Department has water rights with a priority date of 08/04/1945. Land ownership is entirely the Apache-Sitgreaves National Forests, but the Department has maintenance responsibilities for the dam and spillway.

There are no perennial streams entering the lake and lake levels are maintained naturally through winter precipitation and snowmelt. The area can receive significant rain during the summer months, however these rains have little influence on lake levels. “Old timers” speak of springs at the bottom of the lake which might contribute towards maintaining the water level. There are no releases of water out of Big Lake, except to occasionally test the outlet works on the dam.

Current angling regulations at Big Lake fall under the statewide regulations for gear and bag limits, which allow bait, lures, flies, including treble hooks. Daily bag limits include 6 trout in the aggregate, with a 12 fish possession limit. The use of live baitfish is not permitted at Big Lake, or anywhere in Apache County.

Productivity/Water Quality

Water quality parameters (i.e. water temperature, pH, and dissolved oxygen (DO)) have historically met trout stocking standards year-round. Measurements of pH rarely exceeded 8.6 during the summer months historically, until an unusual bloom of *Lyngbya* developed in the summer of 2013. That algae bloom drove pH levels above 9.0 for the first time on record since the lake filled in 1965. The peak mid-summer pH spike has decreased each year since 2013, but has not yet returned to the pre-*Lyngbya* levels. It is unknown how this alga got into Big Lake, as it had not been documented (or bloom like that observed) before 2013. It is possible *Lyngbya* had always been present until some environmental condition triggered it to bloom. At this time, water quality is suitable for trout, even when the pH spikes above 9.0. Spring and early summer stockings occur before pH levels rise in late summer. However, high pH levels have occasionally persisted into October and impacted fall stockings. Stocking at Big Lake is restricted to only April through October per the conditions of the biological opinion from the sportfish stocking consultation completed in 2011. There is no biological necessity for this restriction and it was put in place only because that was the historical stocking season. This timing restriction should be removed to allow flexibility in stocking during changing climate and limnological conditions.

Dissolved oxygen is generally good. While some oxygen depletion does occur in the depths during the winter ice cover, it does not cause winterkills because the upper layers maintain adequate oxygen levels throughout the winter. The lake does not stratify in the summer due to its relatively shallow profile and exposure to winds that keep it mixing.

Nutrient levels at Big Lake are relatively low, with total phosphorus of 0.02 mg/l and inorganic

nitrogen <0.06 mg/l when last measured in 2016 (Table 2). Previous studies by the Environmental Protection Agency (1977) and Novy and Keith (1988) classified Big Lake as early eutrophic, noting that primary production was limited by both nitrogen and phosphorus availability in the summer and was limited only by nitrogen availability in the fall. Despite relatively low nutrients, Big Lake continues to produce moderate growth of trout. Nutrient levels are lower than nearby lakes such as Crescent, Lee Valley, Carnero, and Luna. Big Lake does not have algae bloom issues (with the exception of the appearance of *Lyngbya* in 2013) or nuisance weed problems as are common in those fisheries. An algae bloom of *Gleotrichia* typically occurs in late summer, and sometimes *Aphanizomenon*. Chlorophyll-a typically ranges from 2-20 µg/l, but had spiked up to 122 µg/l in 2013 during the *Lyngbya* bloom (Table 2). It was less than half of that in 2014 (51-54 µg/l) and down to 10 µg/l in 2015 (Table 2), indicating the excessive *Lyngbya* bloom is decreasing from year to year.

While the *Lyngbya* bloom was a nuisance to fishing in 2013 and 2014, and the typical late summer blooms of *Gleotrichia* impact catch rates and angler satisfaction in late summer, the algae blooms have not caused any fish kills. Regardless, Big Lake is a high priority fishery and water quality will be monitored regularly.

Basic water quality (water temperature, pH) will be monitored monthly from spring through fall on an annual basis while visiting other lakes in the area to document conditions are adequate for trout stocking. A monthly water column profile (water temperature, pH, dissolved oxygen, conductivity) will be conducted once every 5 years. A comprehensive limnological survey that also includes nutrients and metals will be conducted quarterly through the year once every 5 years.

Forage/Prey

Forage in Big Lake consists of zooplankton, benthic invertebrates (including crayfish), aquatic and terrestrial insects, and Fathead Minnows *Pimephales promelas*.

Zooplankton were last surveyed in Big Lake by Department Regional biologists in 1987. This survey found moderate densities of zooplankton available to trout. Zooplankton counts ranged from a low average of 52 organisms per vertical net haul in March and December to a high of 345 organisms per haul in June (Table 3). Copepod densities remained relatively stable all year, averaging 38.1 per haul. *Daphnia* sp., which are normally the most important zooplankton for adult trout, were moderately abundant in samples from June through October. Rotifers were relatively low in abundance, without a large spike often seen in other lakes in the region.

Benthic invertebrates in Big Lake were last surveyed by Department regional biologists in 1979. At that time, benthic invertebrates were numerous, ranging from a low of 78 organisms to a high of 546 organisms per dredge sample. Chironomid larvae and Oligochaetes (a group of segmented worms) were the most abundant benthic invertebrates, averaging 74.9 and 72.8 per dredge sample, respectively (Table 4). Scuds *Hyaella azteca* averaged 19.9 per dredge sample overall. This valuable forage organism was abundant in some sample sites, but absent from many others.

Big Lake has an abundant population of Northern Crayfish *Orconectes virilis*. Northern Crayfish are not native to Arizona and were first reported to be present in the 1970s by the Big Lake Store owner, Rick Law (Rick Law, personal communication). Abundance and changes in population

size have not been formally documented. Due to loss of weedbeds since introduction, it can be assumed the abundance of crayfish has increased in Big Lake since the 1970s. Cutthroat Trout are known to prey on crayfish heavily in Big Lake, however, the crayfish likely do more damage to other benthic invertebrates than the benefit they provide to trout in the lake. The benthic invertebrate community is also assumed to have changed since 1979 due to the presence of crayfish. Currently, there are no effective methods for controlling or eliminating crayfish from a lake this size, but if a method was developed in the future, eliminating crayfish from Big Lake should be considered.

Big Lake has a sustainable population of Fathead Minnow that are preyed upon mostly by Cutthroat Trout, and occasionally by larger sized Rainbow Trout. The addition of new forage fishes into Big Lake is not recommended because of sensitive native fishes downstream in the watershed, but a native forage fish could be considered to enhance forage.

Benthic invertebrate and zooplankton surveys will be conducted in Big Lake every 10 years to evaluate changes to the invertebrate food base. A food web dynamics study is needed and should be pursued by a university or research institution.

Habitat

There is little structure in Big Lake. There are few aquatic plants growing in the lake, which are mostly restricted to the back of Railroad Cove, South Cove, and Marina Cove. Weed beds tend to provide quality forage of larger sized invertebrates. However, trout species stocked into Big Lake are not known to require structural habitat, therefore, habitat is not considered to be a limiting factor for trout in Big Lake.

Bathymetric mapping should be conducted in Big Lake to document the available habitat and current amount of weed beds.

Species

Sportfish Species

The Department has been approved to stock triploid Rainbow Trout, Cutthroat Trout, Brook Trout, and Apache Trout *Oncorhynchus apache* into Big Lake, but has not stocked Apache Trout since 2003. Rainbow Trout, Cutthroat Trout, and Brook Trout are the preferred species assemblage and are stocked annually. The most recent survey was conducted in April 2019, Cutthroat Trout dominated total catch (72.1%), then Rainbow Trout (25.6%) and lastly Brook Trout (2.3%) (Table 5).

Stocking Rate: Rainbow Trout will be stocked annually in the spring (150,000 fingerlings) and fall (40,000 subcatchables). Cutthroat Trout will be stocked annually in the spring/early summer with 60,000 fingerlings. Brook Trout will be stocked annually in the spring/early summer with 50,000 fingerlings. Other sizes and numbers may substitute or supplement these stocking rates to help meet management objectives. Species, sizes and numbers may be adjusted and excess fish can be diverted to other waters if objective guidelines are being met consistently.

Current fish composition in Big Lake consists of stocked Rainbow Trout, Cutthroat Trout, Brook Trout, and self-sustaining population of Fathead Minnow. Brown Trout *Salmo trutta* were stocked once in 1942, Arctic Grayling *Thymallus arcticus* were last stocked in 1970, and Apache Trout were last stocked in 2003, but none of these species have persisted in Big Lake.

Trout do not reproduce in Big Lake, which is consistent with other trout lakes in Arizona. Regular stockings are required to maintain this coldwater sport fishery. Trout that are not triploid (sterile) fish may attempt to spawn, however, there is no natural recruitment into the fishery.

Big Lake is prioritized as a Tier I fishery, requiring it be surveyed at a minimum every 2 years (AGFD 2004). Fish population surveys are conducted annually in the spring with gill nets to monitor the success and growth of stocked trout (standardized gear; AGFD 2004). Trend surveys of Big Lake are performed every other year with 20% fixed sites and 80% random sites. Spot check survey are performed in the other years with 100% fixed sites.

Rainbow Trout

Big Lake is managed to meet or exceed the Basic Yield Concept standards for Rainbow Trout. The Basic Yield approach objectives include size structure objectives where 50% or greater of Rainbow Trout surveyed ≥ 10 inches in length, CPUE goals of a minimum of 10 Rainbow Trout per net night in netting surveys or 10 fish/hour of electrofishing, and angler CPUE goals. Angler CPUE will be discussed in the catch section below in greater detail. From 2015 to 2019, 94 % of Rainbow Trout sampled have been greater than 10 inches in length, which exceeds the size structure objective of having 50% or greater of Rainbow Trout surveyed ≥ 10 inches in length. During the past five surveys, the Rainbow Trout population has exceeded the size structure goal each year. (Figure 2)

Mean CPUE of Rainbow Trout from 2015 – 2019 was 8.0 fish per net night, which is below management objectives for a basic yield Rainbow Trout fishery (\geq CPUE of 10 Rainbow Trout per net night. In fact, during the past five surveys, Big Lake has only met or exceeded gill net survey catch rate objectives once (2018) (Figure 3). In the future, survey methods and equipment will be evaluated to attempt to gain a better understanding of the Rainbow Trout population.

Cutthroat Trout

Big Lake is managed to meet or exceed appropriate Featured Species approach standards for Cutthroat Trout. The Featured Species approach objectives include metrics for age distribution and angler CPUE. Angler CPUE will be discussed in the catch section below in greater detail. As an index of age class distribution, the past two Big Lake gill net surveys (2018 and 2019) have shown multiple size classes, indicating multiple age classes (Figure 4 and 5). The most recent survey was conducted in April 2019, Cutthroat Trout ranged in size up to 18.7 inches in length and 1.8 pounds in weight (Table 6). Over 25% of Cutthroat Trout sampled were at least quality size and of that, 16% were preferred size (Figure 5) (Gablehouse 1984). Cutthroats were found in 2 main size classes, with the smaller group dominated by fish in the 11 – 15 inch size class, and the larger dominated by fish in the 16 – 20 inch size class (Figure 5).

Brook Trout

Big Lake is managed to meet or exceed appropriate Featured Species approach standards for Brook Trout. The Featured Species approach objectives include metrics for age distribution and angler CPUE. Angler CPUE will be discussed in the catch section below in greater detail. As an index of age class distribution, the past two Big Lake gill net surveys (2018 and 2019) have failed to show multiple size classes, which would indicate multiple age classes. In fact, the standard gill net surveys of Big Lake failed to capture any Brook Trout in 2018 and only captured one in 2019. In the future, survey methods and equipment will be evaluated to attempt to gain a better understanding of the Brook Trout population of Big Lake.

The management and species assemblage in Big Lake will be managed to benefit anglers, but will also consider possible downstream impacts to sensitive native wildlife in the North Fork of East Fork of Black River and East Fork of Black River. A Conservation and Mitigation Program project is currently in place to prevent stocked trout from escaping the Big Lake and reaching the sensitive species downstream when and if the lake spills. The lake has not spilled since this project was developed in 2011. The fish species currently present in Big Lake match the desired species assemblage for the lake so no large-scale changes in the species stocked are being considered at this time.

Undesirable or Invasive Species

There are no records of aquatic invasive species at Big Lake.

The lake contains Northern Crayfish, which is non-native and undesirable due to their negative impact on other benthic invertebrates that trout forage upon and aquatic vegetation. Big Lake historically had large beds of aquatic vegetation, which tend to grow larger sized desirable invertebrates that provided quality forage for trout. Once common, weed beds have largely disappeared, with the only aquatic vegetation left in the far back corner of small coves. This disappearance began at about the same time that crayfish showed up in the lake, so it has to be assumed that crayfish played a large part in the disappearance of aquatic plants in Big Lake. There have also been several illegally introduced fish species documented in Big Lake including Golden Shiner *Notemigonus crysoleucas*, Brown Trout, and an unidentified sucker, none of which persist in the lake today.

Illegal species introductions will be monitored through the annual spring netting surveys. Depending upon the species detected, actions to prevent the establishment should be taken immediately. These actions could involve mechanical removal, or possible piscicide treatment if the species detected is considered to be a severe threat to the fishery and mechanical removal is not successful.

Access

Big Lake is accessed by paved Highway 273 from Pinetop-Lakeside, or by paved Highway 261 from Springerville, then on a paved spur road (FR 8115) to the store, main boat ramp, and campgrounds. Dirt roads then provide access around the south and west side of the lake. Additionally paved access is available from Alpine via FR 249. There are three boat ramps and

associated boat docks, one “main” ramp near the store, one in South Cove, and one in Railroad Cove (Figure 1). All are usable at higher water levels, but the South Cove ramp is the only fully functional ramp when the water level is low. The Big Lake store is operated by private concession by long-time owner Rick Law, and provides tackle, some food, limited gas, boat and kayak rentals, and fishing licenses. The campgrounds are maintained by Recreation Resource Management through contract with the Apache National Forest and reservations are all on-line through Recreation.gov. A fish cleaning station is located near the store. Boats are restricted to 10 horsepower motors or less.

Access to fishing along the shoreline is good on the south shorelines, in South Cove, in Railroad Cove, and at the dam, where there is close vehicle access. There are no fishing piers or formal Americans with Disabilities Act (ADA) accessible fishing access.

The lake typically ices from December to early-April, but sometimes only until March. The roads leading to Big Lake normally close for the winter during the same timeframe due to heavy snow pack and large, impassible snow drifts. Highways 273 and 261 are typically opened for public use when the last snow drifts are plowed out by heavy equipment. This does not typically occur until the ice cover melts entirely.

Big Lake provides winter ice fishing to anglers that have snowmobiles. There are no restrictions on the size or number of ice holes drilled, but the number of rods that can be fished at one time by an individual licensed angler is still only two.

Challenges in access include:

- All three boat ramps are getting washed out at the end of the concrete, causing a vertical drop that could damage small boat trailers,
- Currently no ADA shoreline or fishing pier access,
- Boat ramps at Railroad Cove and the store area become unusable at low water levels,
- Boat docks are not easily removed during the winter to prevent damage by shifting ice, or easily replaced after ice-out and often go for weeks into the spring before crews from Phoenix can make it up to put them in place.

Access Strategies:

- Add gravel to the end of each boat ramp as a temporary fix to the drop-off at the end of the ramps.
- Support current plans to improve boat ramps at Big Lake, including the replacement of boat docks that can be easily rolled out of the water in the fall and rolled back in the spring.
- Ensure that boat docks are set in place soon after ice-out in the spring to provide boat access during the popular spring fishing, and ensure that boat docks are removed prior to ice formation in the early winter to prevent damage to the docks.
- Develop some ADA accessible shoreline fishing areas/pier/jetty access.

Catch

The target angler catch rate at Big Lake is 1.0 fish per hour (fish/hour) or greater on average, and at least 0.50 fish/hour during the summer (May – August). The last angler creel survey was

conducted by Department biologists in 2005, during which anglers fished Big Lake an estimated 160,000 hours. Shore anglers fished more than boat anglers in the spring and fall, and overall fished more total hours throughout the year (Table 7). Boat angler use became higher in mid-summer, particularly in August, when the shore angler catch rates were lowest (0.18 fish/hour).

The summer months of June, May, and July were the highest angler use months, in that order during the survey (Table 7). Angler catch rates were highest in the spring and fall, with catch rates as high as 2.18 fish/hour from a boat in October (Table 8). Boat angler catch rates met the objective guidelines of 1 fish/hour overall and a minimum of 0.50 fish/hour through the summer months. However, the total catch rates were short of the target catch rate of at least 1.0 fish/hour target, at 0.71 fish/hour during the survey, and was also short of the 0.5 fish/hour through the summer months. Shore angler catch rates did not meet the target catch rates, with catch rates in July and August of 0.22 and 0.18 fish/hour respectively. While fishing is currently moderately good at Big Lake, there is room for improvement.

The majority of trout harvested from Big Lake in 2005 were harvested in May (30%), June (28%) and July (13%) (Table 9). Harvest decreased to less than 3,000 fish in September but increased to over 6,000 in October as water temperatures cooled down. Rainbow Trout were harvested at a greater rate than Cutthroat Trout and Brook Trout (Tables 10 and 11). Over 80% of all trout harvested were Rainbow Trout, while 14% were Cutthroat Trout, and 5% were Brook Trout (Table 11). The different species of trout in Big Lake are generally caught with different tactics. Rainbow Trout are caught most often by bait anglers, while Cutthroat Trout are most often caught by fly or lure. This fact can also change from season to season. Cutthroat Trout are more numerous in the lake yet they are caught much less often. An education campaign to show novice anglers how to catch different species of trout at Big Lake could help to increase catch rates.

The current stocking strategy for Big Lake to attempt to meet management objectives is to stock higher numbers of Rainbow Trout in the lake to keep catch rates high, then stock moderate numbers of Cutthroat Trout to provide larger trout, and just enough Brook Trout to maintain diversity in catch.

In 2013, another statewide angler use survey found that use had increased to an estimated 162,859 angler use days (Fisheries Branch 2013). Big Lake also represented the highest angler user days in the Region, which has been the trend for decades. Angler creel surveys (April-November) should be conducted at Big Lake every five years to determine if the fishery meets management objectives.

Satisfaction

Satisfaction rates at Big Lake did not meet target rate of 80% of fair/good/excellent ratings overall, falling below management objective at an average of 58% (Table 12). The lowest satisfaction rates, and only months that fell below the target, occurred in August (29%), July (35%), and September (46%). This is attributed mainly to lower catch rates in those months.

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Tables and Figures

Table 2. Water quality values recorded at Big Lake from 2011 through 2016.

Date	Depth	Secchi	pH	CHL-a	Tot-N	NO _{2,3}	NH _{3,4}	P-Tot	N:P	DO	TDS	BOD
9/13/2011	7.2	2.7	8.1	12.9	0.75	<0.02	<0.04	0.03	25.0	6.8	41.0	1.9
8/13/2013	6.0	2.0	9.2	18.0	1.05	<0.02	<0.04	0.06	17.5	13.0	101.0	5.8
10/22/2013	7.0	1.3	9.3	122.0	1.62	<0.02	<0.04	0.06	27.0	9.8	87.0	8.2
4/23/2014	6.4	2.6	8.5	6.0	0.83	<0.02	<0.04	0.03	27.7	7.2	94.0	1.0
8/26/2014		1.8	9.4	51.3	1.35	<0.02	<0.04	0.05	27.0	6.8	95.0	3.8
10/21/2014	5.0	1.8	8.8	54.4	1.21	0.01	<0.04	0.04	30.3	7.6	102.0	1.9
10/29/2015	6.0	1.9	9.1	10.7	0.93	<0.02	<0.04	0.04	23.3	8.1	98.0	1.7
4/21/2016	6.6		8.4	2.1	0.80	<0.02	<0.04	0.02	40.0	8.8	93.0	2.3

Table 3. Number of zooplankton per vertical haul in Big Lake in 1983-1987.

	Feb	Mar	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
No. Sample dates	2	1	2	3	1	3	5	3	4	2	
Water Temp (°C)	-	-	-	-	-	-	-	-	-	-	-
Mesh size (u)	153	153	153	153	153	153	153	153	153	153	
Haul length (m)	7.2	7.0	7.5	7.7	8.0	7.7	7.5	7.7	7.5	7.3	7.5
Synchaeta (#/l)	-	-	-	-	-	-	-	-	-	-	-
Asplanchna (#/l)	1.0	-	1.0	41.7	6.0	1.1	13.6	2.0	3.3	10.0	8.0
Euchlanis (#/l)	-	-	-	0.7	-	-	-	0.3	0.3	-	0.1
Filinia (#/l)	2.0	3.0	1.0	0.3	-	-	0.2	-	0.3	-	0.7
Keratella (#/l)	0.5	-	-	1.7	1.0	0.7	0.4	0.6	0.3	-	0.5
Polyarthra (#/l)	-	-	-	-	-	-	0.2	0.3	-	-	0.1
Platyias (#/l)	-	-	-	-	1.0	0.2	-	-	-	0.1	-
Total Rotifers (#/l)	3.5	3.0	2.0	44.4	8.0	1.7	14.6	3.2	4.2	10.0	9.5
Calanoida (#/l)	19.5	33.0	2.5	3.3	1.0	21.0	43.2	20.0	14.5	12.5	17.1
Cyclopoida (#/l)	21.5	6.0	55.5	51.7	17.0	4.3	10.0	10.0	5.8	14.0	19.6
Harpacticoida (#/l)	-	-	-	-	-	-	-	-	0.3	1.5	0.2
Nauplii (#/l)	2.5	-	1.5	0.7	1.0	0.7	3.4	0.6	1.0	1.0	1.2
Total Copepoda (#/l)	43.5	39.0	59.5	55.7	19.0	26.0	56.6	30.6	21.6	29.0	38.1
Alona (#/l)	0.5	1.0	-	0.3	-	0.3	0.8	0.6	0.3	1.0	0.5
Bosmina (#/l)	36.5	-	1.5	184	13.0	1.0	22.8	10.0	11.5	1.5	28.2
Ceriodaphnia (#/l)											
Daphnia (#/l)	10.0	9.0	2.5	60.3	43.0	42.0	76.4	50.7	25.5	10.5	33.0
Total Cladocera (#/l)	47.0	10.0	4.0	245	56.0	43.3	100	61.3	37.3	13.0	61.7
Total Ostracoda (#/l)	-	-	-	-	-	-	-	-	-	-	-
Total Organisms (#/l)	94	52	66	345	83	71	171	95	63	52	109

Table 4. Number of benthic invertebrates in Big Lake in November 1979. Number is given as the mean number of invertebrates in collected by ponar dredge at each of 20 sites in the lake.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean	Relative Density %
Sample Depth (m)	3.0	6.5	2.0	5.0	6.5	7.0	2.0	5.0	5.0	6.5	2.0	7.0	3.0	7.0	1.0	6.5	6.5	6.5	7.0	6.5		
Diptera																						
Chironomidae	144	71	137	104	51	39	26	69	109	32	20	20	131	21	402	20	40	19	15	27	74.9	33.05
<i>Chaoborus</i>	2	3	-	-	2	4	-	-	-	1	-	1	-	2	-	-	2	2	4	2	1.3	0.55
Oligochaetes	125	114	120	19	56	129	-	67	74	65	7	26	108	67	116	24	135	119	33	51	72.8	32.12
Pelecypoda																						
<i>Pisidium</i>	-	50	29	44	68	15	19	84	30	102	46	14	-	44	15	26	18	23	39	58	36.3	16.00
Amphipoda																						
<i>Hyalella azteca</i>	-	-	-	-	-	-	127	80	-	-	178	-	-	-	13	-	-	-	-	-	19.9	8.79
Hirudinea																						
<i>Helobdella</i>	-	2	1	12	2	1	-	15	52	56	1	17	-	3	-	22	2	1	1	17	10.3	4.53
Gastropoda																						
<i>Lymnaea</i>	108	-	-	1	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-	-	6.5	2.87
<i>Gyraulus</i>	19	1	7	3	1	-	7	16	2	1	14	-	-	-	-	4	1	-	-	-	3.8	1.68
Odonata																						
<i>Enallagma</i>	10	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	0.8	0.35
Isopoda																						
<i>Ascellus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.1	0.04
Hydracarina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	0.05	0.02
Total Organisms	408	241	294	180	189	188	181	332	267	257	266	78	266	137	546	96	198	165	92	155	226.8	100

Table 5. Number of fish caught, species composition (%), and catch per unit effort (CPUE; fish/h), and relative weight (Wr) from overnight gill net survey at Big Lake on April 24-25, 2019.

Species	Number Caught	Species Composition (%)	CPUE (fish/net night)	Relative Weight (Wr)
Cutthroat Trout	31	72.1	10.33	78
Rainbow Trout	11	25.6	3.67	97
Brook Trout	1	2.3	-	99
Total	43	100	14.33	

Table 6. Range and mean of length (inches) and weight (pounds) of fish captured during overnight gill net survey in Big Lake on April 24-25, 2019.

Species	Length (inches)			Weight (pounds)		
	Min.	Max.	Mean	Min.	Max.	Mean
Cutthroat Trout	10.8	18.7	14.9	0.4	1.8	1.2
Rainbow Trout	10	17.8	13.0	0.4	2.0	1.0
Brook Trout	-	-	-	-	-	-

Table 7. Angler use and proportion of shore anglers by month at Big Lake in 2005. Numbers in parentheses are standard errors.

Month	Shore Angler Hours	Boat Angler Hours	Total Angler Hours	Proportion Shore Anglers
April	3,024 (998)	576 (403)	3,600 (1,076)	84%
May	25,448 (4,813)	8,780 (1,713)	34,228 (5,109)	74%
June	21,139 (3,005)	16,291 (2,914)	37,430 (4,186)	56%
July	15,330 (1,297)	17,796 (2,434)	33,126 (2,758)	46%
August	7,816 (2,245)	12,572 (3,734)	20,388 (4,357)	38%
September	8,520 (1,884)	5,880 (1,442)	14,400 (2,372)	59%
October	9,751 (2,741)	4,956 (1,598)	14,707 (3,173)	66%
November	4,140 (1,854)	1,320 (179)	5,460 (1,863)	75%
Total	95,168 (7,377)	68,170 (6,011)	163,339 (9,516)	58%

Table 8. Angler catch rates (fish/hour) by month at Big Lake in 2005. Numbers in parentheses are standard errors.

Month	Shore CPUE	Boat CPUE	Total CPUE
April	0.89 (0.18)	0.98 (0.98)	0.91 (0.30)
May	0.62 (0.09)	1.65 (0.15)	0.89 (0.10)
June	0.40 (0.05)	1.50 (0.31)	0.87 (0.16)
July	0.22 (0.05)	0.37 (0.05)	0.31 (0.05)
August	0.18 (0.05)	0.50 (0.18)	0.38 (0.13)
September	0.39 (0.07)	0.98 (0.33)	0.63 (0.18)
October	0.58 (0.04)	2.18 (0.56)	1.12 (0.21)
November	0.87 (0.17)	1.78 (0.30)	1.09 (0.20)
Average			0.71 (0.04)

Table 9. Rainbow Trout caught and harvested per month at Big Lake in 2005. Numbers in parentheses are standard errors.

Month	Trout Caught	Trout Harvested	Proportion Harvested by Month
April	3,263 (788)	1,795 (337)	3
May	30,375 (2,628)	19,672 (2,149)	30
June	32,766 (5,245)	18,537 (1,758)	28
July	10,108 (1,158)	8,315 (1,200)	13
August	7,701 (2,346)	6,040 (1,854)	9
September	9,030 (2,027)	2,861 (568)	4
October	16,486 (2,827)	6,296 (1,525)	9
November	5,965 (806)	2,924 (626)	4
Total	115,695 (7,392)	66,441 (3,968)	100

Table 10. Angler harvest rates (fish/hour) by species and month at Big Lake in 2005. Catch rates by species were not determined because many anglers could not identify trout by species. Numbers in parenthesis are standard errors.

Month	Rainbow Trout CPUE	Cutthroat Trout CPUE	Brook Trout CPUE
April	0.38 (0.09)	0.01 (0.01)	0.10 (0.01)
May	0.48 (0.08)	0.04 (0.01)	0.04 (0.02)
June	0.37 (0.08)	0.06 (0.01)	0.01 (0.01)
July	0.17 (0.05)	0.03 (0.01)	0.00 (0.00)
August	0.17 (0.09)	0.10 (0.03)	0.02 (0.01)
September	0.16 (0.05)	0.03 (0.01)	0.01 (0.01)
October	0.31 (0.08)	0.05 (0.03)	0.01 (0.01)
November	0.37 (0.12)	0.15 (0.06)	0.01 (0.01)

Table 12. Estimated total harvest for Big Lake in 2005.

Species	Total Harvest	Standard Error	Percent Harvest (%)
Rainbow Trout	49,781	3,750	81
Cutthroat Trout	8,327	781	14
Brook Trout	3,140	548	5
Not Seen	5,193	1,841	
Total	66,441	3,968	

Table 13. Satisfaction rates by month at Big Lake in 2005. Numbers represent percent of anglers rating their angling experience as Poor, Fair, Good, or Excellent that month.

Month	n	Poor Experience	Fair Experience	Good Experience	Excellent Experience	Fair/Good/Excellent Combined
April	47	13	30	38	19	87
May	229	26	31	30	14	75
June	228	43	17	28	13	58
July	157	65	23	7	5	35
August	55	71	20	9	0	29
September	59	54	24	17	5	46
October	62	31	29	34	6	69
November	33	24	51	21	3	75
Average	870	42	25	23	10	58

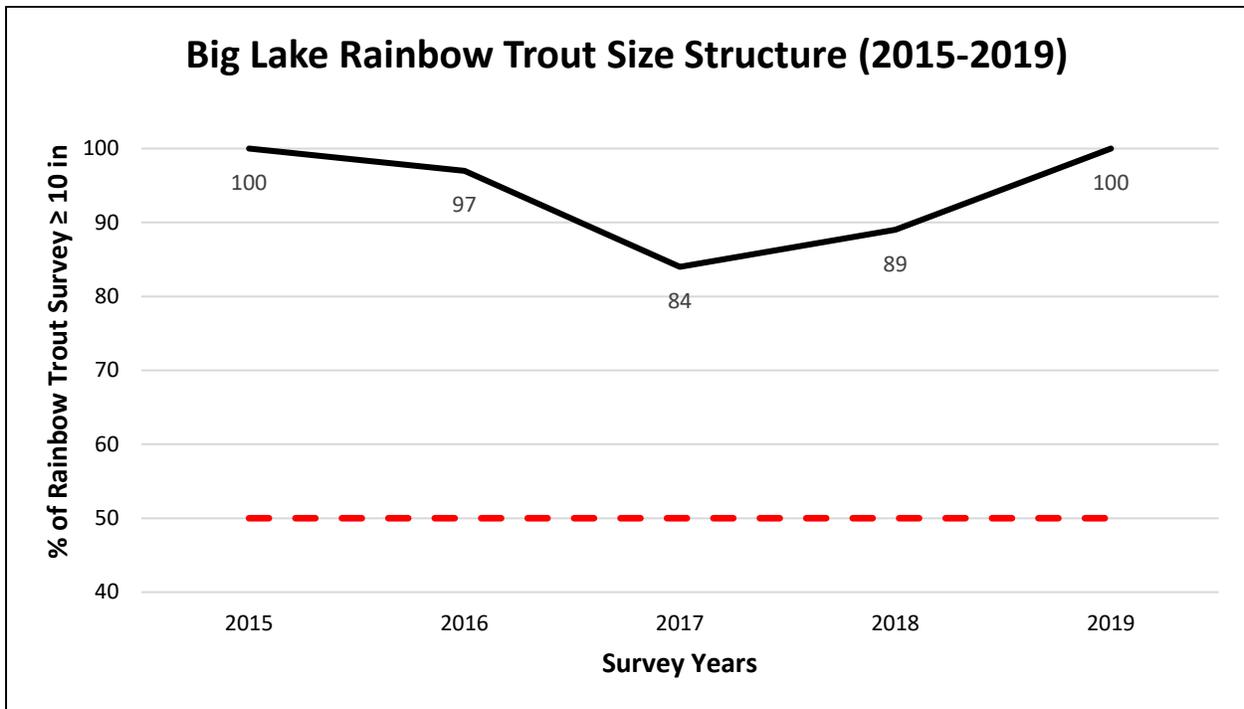


Figure 2. Annual size structure for Rainbow Trout captured during spring gill netting surveys at Big Lake (2015-2019). AGFD Coldwater Vision management objectives are shown with dashed red line.

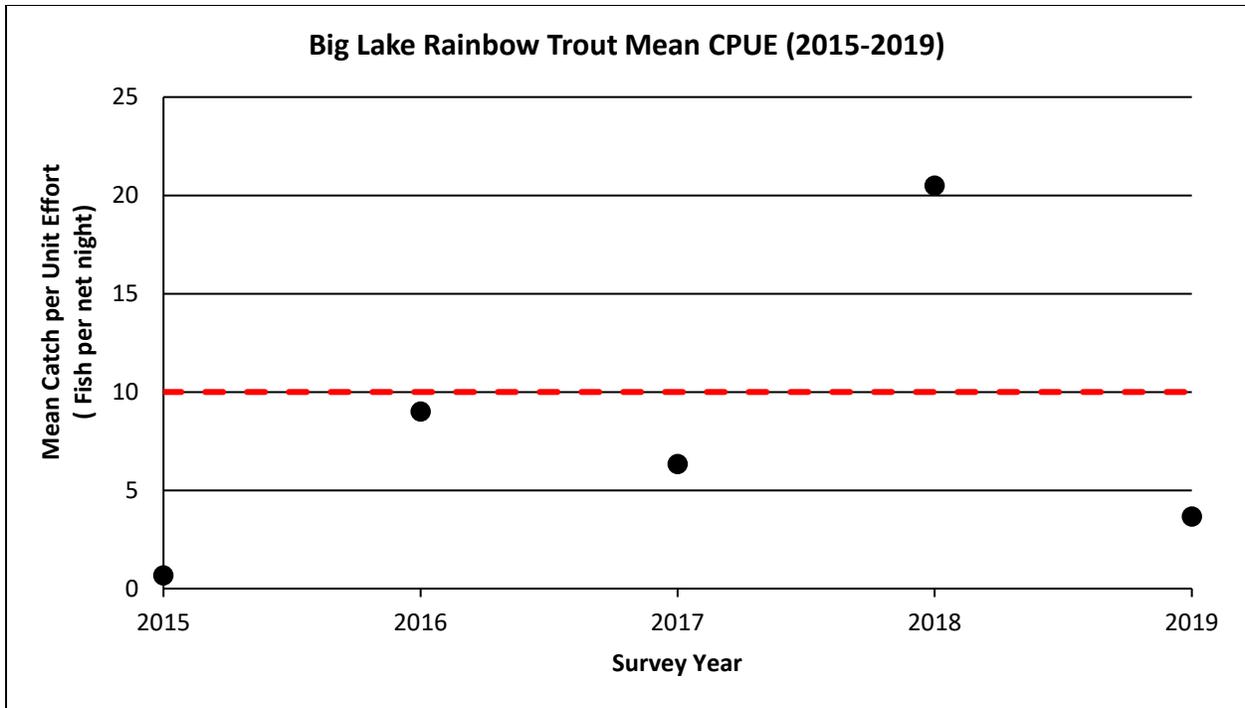


Figure 3. Annual mean catch per unit effort (CPUE) for Rainbow Trout captured during spring gill netting surveys at Big Lake (2015-2019). AGFD Coldwater Vision management objectives are shown with dashed red line.

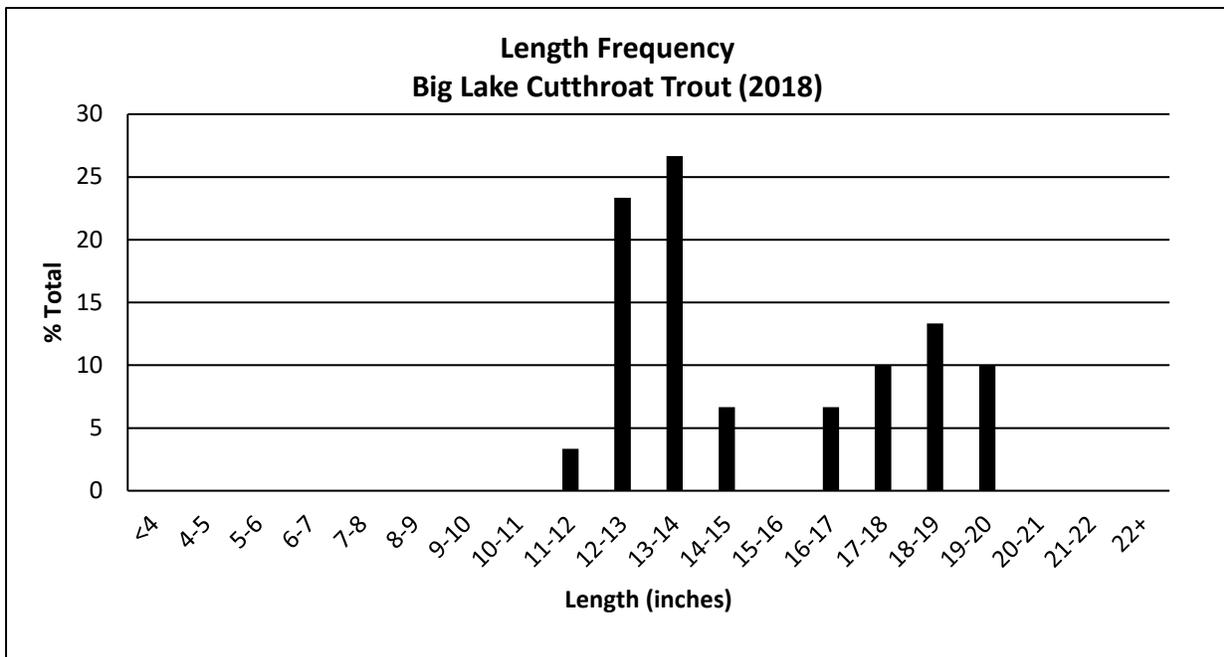


Figure 4. Length-frequency distribution of Cutthroat Trout captured during overnight gillnet survey at Big Lake, Arizona, on April 23-24, 2018.

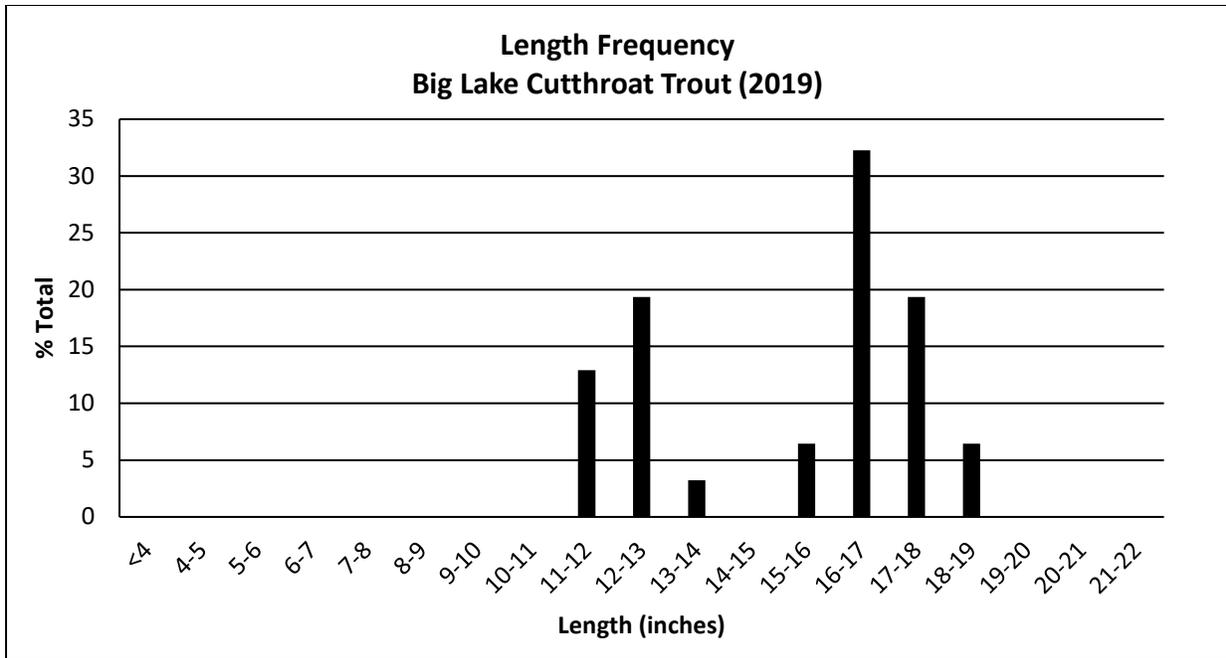


Figure 5. Length-frequency distribution of Cutthroat Trout captured during overnight gillnet survey at Big Lake, Arizona, on April 24-25, 2019.