



**Lower Lake Mary
Fisheries Management Plan
2020-2030**

**Scott Rogers Aquatic Wildlife Program Manager, Region II
Charles Benedict Aquatic Wildlife Specialist, Region II**

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Approved [] by Chris Cantrell D. Andrew Clark for Date 9/1/2020
Aquatic Wildlife Branch Chief

Location

Lower Lake Mary is located about 8 miles southeast of Flagstaff at UTM 447052 3885626.



Figure 1. Location map for Lower Lake Mary showing proximity to Flagstaff.

Management Prescription

The Arizona Game and Fish Department developed approaches to guide coldwater species management under the Coldwater Sportfisheries Strategic Vision Document (AGFD 2019). The primary management for Lower Lake Mary will follow the Intensive Use approach for Rainbow Trout *Oncorhynchus mykiss*.

Management objectives and adaptive management strategies have been set under the Intensive Use approach. 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. Maintain the Rainbow Trout population to meet or exceed Intensive Use standards.

Objective 2: At least 80% of the anglers interviewed during creel census rate the fishing as fair, good or excellent.

Table 1. Lower Lake Mary Objectives and Adaptive Management Strategies:

Parameters	Objective Guideline	Trigger point to address unmet Objectives	Strategies if Objectives are not met
<i>Objective 1: Maintain the Rainbow Trout population to meet or exceed the Intensive Use standards.</i>			
Catch Rate	Catch rate for trout exceeds .5 fish per hour during assessment of catch rates on a 10 year rotational basis through creel surveys.	Catch rate during creel census is less than .5 fish per hour.	Develop an angler outreach program to attempt to increase the angler's ability to catch fish on Lower Lake Mary.
Catch Rate	Catch rate for all species combined exceeds .5 fish per hour.	Catch rate during creel census is less than .5 fish per hour.	Increase the number of Rainbow Trout stocked.
<i>Objective 2: At least 80% of the anglers interviewed during creel census rate the fishing as fair, good or excellent.</i>			
Angler Satisfaction	A minimum of 80% of angler's rate fishing as fair, good or excellent during creel census.	Creel Census shows less than 80% of the angler's rate fishing as fair, good or excellent.	Develop an angler outreach program to attempt to increase the angler's ability to catch fish on Lower Lake Mary.

Background

Lower Lake Mary is a shallow, weedy reservoir located in the southwest part of Coconino County. The lake is eight miles southeast of the City of Flagstaff on the Coconino National Forest (Forest). When full, Lower Lake Mary (LLM) is one of the most productive waters in northern Arizona. Unfortunately the reservoir has developed several sinkholes through which a large volume of water is lost annually. The presence of these sinkholes has led to wildly fluctuating water levels since the dam's completion in 1904. Currently, the lake is managed by the Arizona Game and Fish Department (Department), and the Forest for recreation. The Forest maintains the picnic grounds and surrounding areas, while the Department stocks Rainbow Trout when water levels are sufficient. During high water years, stocked Rainbow Trout have very high growth rates and provide a high quality fishing experience for the public, while in low water years a short season (March-June) intensive use Rainbow Trout fishing opportunity is provided.

The dam that forms LLM was built in 1904 on a basalt bedrock base (Natural Channel Design 2018). The earthen dam has an elevation at its spillway of 6,811 feet, a maximum height of 33 feet and a crest width of 12 feet. When full, the lake impounds 8,617 acre/feet (2.8 billion gallons) of water, and has a surface area of 910 acres, 3.6 miles of shoreline, and an average depth of 12 feet. The spillway for the lake is located about 1,700 feet west of the dam and consists of a channel cut in basalt bedrock.

Shortly after the dam was completed, large sinkholes formed in the bottom of the reservoir. Seepage from the sinkholes has been estimated at 5-10 gallons per minute per sinkhole (7,200 –14,400 gallons a day), with most of the seepage occurring on the south side of Lower Lake Mary (Niccum, 2000). Many attempts have been made to plug the holes with rocks, brush, and dirt with little or no success. In order to eliminate the flow of water to the sinkholes, a coffer dike was constructed in 1968. In 1973, the coffer dike was overtopped by high water and in 1980, the top level of the dike was raised above spillway elevation. Numerous sinkholes are still visible between the dike and the dam. All of these attempts were unsuccessful and seepage problems continue to this day.

The cause of the water loss problem lies in the geology of the area. LLM is in a graben (valley) that lies between two normal faults that parallel the entire length of the lake (Blee, 1988). The Lake Mary fault is located along Lake Mary road while an unnamed secondary fault is located along the south east side of the valley. Natural Channel Design, a company specializing in geomorphology, located and catalogued numerous sinkholes located on the southwest side of the lake near the location of the secondary fault. The sinkholes ranged in depth from 2 to 8 feet in depth and some had fractured limestone bedrock visible in the bottom. As part of the study, they also conducted soil boring east of the secondary fault to depths up to 26 feet. Boring also found that the soils of the lake bed had moderate to high clay content with low permeability. Groundwater was found in the bore holes at about the same level as the lake surface at the time of the boring. The study concluded: the groundwater depth within the graben is fairly stable in the soil zone. However groundwater

does likely migrate horizontally through the soils and is lost when it reaches what is likely a limestone bedrock wall at the fault line (Natural Channel Design, 2018).

Productivity/Water Quality

Little water quality information is available for LLM due to wildly fluctuating water levels. Information that has been collected suggests low dissolved oxygen levels, less than 4 ppm, can occur occasionally during the winter/spring when aquatic plants are decaying. High pH levels, greater than 9.5, can occur during the summer when algal blooms occur or there are large numbers of aquatic plants.

Productivity data is lacking for LLM, but the rapid fish growth suggests an extremely productive system. This makes sense since every time LLM fills it is essentially a new reservoir and benefits from the increased nutrients from the newly flooded meadow. Productivity and water quality may be monitored opportunistically by Department, university or volunteer efforts. However, due to the ephemeral nature of this reservoir, productivity and water quality studies will fall to a lower priority.

Forage/Prey

Primary forage items for stocked Rainbow Trout, depending on time of year and water level, are earthworms (when the lake is filling), aquatic insects, terrestrial insects, zooplankton, duck leaches and snails.

Habitat

The only fish habitat in LLM is provided by the aquatic plants that grow in the lake. Due to the ephemeral nature of the lake, installation of additional habitat is not recommended.

Species

The fish species in LLM vary depending on water level and if/when Upper Lake Mary has spilled. During relatively low water years there may be no fish found in the lake or only stocked Rainbow Trout. During high water years when Upper Lake Mary (ULM) has spilled, any species of fish found in ULM can be found in LLM. The species in ULM include Northern Pike *Esox lucius*, Yellow Perch *Perca flavescens*, Walleye *Sander vitreus*, Black Crappie *Pomoxis nigromaculatus*, Channel Catfish *Ictalurus punctatus*, Yellow Bass *Morone mississippiensis*, Bluegill *Lepomis macrochirus*, Green Sunfish *Lepomis cyanellus*, Largemouth Bass *Micropterus salmoides*, Golden Shiner *Notemigonus crysoleucas* and Fathead Minnow *Pimephales promelas*.

LLM can fluctuate from dry to full (900+ surface acres) during one spring runoff season and then shrink to less than 100 surface acres by the following spring. Due to these drastic fluctuations, the stocking regime for LLM depends on the current water level of the lake. Therefore LLM will be managed under four different stocking schemes:

1. During the years of low water levels the water quality of the lake is such that lake will not support any fish. No stocking or management will occur.
2. During years of “normal” water levels (Figure 5) where trout are expected to live 3-4 months variable numbers of catchable (8-12 inch) Rainbow Trout (up to 20,000 depending on water level) are stocked starting in March and the lake is managed as an Intensive Use concept Rainbow Trout fishery. During these years, the water quality (primarily pH or dissolved oxygen) will deteriorate, during the summer, to the point where the lake will not support trout.
3. During years that the lake fills to about $\frac{3}{4}$ full (Figure 6) a mixture of catchable and subcatchable Rainbow Trout are stocked and the lake is managed as a Basic Yield concept fishery.
4. During years the lake spills or approaches spilling (Figure 7) and fish are expected to survive for more than one year up to 120,000 Rainbow Trout of all sizes are stocked and the lake is managed as a Basic Yield fishery. It is during these few high water years that LLM produces large trout.

The Basic Yield concept, as described in the Coldwater Sportfisheries Strategic Vision Document assumes conditions exist to allow fish to survive multiple years (AGFD 2019). This is typically not the case for LLM but utilizing smaller age classes of trout when conditions allow helps reduce pressure on the hatchery system to produce high numbers of catchable sized fish. To further assist in stocking strategies, a decision tree concept will be used that takes season, water level and presence of Northern Pike, both adult and young of the year (yoy) into account (Figures 2, 3, and 4).

Access

Access to LLM is by paved county road (FH3). There is parking along the road along with parking at the picnic ground near the dam. The picnic ground is closed from the beginning of October through May during most years, but occasionally the Forest has opened the picnic ground early to provide parking for anglers. There is a fee for using the picnic ground when it is open during May-October.

Opening the picnic ground during the spring and fall months would improve angler access during years when the lake has sufficient water for fish to survive.

Catch

The most recent creel census on LLM was conducted during April, May, and June of 2014. The catch rate was 1.31 fish per hour during that 3 month span (Benedict 2015). During 2014, a total of 19,674 fish were stocked in the lake between March 6 and April 16 with 72% (14,213) being caught by anglers. Low water conditions were seen in 2014 and by the end of June the water temperature and pH had reached a point trout couldn't survive. No large fish kill occurred indicating most of the fish were removed from the lake by anglers, Osprey and Bald Eagles.

A creel census was also conducted during last high water year on LLM in 2010. A total of 40,599 catchable Rainbow Trout were stocked and 21,065 (52%) were caught by anglers (Benedict 2010). The catch rate averaged 0.48 fish per hour during the April-December creel census.

A creel census was also conducted from March of 2005 – May of 2006 after the lake filled in January 2005. A total of 150,594 Rainbow Trout were stocked with 95,341 of the trout being fingerlings (Benedict 2006). An estimated 103,313 angler days were expended with 55,270 Rainbow Trout being caught and 42,746 being harvested. The average length and weight of the Rainbow Trout measured between November of 2005 and May of 2006, was 15 inches, with a weight of 1.6 lbs. The largest measured was 19.7 inches long and weighed 3 lbs. The return to creel of stocked Rainbow Trout was 37%.

Satisfaction

Satisfaction on any lake is difficult to judge as satisfaction is often not clearly defined. During creel surveys in 2010 and 2014, angler satisfaction was measured two ways. The first was fishing satisfaction; anglers were asked how they would rate the fishing (number of fish caught, catch rates, size and quality of fish) independent from any other factors that might influence their overall experience. The second was overall satisfaction. This included all of the factors (weather, scenery, number or people at the lake, quality of facilities, etc.) that effect their enjoyment or lake experience.

During the 2010 creel census 33% rated the fishing as good to excellent while 38% rated it as poor or very poor, 75% of the anglers surveyed rated their overall experience as good or excellent.

During the 2014 creel census, 57.9% of the anglers rated the fishing as good or excellent while 8.9% rated it as poor or very poor, 96.3% of the anglers surveyed rated their overall experience as good or excellent.

Literature Cited

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- Benedict C. T., R.S. Rogers, M. A. Rinker, P Wolters, K Manuel, and L. Burton. 2011. Lower Lake Mary and Upper Lake Mary 2010 Creel Census Report. Arizona Game and Fish Department, Phoenix, Arizona.
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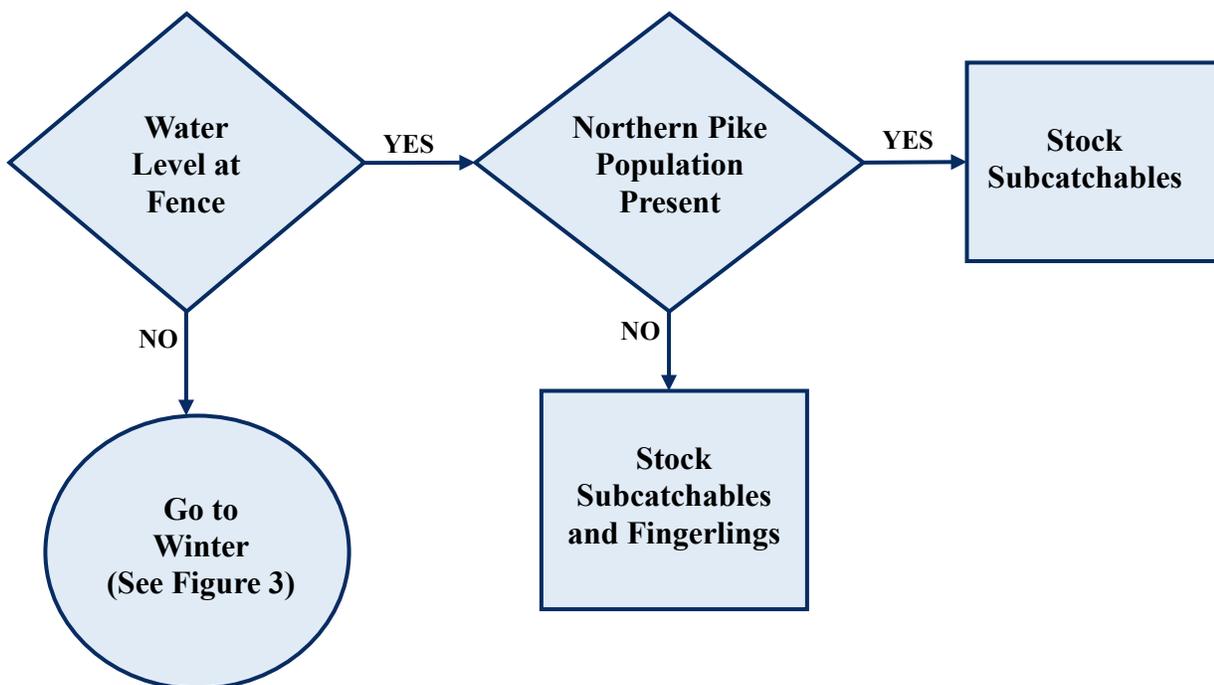
Blee, J.W.H., 1987, Determination of evaporation and seepage losses, Upper Lake Mary near Flagstaff, Arizona: U.S. Geological Survey Water-Resources Investigations Report 87-4250, 39 p.

Natural Channel Design. 2018. Lower Lake Mary Habitat Enhancement Feasibility Analysis Focused on Geologic and Hydrologic Considerations. Flagstaff, Arizona.

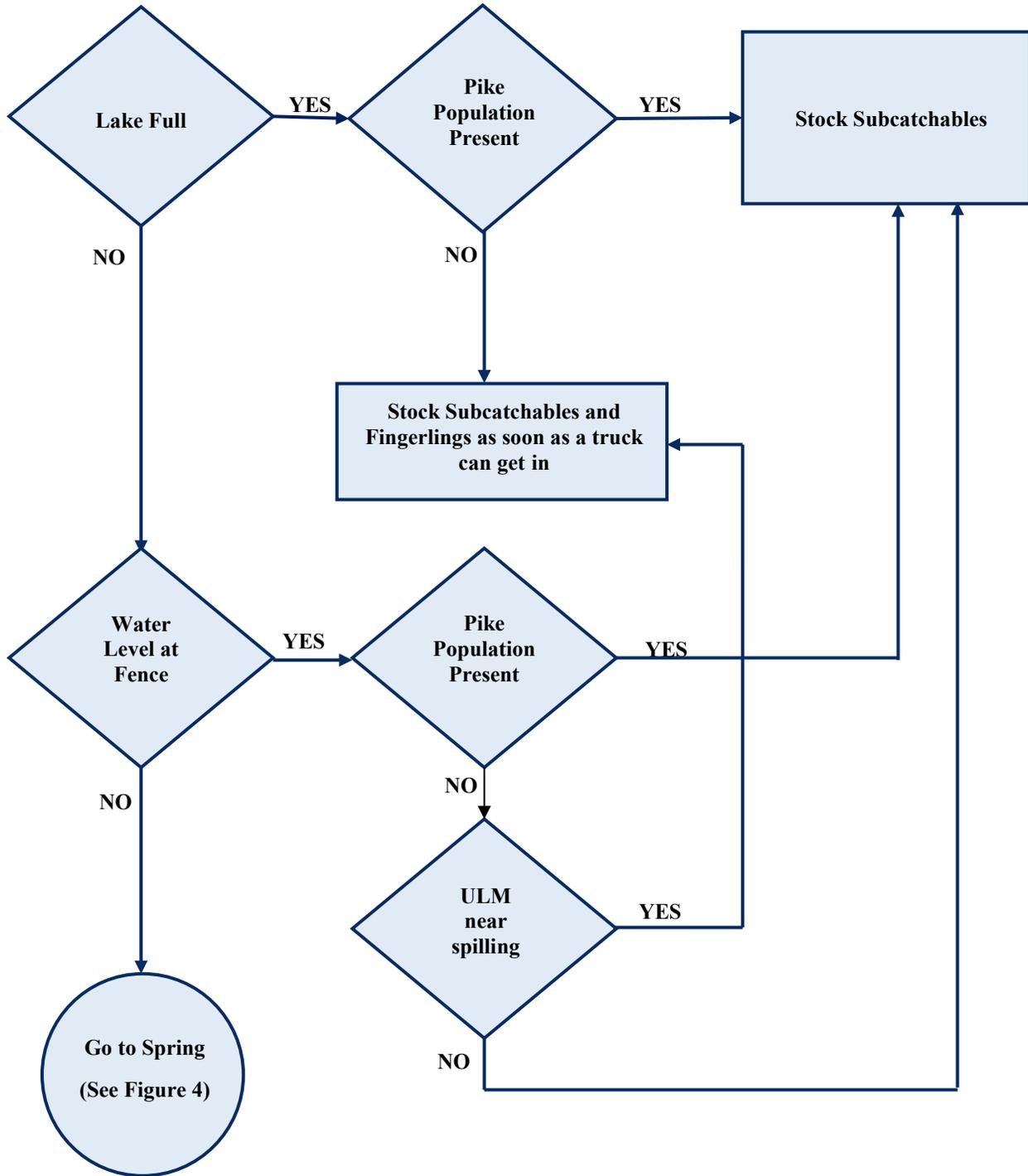
Niccum J., 2000 Lower Lake Mary Lake Management Plan, Arizona Game and Fish Department, Phoenix, Arizona.

Figures and Tables

**Figure 2. Lower Lake Mary Stocking Decision Tree
Fall (October – November)**



**Figure 3. Lower Lake Mary Stocking Decision Tree
Winter (December – February)**



**Figure 4. Lower Lake Mary Stocking Decision Tree
Spring (March–May)**

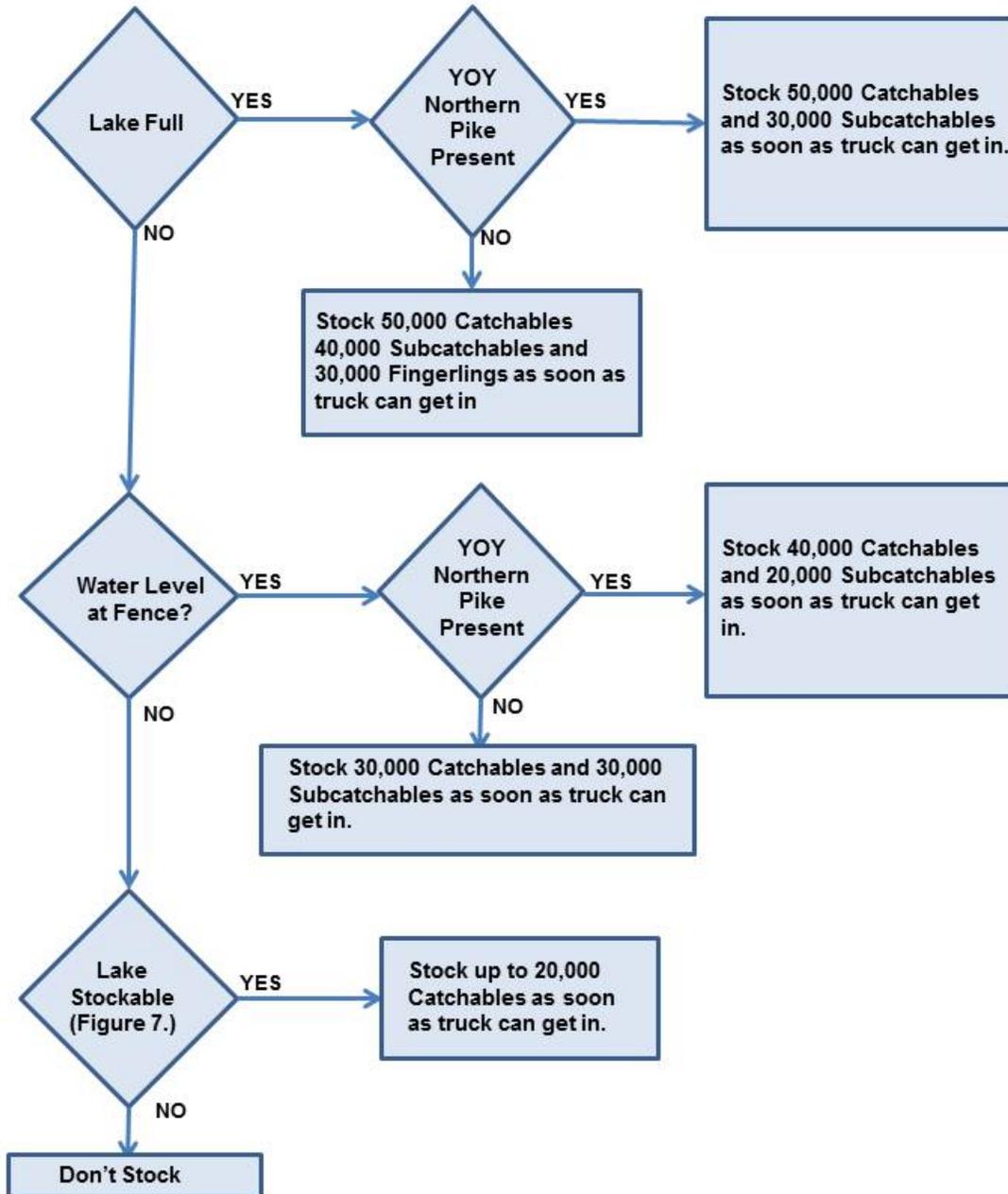


Figure 5. Lower Lake Mary Minimum Stocking Level.

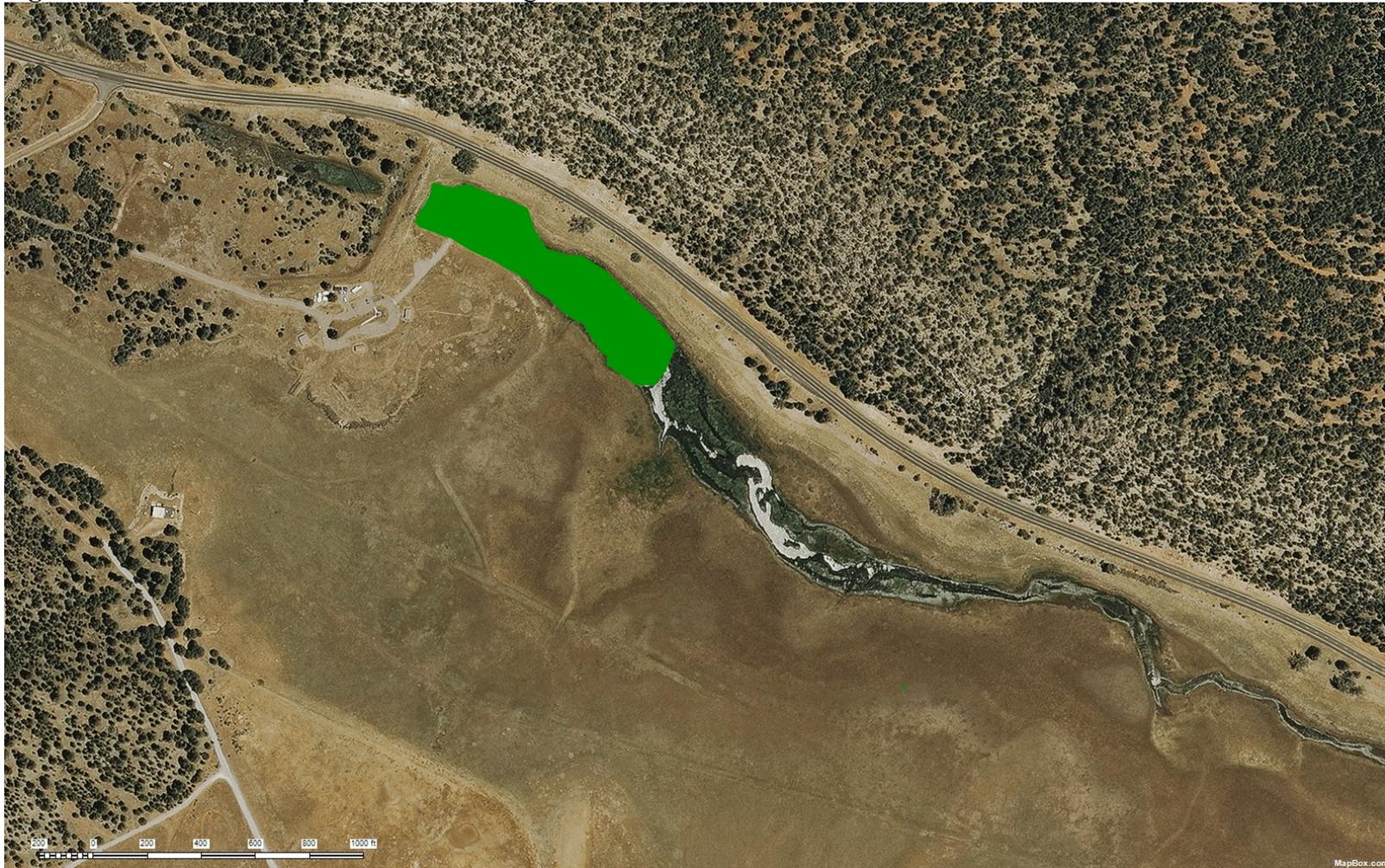


Figure 6. Lower Lake Mary at Fence (Water Reaches Approximately UTM 450907 3882994)

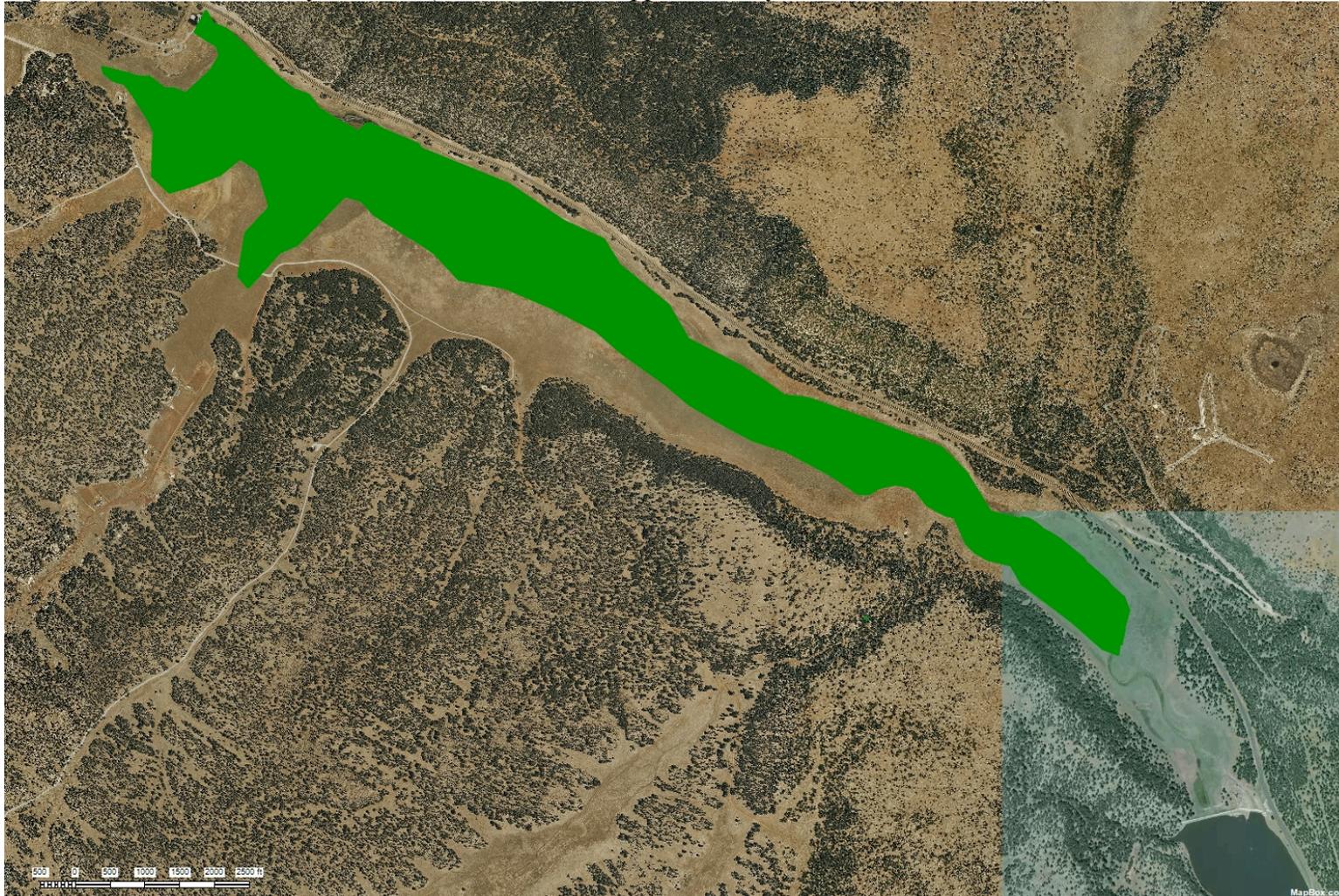


Figure 7. Lower Lake Mary at full pool.

