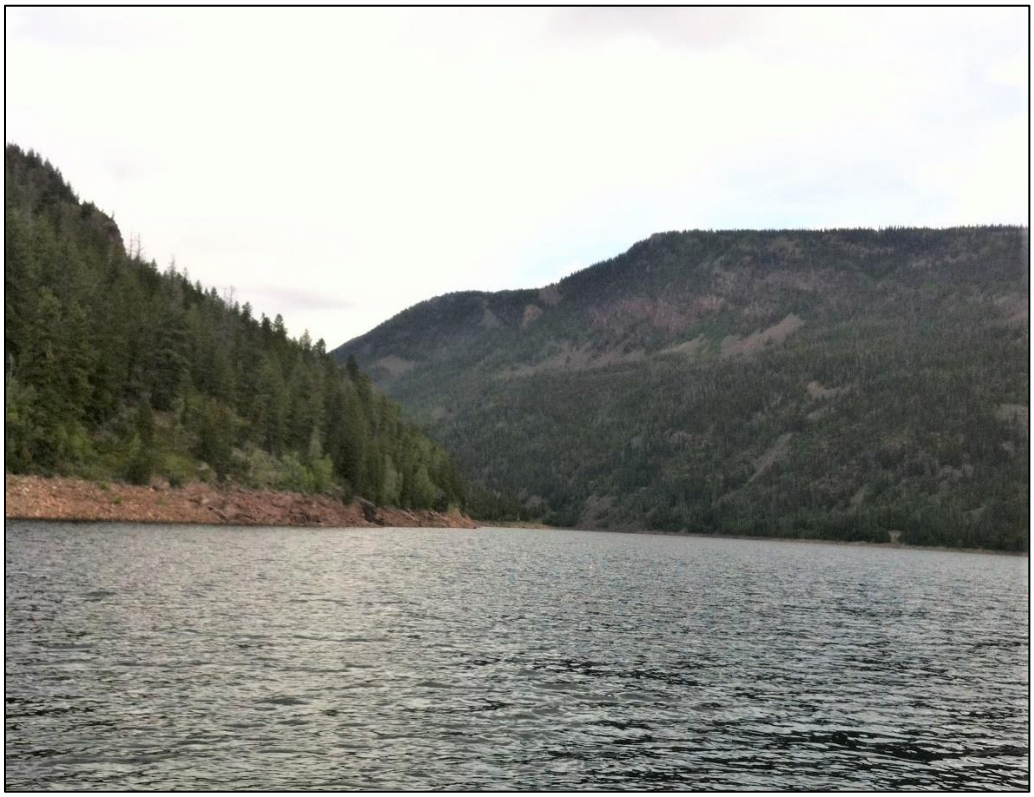
STATE OF UTAH

DEPARTMENT OF NATURAL RESOURCES

Division of Wildlife Resources- Sportfish Program

Moon Lake Creel Survey

July 2018- June 2019



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Introduction

Moon Lake is a natural lake, originally carved by a glacier. It was enlarged by an earth-filled dam, which was completed in 1938 by the U.S. Bureau of Reclamation (BOR) as part of the Moon Lake Project. Moon Lake Water Users Association (Association), which is comprised of eight irrigation companies, operates and maintains the entire project, including Moon Lake dam. The Association delivers Moon Lake water to irrigate approximately 75,000 acres of farmland in Duchesne and Uintah counties. The lake sits in the Lake Fork drainage and impounds Lake Fork Creek, Brown Duck Creek and Fish Creek (Figure 1). Moon Lake sits at an elevation of 8,083 feet and is 770 surface acres at full pool. The lake has a maximum capacity of 35,847 acre-feet; the Utah Division of Wildlife Resources (Division) does not have a conservation pool on this waterbody. Maximum depth at full pool is 158 ft. A small hydroelectric power plant sits at the base of the dam; the plant is owned by Moon Lake Electric. The United States Forest Service (USFS) owns the entire reservoir shoreline with a small area above the western shoreline privately owned (Moon Lake Resort). Access to Moon Lake is via County Road 131, north from Mountain Home approximately 15 miles across Ute Tribal lands and into the Ashley National Forest.

Moon Lake is filled with runoff from the high Uintas (Lake Fork, Brown Duck, Fish Creek drainages), which typically peaks in June. The lake is usually full or nearly full going into the summer months and irrigators are reliant on Moon Lake water into the late summer, at which point the reservoir is quickly drained to meet this demand. In some years, the lake reaches its dead pool, the point at which the outlet is exposed.

Moon Lake is an important lake for recreation. The U.S. Forest Service (USFS) owns the land around the lake and to the north of the lake. The wilderness boundary for the high Uinta wilderness runs across the north portion of the lake. Hunting, fishing, hiking and backpacking are the main uses of the lake and its surrounding area, but resort-goers utilize the area for relaxing, picnicking, and all the things associated with summer resort lodging. The resort offers small boat rentals between Memorial Day and Labor Day, in addition, some boaters launch their private boats; however, there is no boat ramp and launching is considered "at your own risk" especially later into the summer as the water level is drawn down and the sandy shoreline is exposed.

According to the Utah Division of Water Quality (UDWQ), the water quality of Moon Lake is very good. Using Carlson's Trophic State Index, UDWQ classified the lake as oligotrophic in 2006-2007 (the last time it was assessed), though its index value has resulted in a mesotrophic classification in some sampled years (DWQ 2008). Its beneficial uses are listed as domestic, infrequent primary contact and secondary contact (boating and wading), coldwater species, and agriculture; the lake has met these uses in all years monitored (DWQ 2008). The lake does stratify slightly but may be more intense during select times of the year. The lake is nitrogen limited with low levels of the nutrient present.

Moon Lake contains a variety of fish species including Brown Trout (*Salmo trutta*), Rainbow Trout (*Oncorhynchus mykiss*), Tiger Trout (*Salmo trutta* x *Salvelinus fontinalus*), Mountain Whitefish (*Prosopium williamsoni*), Mountain Sucker (*Catostomus platyrhynchus*), Splake (*Salvelinus fontinalis* x *Salvelinus namaycush*), kokanee salmon (*Oncorhynchus nerka*), Brook Trout (*Salvelinus fontinalis*) and Arctic Grayling (*Thymallus arcticus*). The Division's quota has slowly increased for Moon Lake, which was understocked (based on acreage) for many years. The 2021 request is for 750 (10-in) Tiger Trout (first year for this size), 10,000 (3-in) Splake and 4,450 (12-in) Rainbow Trout (first year for this size). While the Splake request has been steady for many years, the hatchery has not always been able to provide the full quota and in half of the years in the decade preceding the creel, Splake numbers stocked were less than half the requested number. Tiger Trout have been stocked since 2007 (10,000 3-in fish) and the lake has received its full quota for eight of the 10 years preceding the creel. Hatcheries have always been able to meet the Rainbow Trout quota; however, the request has changed over the years from 5,500 10-in fish before 2010 down to 2750 10-in fish 2011-2015 as a result of required cuts. From 2016 on, the Division has slowly been increasing the Rainbow Trout quota as Rainbow Trout have been freed up from other regional waters. In 2020, the quota was 8,580 and although 2021 represents a reduction in numbers, due to the size increase to 12-in, the pounds stocked into the water will remain the same. In the four years preceding the creel survey, Moon Lake received 2,759 Rainbow Trout (2015; averaged 9.8 in), 2,750 Rainbow Trout (2016; averaged 8.4 in), 6,998 Rainbow Trout (2017; averaged 8.0 in), and 7,810 Rainbow Trout (2018; averaged 9.0 in). Moon Lake is sampled periodically as outlined by the Division's Northeastern Region reservoir sampling plan. Sampling is performed using gillnets as a sampling tool per the AFS standard sampling recommendations.

Since completion of the dam, Moon Lake has been predominantly a "put-and-take" Rainbow Trout (RBT) fishery with Splake and Tiger Trout (TGT) more recently added as "put-grow-take" fisheries. Utah's new stocking strategy lists all three species under the "Opportunity" management concept, although the evaluation metrics show that the Splake fishery should be either "Quality" or even a "Trophy" fishery with a little improvement in the size structure. The TGT fishery could be considered a Predator Management or Unique

fishery as they were stocked to take advantage of the numerous Mountain Sucker and to provide another unique experience for anglers.

Historical information on the history of this fishery is extremely limited, likely due to its remoteness and limited productivity. In a survey of the lake from 1968, biologists noted that the plankton and bottom fauna crop was "Fair" (essentially a rating of '2' on a scale of 1-4) and zooplankton surveys on two occasions in 2020 show a very limited zooplankton food base. This recent sampling was not extensive but it did show predominantly rotifers, though in low abundance (May). Summertime samples showed a few more Daphnia and copepods but productivity in this waterbody is much less than other NER reservoirs. They recognized the limited potential of this fishery back in 1979 and discussed stocking *Gammarus pseudolimnaeus*. This action never occurred, however, likely due to the limited submerged vegetation in the lake, which would have been essential for the species' success. Submerged vegetation continues to be limited around the lake due to steep shorelines for about 65% of the lake and extreme water level fluctuations affecting the ability of vegetation to establish in littoral areas.

Data from the opening weekend creel in 1974 were not summarized but did show that creel clerks contacted 135 anglers on June 1 for a total of 344 fish harvested, the vast majority were RBT. Only 46 anglers were contacted on June 2 for a total of 58 fish harvested, mostly RBT again. These were split between boat and shore anglers. Estimated catch rates for both days was 0.88 fish/hr from shore and 1.04 fish/hr from boat. They estimated a total harvest of 3,011 fish that year; however, the timeperiod for that estimated harvest was unclear. Total angler days were 765 shore days and 98 boat days. These results suggest that they had improved catch rates between a netting completed in 1965 and the 1974 opening weekend creel, likely by increasing the size of RBT stocked. Correspondence with the Ashley National Forest in 1982 stated that the fishery was being managed with catchable RBT in 1978, and this change was likely made a few years before the correspondence.

In 1978, staff completed a 3-month creel covering June through August. Data is limited from this effort; however, total estimated harvest ranged from 5,740 in June to 12,239 in July and 2,483 in August. Again, the vast majority of harvest was RBT, though a few CTT, KOK, and one MWF were taken. Catch rates for RBT were 0.514 fish/hour (hr) in June and 0.432 fish/hr in July. Estimated angler days were 3,069 hrs in June, 9,448 hrs in July, and 3,611 hrs in August. Shore and boat anglers were split almost evenly in June but boat anglers had declined to only 11% of the angling clientele by August. This is similar to the current situation, which is a result of the drastic drawdowns at Moon Lake making it difficult to launch a boat in the late summer.

The last creel survey we have records from occurred in 1987. This was again a June-August creel. The abstract says that they contacted 289 anglers who spent a total of 781.5 hrs fishing and harvested 218 RBT, six CTT, two BKT, two MWF, and one KOK. The overall catch rate was 0.29 fish/hr. Angler days were not calculated, but they report 6,759 boat angler hrs and 16,285 shore angler hrs. The report for this creel noted that anglers complained of the small size of fish and the low catch rates. Fish were stocked early in the season in an effort to improve success of early season anglers. Despite this, angler effort was down as were catch rates. The authors note that poor fishing was likely a main factor but that also the biting flies were a huge problem that year and likely kept the anglers away to a certain extent (this would affect angler effort, but shouldn't affect catch rates).

The authors recommend stocking larger, fewer RBT and also stocking a different species (Splake were suggested).

Regulation of this fishery is now focused on Opportunity as a management concept (e.g., higher catch rates instead of larger size). Beginning in 2021, the RBT component will be a true "put-and-take" fishery where 4,450 12-in RBT will be stocked annually starting in 2021 and we anticipate more harvest during their first year in the lake. RBT have always been stocked into Moon Lake in late May to early June and are intended to provide high catch rates and opportunities for harvest over the summer, which is the main fishing season as it is only accessible via snowmobile in the winter. The only special regulation at Moon Lake is a limit on the Splake harvest. The trout limit is four fish/day (which is the statewide limit); only two of the trout can be Splake.

According to Division records, biologists have never completed an extended creel at Moon Lake. As a result, we chose to implement a creel survey to estimate angler pressure, catch and harvest rates, overall harvest by species, and determine angler preferences and overall angler satisfaction at the lake. Due to the limited winter access, we performed this creel from July to November in 2018 and May to June in 2019.

Methods

Between July 2018 and June 2019, a stratified roving creel census (Thomas and Chamberlain 2002) was conducted at Moon Lake. Survey days included three randomly selected weekdays and three randomly selected weekend days (including holidays) per month; random selections included alternate dates for each, although those were rarely used. Length of survey was dependent upon the number of daylight hours, which was consistent within month but varied between months. Instantaneous angler counts were conducted four times on each survey day. Angler count times were determined systematically based on a random selection of a start time that allowed the four counts within a day. Including the randomly selected count time, counts were conducted every two hours from the randomly selected start time. For example, if 7:30 am was randomly selected then count times occurred at 7:30, 9:30, 11:30 and 1:30 pm. Anglers were interviewed throughout the day, before and after all creel counts. Information was collected on each group of anglers including type of angling (boat, shore, float tube), age of anglers in the group (<14, 14-30, 31-60, >60), whether their trip was complete, number of anglers in the group, hours (hrs) fished, type of fishing gear (bait, fly, lure), fish species sought, and numbers, species, and disposition (harvested or released) of fish caught. When possible, harvested fish were measured for total length (TL) to the nearest millimeter. Because creel clerks could not verify the number of species caught and released (fish were not in possession at the time), this number should be considered a close approximation, not an exact value. Clerks attempted to interview anglers at the completion of their fishing trip as often as possible; however, some interviews did occur before an angler's trip was completed. Both complete and incomplete interviews were used in the analysis and were not differentiated. Anglers were also asked five additional questions about the fishing habits, preferences, and satisfaction (see Appendix 1, Moon Lake Creel Design).

The program, The Utah Division of Wildlife Resources Statistical Analysis Program for Roving Creel Surveys, was used to estimate fishing effort, catch, catch rates, harvest, and harvest rates overall, by species, and by fishing method (Thomas and Chamberlain 2002). All statistical analyses were performed using SAS v9.4

(Statistical Analysis Systems; SAS Institute, 1996). We provide the standard error of the estimated mean to present variability.

Analysis of responses generated from the five additional questions were analyzed using basic analysis tools in Microsoft Excel (Microsoft Office Professional Plus 2016, Version 16.0.5095.1000) and data is presented as a percentage of the overall total that responded similarly.

Results

Fishing Effort

The estimated annual angling effort for all methods in the 2018-2019 Moon Lake creel census was 7,711 hrs (95% confidence interval [CI] = 6,702-8,720) or 10.0 hrs per surface acre. Of this effort, 35% of the effort was from anglers using watercraft (i.e., boats, float tubes or kick boats) and 65% was from shore anglers. Float tube anglers were contacted in June, July, and August with minimal fishing effort in this category each month (5% of total effort). Boat fishing effort was greatest in June (1,213 hrs), distantly followed by July (461 hrs) and August (432 hrs), a pattern mirrored by shore fishermen as well (2,280 hrs; 806 hrs; and 716 hrs respectively). Total effort was greatest in June (3,547 hrs) and again followed distantly by July (1,474 hrs) and August (1,316 hrs). May and September had many fewer angler hrs (663 hrs and 675 hrs respectively) and October and November had very few angler hrs (15 hrs and 23 hrs respectively; Table 1, Figure 2). Moon Lake received an estimated 1,516 angling trips in the 2018-2019 season with the majority of trips occurring in June (623 trips) and the next highest in July (325 trips; Table 2, Figure 3). The average length of these trips was 5.1 hrs. In most months, weekday trips were fewer than weekend trips. For those months with more weekday trips, the difference was a result of summer vacationers (Table 3; Figure 4).

Total Catch and Catch Rate/Mean Catch and Catch Rate by Month

An estimated 3,503 fish (95% C.I. = 2,843 – 4,163 fish) were caught at Moon Lake during the 2018-2019 fishing season. Mean Catch per Unit Effort (CPUE) for all species of fish in Moon Lake was 0.45 fish/hr. By month, overall catch was highest in June with 1,610 fish caught, followed by July (1,071 fish), then August (483 fish; Figure 5). CPUE was highest in July (0.73 fish/hr), then June (0.45 fish/hr), then September (0.41 fish/hr; Figure 5).

Total Harvest and Harvest Rate/Harvest Percentages/Mean Harvest and Harvest Rate by Month

The total estimated harvest for all species at Moon Lake was 605 fish (or 17% of fish caught; 95% C.I. = 444 – 766 fish) with overall harvest per unit effort (HPUE) at 0.08 fish/hr. By species, the total estimated harvest for RBT was higher than for any other species in the reservoir. RBT harvest accounted for 439 of the total fish harvested making them 73% of total harvest at Moon Lake during the 2018-19 season. Anglers harvested 83 TGT or 14% of the total, 45 Splake (7%), 37 BKT (6%), and no cutthroat trout. The remaining fish harvested was a kokanee salmon.

By month, June had the highest harvest with 263 fish harvested, followed by August (137 fish), and then September (115 fish). September and November had the highest HPUE with 0.17 fish/hr harvested during each of those months followed by August (0.10 fish/hr; Figure 5).

Catch/Catch Rates/ Harvest/Harvest Rates by Month and Species

Mean Catch, CPUE, Harvest, HPUE, and Length by species is included in Table 4 for quick reference.

Rainbow Trout

An estimated 2,552 RBT were caught during this creel survey; of those, an estimated 439 RBT (or 17.2%) were harvested. Mean CPUE for RBT was 0.33 fish/hr and mean HPUE was 0.06 fish/hr. Total catch for RBT was highest in June (1,026 RBT) with July (930 RBT) and August (399 RBT) next highest (Table 5, Figure 6). CPUE for RBT was highest in July (0.63 fish/hr), followed by August (0.30 fish/hr) then June (0.29 fish/hr; Table 5, Figure 6). Most RBT were harvested in June (176 RBT), followed by August (131 RBT; Table 5, Figure 6). HPUE was highest in September (0.13 fish/hr) followed by August (0.10 fish/hr; Table 5, Figure 6). Average total length of RBT harvested was 253.4 mm (n=77).

Tiger Trout

An estimated 275 TGT were caught during this creel survey; of those, an estimated 83 TGT (or 30%) were harvested. Mean CPUE for TGT was 0.04 fish/hr and mean HPUE was 0.01 fish/hr. Total catch for TGT was highest in June (214 TGT) followed by May (37 TGT; Table 6, Figure 7). CPUE for TGT was highest in May and June (0.06 fish/hr; Table 6, Figure 7). Harvest was highest in June (83 TGT) with HPUE also highest in June (0.02 fish/hr; Table 6, Figure 7). Average total length of TGT harvested was 278.6 mm (n=10).

Splake

An estimated 135 Splake were caught during this creel survey; of those, an estimated 45 Splake (or 33.3%) were harvested. The mean CPUE of Splake was 0.02 fish/hr and mean HPUE was 0.006 fish/hr. Total catch for Splake was highest in August (51 Splake) then June (45 Splake), but CPUE was highest in November (0.16 fish/hr) followed by September (0.04 fish/hr; Table 7, Figure 8). Harvest was highest in June (22 Splake) followed by September (19 Splake), but HPUE was highest in November (0.17 fish/hr) followed by September (0.03 fish/hr; Table 7, Figure 8). Average total length of Splake harvested was 304.9 mm (n=8).

Brook Trout

An estimated 221 BKT were caught during this creel survey; of those, an estimated 37 BKT (or 16.7%) were harvested. The mean CPUE of BKT was 0.03 fish/hr and mean HPUE was 0.005 fish/hr. Total catch for BKT was highest in July (104 BKT) followed by September (62 BKT; Table 8, Figure 9). CPUE for BKT was highest in September (0.09 fish/hr) followed by July (0.07 fish/hr; Table 8, Figure 9). Harvest was highest in July (31 BKT) followed by June (4 BKT) and August (3 BKT). BKT were not harvested in any other month. HPUE for BKT was highest in July (0.02 fish/hr; Table 8, Figure 9). Average total length of BKT was 259.7 mm (n=9).

Cutthroat Trout

An estimated 48 CTT were caught during this creel survey; none were harvested. The mean CPUE of CTT was 0.01 fish/hr. All 48 CTT were caught during the month of August. Because no CTT were harvested, none were measured during this creel survey.

Kokanee

An estimated 355 KOK were caught during this creel survey; one was harvested. Mean CPUE for KOK was 0.05 fish/hr and mean HPUE was negligible. Kokanee were caught between June and September (315 KOK, 21 KOK, 9 KOK, 10 KOK respectively). The one KOK measured during this creel survey was 241 mm.

Catch/Catch Rates/ Harvest/Harvest Rates by Month and Fishing Type

Boat

During the months that boat and float anglers were recorded, these groups consistently had higher CPUE than shore fishermen. Boat fishermen had the highest catch in June, but the highest CPUE in July (896 fish, 1.2 fish/hr respectively); CPUE was >0.5 fish/hr in three of the four months in which boat anglers were recorded (June through September; Table 9, Figure 10). Boat harvest was highest in June (98 fish) and August (85 fish); HPUE was highest in August (0.20 fish/hr) and September (0.14 fish/hr; Table 9, Figure 10). Mean CPUE for boat anglers was 0.77 fish/hour; mean HPUE was 0.10 fish/hour. Float anglers were only recorded in three months (June-August) and were recorded catching fish in only two months (July and August). Float anglers caught 169 fish in July and 115 fish in August, with a CPUE of 0.82 fish/hr and 0.69 fish/hr, respectively. Float anglers were only recorded harvesting fish during the month of July in which they harvested 22 fish with a HPUE of 0.11 fish/hr.

Shore

Shore catch was highest in June (774 fish) then September (135 fish; Table 10, Figure 11). CPUE was highest in June (0.33 fish/hr) followed by September (0.26 fish/hr; Table 10, Figure 11). In all other months, CPUE was 0.17 fish/hr or below. Harvest was highest in June (147 fish) then September (87 fish; Table 10, Figure 11). Mean CPUE for shore anglers was 0.23 fish/hr; mean HPUE was 0.06 fish/hr.

Angler Demographics and Preferences

Basic demographic data is the result of interviewing 420 anglers during the 2018-2019 Moon Lake creel survey. The majority of these anglers were from Utah (94.0%). Of Utah anglers, the highest percentage (36%) were Salt Lake County residents, followed by Duchesne (21.3%), and Utah (19.3%) counties (Figure 12). Non-resident anglers were predominantly from Colorado and Oregon, but also Washington and Wyoming (Figure 13). Male anglers comprised 73.5% of anglers interviewed. Most anglers were between the ages of 30 and 60 years old (43%), followed by 14-30 years old (28.9%); 22.9% were under the age of 14, and 5.3% were older than 60 (Figure 14).

Seventy-seven anglers responded to the first opinion question. The first asked them in general (not just this particular fishing trip) which species group they prefer to target. Potential responses included trout, pike, bass, panfish, and catfish. Fifty-one anglers (or 69.9%) responded that they only fished for trout; 8.2% responded that they don't have a preference, 6.8% responded trout and bass, 5.5% catfish, and 4.1% bass (Figure 15). The

remaining four anglers each said something different (panfish, pike, trout/pike, and bass/catfish). When accounting for combination species groups (and adding the six anglers that had no preference to each group), 60.6% of anglers said trout, 14.4% said bass, 10.6% said catfish, 7.7% said pike, and 6.7% said panfish (Figure 16).

Seventy-three anglers responded to the second question, which asked if they were satisfied with their fishing trip that day. Sixty-six anglers responded that they were satisfied (90.4%) and only seven (9.6%) were dissatisfied with their trip (Figure 17). Of those anglers that were satisfied, 60.9% gave a reason listed as "other." Responses in the comments section from these anglers included things like "nice view," "good environment," and "love the location," suggesting that these anglers come to Moon Lake for the resort and the area, not primarily to fish. Twenty-three percent of anglers responded that they were satisfied due to fish quantity, 6.3% due to fish species, 4.7% due to level of pressure, 4.7% due to species diversity, and 3.1% said it was due to both quantity of fish and level of pressure (Figure 18). No angler said he or she was satisfied due to fish size. Of the seven anglers that were dissatisfied, these anglers wanted either more fish, bigger fish, or both. Of the anglers that wanted to catch more fish, only one angler caught a single fish; the rest were "skunked." Of the two groups that wanted to catch bigger fish (counted as single anglers during the interview), these groups caught 10 fish between them and each group had three anglers.

Seventy-three anglers responded to whether they were aware that Splake are stocked into Moon Lake. Sixty-one percent responded that they were not aware of this and only 32.9% responded that they were aware.

When asked what species they targeted when fishing Moon Lake, over half of anglers responded they were targeting "any" species (56.8% of 74 respondents), 23% said RBT, 5.4% said RBT and BKT, 4.1% said BKT, and two anglers each said Splake, other, RBT/other, or TGT (Figure 19). When multi-species responses were lumped together, anglers responding that they targeted RBT went up to 60.2%, Splake 23.8%, BKT 10.0%, and TGT 6.3% (Figure 20).

Discussion

Fishing Effort

Based on information gathered during the 2018-2019 creel survey, Moon Lake is the least fished of the seven regional waters creeled with this protocol in the last decade (Figure 21). Total fishing effort was the lowest (though remember the lake not accessible for five months of the year) of all our creels, even lower than Red Fleet Reservoir, the next lowest total effort (9,002 hrs). Accounting for its size, it has much less effort than our other waters (10 hrs/surface acre (SA) vs Red Fleet at 17.3 hrs/SA). In defense of this water; however, Moon Lake is drawn down significantly and is not at full pool (770 surface acres) most of the year. Over the time period of January 2016 to February 2021, the reservoir actually averaged 503 surface acres according to the Association via the automated website "duchesneriver.org." Effort per surface acreage would be 15.3 hrs/SA using the average value, which is still lower than other regional waters.

Most visitors were either from Salt Lake or Duchesne counties, with the next highest visitation rate from Utah County. This is interesting as it shows that Uintah County residents, who are closer than Salt Lake or Utah

residents, don't tend to travel to Moon Lake (only two hours from Vernal, UT). In a small, anecdotal Facebook survey done after this creel was performed, many Uintah County residents said that they had never heard of Moon Lake. If this is the case, Moon Lake has potential to become a more important regional fishery with a little bit of outreach (this water was the location of the Fishing with the Fox tagged fish contest in 2020 to begin this effort).

In order to increase effort here, however, it is likely that we'll have to increase catch rates and/or the average total lengths, especially for RBT, the species most often targeted by Moon Lake anglers. Of the seven reservoirs recently creeled in the Uintah Basin, six of them had annual RBT quotas in the years leading up to the creel survey (Red Fleet, Matt Warner, Calder, Starvation, Steinaker, and Moon Lake). Testing the correlation between effort/SA and RBT mean TL shows a positive correlation ($r(4)=.71$), while that same test between effort/SA and RBT CPUE shows a positive, slightly stronger, correlation ($r(4)=.79$). Calder has the highest angler effort for its size and also the largest mean total length and CPUE for RBT (Figures 22, 23). Starvation is next highest for average TL, but lowest for CPUE and potentially as a result sees the fourth highest angler effort for its size. Matt Warner is second for CPUE and third for average TL, which seems to be reflected in angler effort there. Red Fleet (RBT were stocked here prior to 2015) was third highest for RBT catch rates, though had the lowest average TL for RBT, which seems to have impacted angler visitation during that creel survey. Red Fleet also suffers from a lack of easily accessible, fishable shoreline and given that most anglers creeled there were boat anglers, the low angler hours at Red Fleet may also be a result of few shore anglers relative to other waters. Steinaker is fourth highest for both CPUE and average TL, but third highest for effort for is size, which is likely due to its proximity to Vernal and greater amount of accessible (to fully capable anglers, not necessarily handicapped or limited mobility anglers) and fishable shoreline. As for Moon Lake, it almost has the lowest RBT CPUE (0.33 fish/hr vs 0.32 fish/hr at Starvation) and has by far the lowest average total length for RBT (253 mm vs 330 mm at Red Fleet, the next smallest average total length). Moon Lake is oligotrophic to mesotrophic and does "suffer" from lack of nutrients. It also has very little fishable shoreline and no improved boat launching so it does make sense that few anglers visit the water and that the lake is not on too many angler's radars. In general, at least for the Uintah Basin, the recipe for attracting anglers appear to be: have as many RBT as possible (so that CPUE is on target or slightly above) while still preserving the ability of the water to provide a quality fish. If you can't create this balance, then be close to a population center and have extensive lengths of accessible, fishable shoreline with reasonable catch rates and the chance to catch larger fish. Moon Lake has none of these attributes.

In reviewing the total lengths of harvested RBT, it appears that there is one large year class of stocked fish and that overwinter survival may be low (Figure 24). Upon closer inspection, and given the oligotrophic status of this water, the more likely explanation is slow growth. Upon comparing fish size by date harvested and stock date for each year, it does appear that survival is good. In fact, 36% and 13% of fish harvested in 2018 and 2019 respectively were likely stocked in the year before being caught/harvested. In addition, of fish caught in May and June 2019, 77% likely overwintered for at least one year. It would be best to confirm this with age data from hard structures; however, this assumes a maximum of 0.5 inches of growth per month during the growing season (May-Oct) so while conservative, this is not unlikely given the lake's nutrient status. In 2018, the age-1

year class (stocked in 2018) was the predominant year class in the creel. In 2019, many fewer fish were caught, but the age-2 year class (stocked in 2018) was again the predominant year class in the creel.

In the years leading up to this creel survey, three different RBT strains were stocked, depending on the year. In 2016, the 2,750 8-in RBT that went in in the spring were the Heritage-Erwin strain. We cannot estimate survival of this particular strain into the years of the creel, but it does appear that anglers caught two of these fish in 2018 and one in 2019 (fish measured that were over 14-in). The 2017 strain was Harrison-Hofer and these fish were stocked in the fall due to the hatchery's inability to provide a triploid RBT in the spring that year. Based on assumed growth rates and lengths of fish caught (and measured) during the creel, we believe that nearly a third of the RBT caught were from the 2017 stock. All but one of these were caught in 2018. The vast majority of fish captured in the creel (and measured) were from the 2018 stock. These fish were Fishlake-Desmet strain as were the 2019 stock. It is likely that three or four of the RBT caught (and measured) in June 2019 were the recently stocked Fishlake-Desmet fish. Given this information, no one strain really stands out as better or worse for this water.

Given the oligotrophic status of the lake, overstocking could be a real concern; however, we are not only concerned about condition and survival of the fish, but also angler satisfaction and anglers do want to catch more and larger fish at Moon Lake. A knee-jerk reaction to this desire is likely to say "who doesn't?!" However, it is clear from our data that fish are not growing quickly, although overwinter survival does seem to be occurring. In addition, catch rates by species are lower for shore anglers than we would like to see for an Opportunity water. Given this, we feel that we should try to improve size and catch rates at Moon Lake. In 2021, we have requested an increase to a 12-in RBT (and reduction in numbers from 8580 RBT to 4450 RBT) to help increase angler satisfaction since growth is so slow here. Data from Washington found that RBT were twice as likely to return to the creel when stocked at 11-in or 12-in (Losee and Phillips 2017). This same report observed an increase in harvest as well, likely meaning that anglers were more satisfied with the size of their catch (Losee and Phillips 2017). In addition, also beginning in 2021, we have requested 750 10-in TGT rather than the 10,000 3-in TGT. This size increase is in an effort to increase angler satisfaction, but more importantly, to stock something that can switch over to piscivory more quickly once in the reservoir. As 3-in fish, the TGT compete with the RBT and the stocked Splake for an unknown time. Our sampling information has recorded TGT consuming invertebrates up to 21-in and zooplankton up to 19-in and Splake consuming invertebrates up to 15-in; though these species more often have KOK or MTN in their stomachs at these sizes.

Total Catch and Catch Rate/Mean Catch and Catch Rate by Month

Anglers did not catch many fish at Moon Lake during this creel survey, especially relative to the number of fish stocked in the lake. Overall CPUE (0.45 fish/hr) did meet our stocking plan creel goal of 0.36 fish/hr for Opportunity fisheries; however, by species, RBT was the only one that came close to the goal (0.33 RBT/hr; Table 4) and this was heavily influence by July's RBT CPUE (Table 5, Figure 6). The remaining months had much lower CPUE (Table 5; Figure 6). In addition, the overall catch rate was very low relative to other Uintah Basin waters except Starvation (Figure 25). The reservoir appears to be most fishable over the summer (Jun-Aug), although Splake and BKT catch were elevated into September as well. Higher catch rates during the summer likely had as much to do with accessibility of the reservoir as vulnerability of the fish. Moon Lake fills with spring runoff, which happens later in the spring at high elevation waters. If it fills, the lake would be at full

pool in June and water levels steadily decline after that and can be quite low by September. Launching a boat becomes more difficult as water levels decline, although the resort does have small boats for rent from Memorial Day to Labor Day. This was reflected in boat angler effort (Table 1, Figure 2) and very few boats were recorded in May and September and none were recorded in October or November. And given the lake's inaccessibility during the winter (it is even difficult to access with snowmobiles), we were unable to reach it to perform the creel and can assume that ice fishing pressure was negligible to non-existent.

We have very little historical information for this water; however, it appears that Moon Lake has suffered from low catch rates and low satisfaction for as long as we have records. The 1974 opening weekend creel showed a promising increase in RBT catch rates for shore anglers (0.88 fish/hr). While this information is not directly comparable to our effort due to a completely different creel design, it does show an improvement in the RBT fishery at Moon Lake. The next creel, performed in 1978, was a 3-mo creel showing good catch rates for RBT in June and July, with catch rates falling off for August, similar to our results (overall CPUE by month; Figure 5). The last creel (another 3-mo creel) we have record of occurred in 1987 and results show a return to poor overall catch rates (0.29 fish/hr) and low angler satisfaction. Anglers complained about the size of fish and the quantity of fish. The authors of the report recommended stocking a new species such as Splake, but mentioned no rationale for this particular species.

Given our results, Moon Lake appears to have potential to be a good fishery between Memorial Day and Labor Day. There is likely not much point in trying to improve catch rates during shoulder seasons at this water. That can be done at other, more accessible waters. Utah has numerous waters around the state that are good fishing only on a seasonal basis. No one water can have high catch rates throughout the entire year. We know catch rates are highest here during the main fishing season and from a boat and we should capitalize on that fact. In 2020, the Division put tagged fish into Moon Lake for the Fishing with the Fox tagged fish contest and most of the fish stocked were actually caught by anglers. Promotions like this, which run from the end of May through mid-August can help spread the word about this as a great opportunity for summertime fishing.

Total Harvest and Harvest Rate/Harvest Percentages/Mean Harvest and Harvest Rate by Month

Anglers harvested 17.2% of fish they caught at Moon Lake during the creel survey with RBT comprising the majority of fish harvested with TGT next. Harvest per unit effort was 0.08 fish/hr for all species. Monthly overall HPUE was always much lower than CPUE except for the months when CPUE was also low (October, November, and May). HPUE and CPUE were equal in November due to one group harvesting all fish caught. (Figure 5). These results show that overall harvest is very low at Moon Lake, meaning that either anglers do not fish at Moon Lake to harvest but rather to catch fish or just enjoy the area *or* that anglers do not think fish are large enough to harvest (some anglers did request larger fish). We do see some evidence of this in our results as TGT and Splake average total length was larger than average total length of RBT and BKT and anglers harvested a greater percentage of those species relative to the number caught. If size is the main barrier to harvest, stocking a super-catchable RBT and a catchable TGT is likely a good place to start. Evaluation of this can occur through summer spot creels as time allows, an online survey post-fishing season, or the Division's new "reward tag" system as we are on a 10-12 year cycle for creel surveys in the region meaning that Moon Lake won't be re-surveyed for awhile.

Harvest by species

Total annual stock into Moon Lake in 2018 was 3,357 pounds (vast majority from catchable RBT), but clearly, anglers harvest only a small percentage of these. Anglers mostly harvested RBT (439 fish) and TGT (83 fish), but they also harvested Splake (45 fish) and BKT (37 fish). The annual stocking request at Moon Lake for the two years of the creel was 3,157 pounds of RBT (7,700 catchables), 105 pounds of Splake (10,000 fingerlings), and 95 pounds of TGT (10,000 fingerlings). Using the average total length of each species harvested during this creel, and making some assumptions about weight at time of harvest (we did not weigh any fish during this creel), we can reach conclusions about the return on our investment at this water. With an average TL of 253.4 mm, most RBT caught had not grown substantially since stocking, resulting in a 33% return on fish stocked in 2018. These fish do survive overwinter and are caught in subsequent years so return on this year's stock would be a little higher than 33% with all years included. We stock 95 pounds of 3-in TGT each year meaning that this species sees good growth between stocking and return to the creel (average TL was 278.6 mm (n=10)). Given the average length at harvest, we do get a better return on this species per pound than RBT; however, we see many fewer TGT harvested. Average TL of Splake harvested was 304.9 mm (n=8). In 2018, we stocked 105 pounds of Splake in Moon Lake (no Splake were stocked in 2019). We see good growth between stocking and return to the creel for this species. Assuming a 304.9 mm (12-in) fish weighs one pound, we see a greater return to the catch, but not the creel as few Splake were harvested. No other species are stocked into Moon Lake. Given these harvest numbers, the lower catch rates for shore anglers, and the low harvest by all anglers (potentially as a result of small size), it is clear that Moon Lake could use some improvements. Again, converting the RBT stock to super-catchables and the fingerling TGT to catchables should help with this. This effort will be monitored and evaluated for a few years after the initial stock.

Catch and harvest of non-stocked species (BKT, CTT, and KOK) was low; however, because we do not stock these fish or feed them in the hatchery, they certainly represent a more efficient component of the fishery. This is especially true for BKT since anglers were able to catch this species and even harvested a few of them.

Catch and Harvest by Fishing Type

Boat anglers consistently had higher catch rates than shore anglers when they were able to access the reservoir (Tables 9-10; Figures 10-11). In fact, during the months that boaters were able to fish Moon Lake, they actually had good CPUEs (0.41-1.2 fish/hr depending on the month). Shore anglers, on the other hand, consistently had low CPUEs (0-0.34 fish/hr) and most months it was around 0.1 fish/hr, much lower than our creel goal for Opportunity waters. The new resort owners would like to install a fishing pier at Moon Lake and while a fishing pier would help improve shore angler access and potential catch rates at this water, fishing piers are expensive and can be logistically difficult to maintain, especially in irrigation reservoirs (where water levels fluctuate daily) and windy locations where no breakwater facilities exist. We believe a better route for the resort owners would be to encourage boat fishing more. They do have a dozen small jon boats available for rent each day during the summer. Shore anglers could switch to boat fishing at Moon Lake without having to own a boat.

Other, more logistically feasible methods for increasing shore angler access could include stocking a species that will use the extensive sandy shoreline east of the resort where most Moon Lake anglers fish, installing habitat structures that would attract fish, or encouraging Moon Lake anglers to walk further and fish from other areas where fish are more likely to be found. Each of these comes with its own difficulties, as few fish available

to us would use the extensive sandy shoreline more often. The Division did review potential for one of four salmonid species (Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*Oncorhynchus kisutch*), Atlantic Salmon (*Salmo salar*), or Arctic Char (*Salvelinus alpinus*)) for this water in a literature review in 2020. And while Arctic Char may one day provide an interesting and unique species for Moon Lake (see Species Review 2020, unpublished DWR literature review), the species will not likely increase shore angler catch rates except in the fall. From information found in the literature, the species prefers deep water below the thermocline and are only seasonally found in shallow areas, leading up to and during their spawn as they are in-lake spawners (Johnson 1980; Everhart and Waters 1965). In addition, preparations would have to be made statewide before a new species can be stocked and this would take many years. One way to increase use of this habitat type would be to overstock fish and force them to use non-preferred habitat; however, this is not an efficient use of hatchery fish. In addition, the drawdown on this water is extensive. Over the last year (2020), Moon Lake reached its high elevation of 8137 ft in early June and its low elevation of 8095 ft in September. This is a change of 42 ft and can happen every year. Each time the reservoir is drawn down, that sandy shoreline goes from inundated to completely exposed over the growing season, meaning no submerged vegetation can grow. The difficulty with artificial habitat would be that each structure, which would be one small point in the reservoir, would be fishable for only a short time before becoming exposed. And with yearly exposure to the air, algae is not likely to grow on these structures. Structures could be placed below 8095 ft and be "fishable" only late in the season, but regardless, habitat structures in this reservoir are likely to be fishable for only a short time period each year. Finally, it would be very inexpensive and very easy to encourage shore anglers to walk further and move to a better location to increase their catch. Only serious anglers will do this, however, and at least some of our Moon Lake anglers are just visiting the resort and fishing since they are there. Individuals already planning to hike may go further to fish, if they do not have small children or individuals with limited mobility in their parties.

Angler Demographics and Preferences

The average Moon Lake angler is a Utah resident hailing from Salt Lake County, is male, and is between the ages of 30 and 60 (Figures 12 and 14). This coincides closely with the latest Utah attitudinal survey in which most Utah anglers were older than 35 and male (Krannich et al. 2016). Statewide, anglers over the age of 65 comprise nearly 15% of the angling population, which is higher than what we saw at Moon Lake (5.3%) meaning that anglers over 60 are slightly underrepresented in this creel. Access is an extremely important consideration for anglers, especially older anglers with limited mobility, and little of Moon Lake's shoreline is accessible to shore anglers without expending effort. This may be limiting anglers over 60 and may point to a need to work with Moon Lake Resort on how to improve fishing access for shore anglers, especially for those 60+. On the other hand, younger anglers (<30) are more represented at Moon Lake (51.8%), potentially due to the presence of the resort and the use of the area for summertime family vacationing. Given the difficulties associated with providing access to those with limited mobility, and the remoteness of the area, rather than improving shore access for older anglers, a more efficient option might be to simply promote the area to families with younger children. Older anglers could be encouraged to rent a boat from the resort or fish at another water with better access.

The typical Moon Lake angler prefers to fish for trout (70%), even when not fishing at Moon Lake. This makes sense as Moon Lake is a coldwater fishery (Figure 15). When fishing at Moon Lake, the average angler prefers to target RBT, with Splake a distance second (Figure 20). Very few Moon Lake anglers were targeting Tiger Trout during this creel (6.3%), despite their having been stocked in Moon Lake for over a decade and having a higher catch rate than Splake, which were targeted by more anglers. This presents an outreach opportunity for the Division as anglers may just not be aware that this fish is stocked into Moon Lake or they may not know how best to target them.

Most anglers contacted during the creel were satisfied with their fishing trip. Mostly, anglers were just happy to be outside in a beautiful location; 20% contacted were satisfied with the quantity of fish caught (Figure 18). No anglers were satisfied due to size of fish caught. Of those that were dissatisfied (9.6%), the majority (75%) were dissatisfied due to low catch rates. All of the remaining dissatisfied anglers wanted to catch larger fish. Twenty-five percent of these dissatisfied anglers actually mentioned both larger fish and more fish. While there are times and occasions when angler expectations exceed what can be provided, fish are small at Moon Lake and they do grow slowly. In addition, much of the productivity is taken up by Mountain Sucker, an important non-game species, but also a potential forage species. There is likely extensive competition for limited zooplankton and macroinvertebrate resources, and increasing the size piscivorous fish stocked could help reduce competition and encourage greater utilization of the abundant fish forage in the lake. The Division's switch to a 10-in TGT stock in 2021 should help to reduce competition and also encourage greater utilization of this abundant food source. Removing a zooplankton competitor may increase growth rates and/or improve condition of RBT and KOK, which we will try to monitor over the next few years through our sampling. In addition, in the future, Arctic Char could take the place of a portion of the Splake stock, as although they prefer deeper habitats most of the year, they were noted as feeding benthically for part of the year and also turning to piscivory early (DFO 2004).

Our Moon Lake anglers are typically resort-goers with a few hours to spend fishing, likely in-between hikes and other activities around the area. Twenty-one percent of the anglers contacted and interviewed during the creel were locals from Duchesne County, meaning they travelled at least one half hour specifically to fish Moon Lake. The vast majority are coldwater anglers and predominantly prefer to target RBT, a readily catchable generalist, suggesting that they are not likely specialized anglers. Although the 24% that targeted Splake are likely more experienced and more specialized anglers.

One angler did request that the Division pursue constructing a boat ramp at Moon Lake. In fact, this is a common request for this water. The Division and USFS had worked towards a boat ramp between the years of 2008 and 2015, including receiving funding for construction. This effort ended in disaster; however, and the funding entity is unlikely to fulfill a request for a boat ramp here unless we can demonstrate a greater likelihood of success. Part of the problem is the expense. Because of the drawdowns that happen there, a boat ramp covering that entire sandy shoreline, high water to low water, would be long and expensive. This was the case originally, even after the original estimate was cut back by reducing the engineering of the original design. One option might be to construct a shorter boat ramp, but since drawdowns happen so quickly, it would only be used for one-two months of the year, making it an extremely inefficient expenditure. It is highly likely that if we could improve fall access to boaters, this water could become more important as a fall fishery. Another option

would be to use material other than concrete for construction (e.g., Flexamat). The other problem was the shallow slope of the shoreline, which would require fill material to build up the ramp or a great deal of excavation to excavate the appropriate slope over the length of the ramp. This latter design would require clearing sand from the ramp as the reservoir is drawn down annually and both of these methods were expensive.

The good news is that most anglers were satisfied with their overall experience at Moon Lake. Therefore, if the Division changes nothing, Moon Lake would still likely see the same visitation rate. However, with a few stocking tweaks and a more targeted outreach effort, the Moon Lake fishery could be quite improved over the next decade.

Recommendations

- Begin stocking 4,450 12-in RBT and 750 10-in TGT into Moon Lake and see how these fish perform in subsequent years. Ensure that the RBT strain used remains stable over time to help with this evaluation. Use an online survey or reward tagging system beginning in 2023 to track angler satisfaction in the years following initial stocking and Division netting to track growth and condition. As time allows, send creel techs to Moon Lake during the summer to add to angler satisfaction knowledge.

- Continue to stock 10,000 Splake into Moon Lake. Although 67% of anglers did not realize Splake were stocked into Moon Lake on a regular basis, a third of anglers contacted did and 24% spent time targeting them. The species does represent the opportunity for an occasional larger fish as the Splake harvested were on average larger than the RBT and as a piscivore, the species can get quite large.

- Promote Moon Lake as a great place for young families to fish between Memorial Day and Labor Day. Rather than trying various means to increase catch rates year round, focus on improving catch rates within the timeframe the water is most accessible.

- Promote all species stocked into Moon Lake, especially TGT and Splake, which offer unique fishing experiences for experienced anglers.

- Encourage Moon Lake Resort to use our data to promote their boat rentals. If resort goers are aware that catch rates were substantially higher for boat anglers, they may be more likely to rent a boat and try to increase their own catch rates.

- If interested in pursuing a boat ramp in the future, find ways to minimize expenditure and maintenance required. Work with the USFS (engineering staff as well as biologists and recreation staff) through all phases of the project. And finally, evaluate the cost of an improved ramp against the effort expended at the lake and the seasonal nature of the lake.

- Do not stock any new species into Moon Lake at this time. However, if catch rates and condition improve with our 2021 stocking changes and statewide preparations can be made, pursue replacing at least part of the Splake quota with Arctic Char for a unique opportunity.

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Tables – Months are presented in order of when data was collected

Table 1. Total effort (hours) by type of fishing and by month, Moon Lake 2018-2019. Standard error is displayed as a measure of variability around estimated values.

Month	Total	SE Total	Shore	SE Shore	Boat/Float	SE Boat/Float
July	1473.8	510.8	806.3	390.5	667.5	267.2
August	1316.0	423.8	716.3	266.5	599.7	299.9
September	674.9	262.7	523.3	165.9	151.7	118.8
October	14.7	21.4	14.7	21.4	0.0	0.0
November	22.5	31.8	22.5	31.8	0.0	0.0
May	662.5	442.3	640.0	423.5	22.5	31.8
June	3546.7	558.5	2280.0	477.1	1266.7	373.8

Table 2. Angler trips by fishing type and month, Moon Lake, 2018-2019. Standard error is displayed as a measure of variability around estimated values.

Month	Total	SE Total	Shore	SE Shore	Boat/Float	SE Boat/Float
July	324.6	171.8	162.1	114.0	153.7	74.8
August	225.6	91.0	207.3	57.9	81.4	44.3
September	122.2	42.3	86.9	22.8	32.6	24.6
October	11.0	8.7	11.0	8.7	0.0	0.0
November	3.8	3.1	3.8	3.1	0.0	0.0
May	206.2	84.1	197.4	77.9	6.4	5.2
June	623.0	144.8	405.9	101.0	300.2	70.7

Table 3. Weekend vs. weekday angler trips by month and fishing type, Moon Lake, 2018-2019. Standard error is displayed as a measure of variability around estimated values.

Weekend vs Weekday Angler Trips by Month												
Month	Total				Shore				Boat/Float			
	Total WE	SE Total WE	Total WD	SE Total WD	Shore WE	SE Shore WE	Shore WD	SE Shore WD	Boat WE	SE Boat SE	Boat WD	SE Boat WD
July	186.6	167.2	138.0	39.5	105.6	108.9	56.6	34.0	73.3	72.4	80.4	42.1
August	107.7	39.1	118.0	82.1	98.5	43.9	108.8	37.8	25.8	14.0	55.6	43.8
Sept	98.9	41.9	23.3	5.5	70.4	21.6	16.5	7.6	25.7	23.2	6.9	8.3
Oct	11.0	8.7	0.0	0.0	11.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0
Nov	3.8	3.1	0.0	0.0	3.8	3.1	0.0	0.0	0.0	0.0	0.0	0.0
May	123.7	74.5	82.5	39.0	114.9	67.4	82.5	39.0	6.4	5.2	0.0	0.0
June	232.1	83.5	390.9	118.3	151.3	48.1	254.6	88.9	134.2	100.8	166.0	62.9

Table 4. Total catch, catch rate (fish/hour), harvest, and harvest rate (fish/hour) estimated, Moon Lake, 2018-2019. Mean length was calculated from actual measurements of harvested fish. Standard error is displayed as a measure of variability around estimated values.

Species	Total Catch	SE Total Catch	Catch Rate	Total Harvest	SE Total Harvest	Harvest Rate	Mean Length (mm)
All	3,503	659.6	0.45	605	160.7	0.08	-
Rainbow Trout	2,552	476.9	0.33	439	112.6	0.06	253.4 n=77
Tiger Trout	275	105.3	0.04	83	68.0	0.01	278.6 n=10
Splake	135	52.1	0.02	45	23.6	0.01	304.9 n=8
Brook Trout	221	83.2	0.03	37	23.9	0.01	259.7 n=8
Cutthroat Trout	48	48.0	0.01	0	0.0	NA	NA
Kokanee	355	183.6	0.05	1	0.0	NA	NA

Table 5. Catch, CPUE, harvest, and HPUE by month for Rainbow Trout, Moon Lake, 2018-2019. Standard error is displayed as a measure of variability around estimated values.

Month	RBT Catch	SE RBT Catch	RBT CPUE	RBT Harvest	SE RBT Harvest	RBT HPUE
July	930	262.3	0.63	44	24.0	0.03
August	399	120.9	0.30	131	42.8	0.10
September	184	88.7	0.27	87	51.8	0.13
October	0	0.0	0.00	0	0.0	0.00
November	0	0.0	0.00	0	0.0	0.00
May	12	12.1	0.02	12	12.1	0.02
June	1026	364.9	0.29	176	86.2	0.05

Table 6. Catch, CPUE, harvest, and HPUE by month for Tiger Trout, Moon Lake, 2018-2019. Standard error is displayed as a measure of variability around estimated values.

Month	TGT Catch	SE TGT Catch	TGT CPUE	TGT Harvest	SE TGT Harvest	TGT HPUE
July	10	6.2	0.01	0	0.0	0.00
August	6	6.6	0.00	3	3.3	0.00
September	8	7.6	0.01	8	7.6	0.01
October	0	0.0	0.00	0	0.0	0.00
November	0	0.0	0.00	0	0.0	0.00
May	37	34.1	0.06	0	0.0	0.00
June	214	98.9	0.06	83	67.5	0.02

Table 7. Catch, CPUE, harvest, and HPUE by month for Splake, Moon Lake, 2018-2019. Standard error is displayed as a measure of variability around estimated values.

Month	Splake Catch	SE Splake Catch	Splake CPUE	Splake Harvest	SE Splake Harvest	Splake HPUE
July	5	5.0	0.003	0	0.0	0.00
August	52	44.3	0.04	0	0.0	0.00
September	30	15.9	0.04	20	16.9	0.03
October	0	0.0	0.00	0	0.0	0.00
November	4	3.1	0.17	4	3.1	0.17
May	0	0.0	0.00	0	0.0	0.00
June	45	21.3	0.01	23	16.2	0.006

Table 8. Catch, CPUE, harvest, and HPUE by month for Brook Trout, Moon Lake, 2018-2019. Standard error is displayed as a measure of variability around estimated values.

Month	BKT Catch	SE BKT Catch	BKT CPUE	BKT Harvest	SE BKT Harvest	BKT HPUE
July	104	62.5	0.07	30	23.4	0.02
August	32	13.1	0.02	3	3.3	0.002
September	62	51.4	0.09	0	0.0	0.00
October	0	0.0	0.00	0	0.0	0.00
November	0	0.0	0.00	0	0.0	0.00
May	12	12.4	0.02	0	0.0	0.00
June	11	6.6	0.003	4	3.7	0.001

Table 9. Catch, CPUE, harvest, and HPUE by month for boat anglers, Moon Lake, 2018-2019. Standard error is displayed as a measure of variability around estimated values.

Month	Boat Catch	SE Boat Catch	Boat CPUE	Boat Harvest	SE Boat Harvest	Boat HPUE
July	547	96.3	1.20	15	11.0	0.03
August	179	102.1	0.41	85	32.1	0.02
September	125	97.6	0.83	21	19.8	0.14
October	0	0.0	0.00	0	0.0	0.00
November	0	0.0	0.00	0	0.0	0.00
May	0	0.0	0.00	0	0.0	0.00
June	896	336.8	0.74	98	71.2	0.08

Table 10. Catch, CPUE, harvest, and HPUE by month for shore anglers, Moon Lake, 2018-2019. Standard error is displayed as a measure of variability around estimated values.

Month	Shore Catch	SE Shore Catch	Shore CPUE	Shore Harvest	SE Shore Harvest	Shore HPUE
July	92	68.3	0.11	42	42.7	0.05
August	82	31.3	0.11	16	10.0	0.02
September	135	57.7	0.26	87	58.7	0.17
October	0	0.0	0.00	0	0.0	0.00
November	4	3.1	0.17	4	3.1	0.17
May	62	41.3	0.10	13	12.6	0.02
June	775	231.9	0.34	147	69.8	0.06

Figures

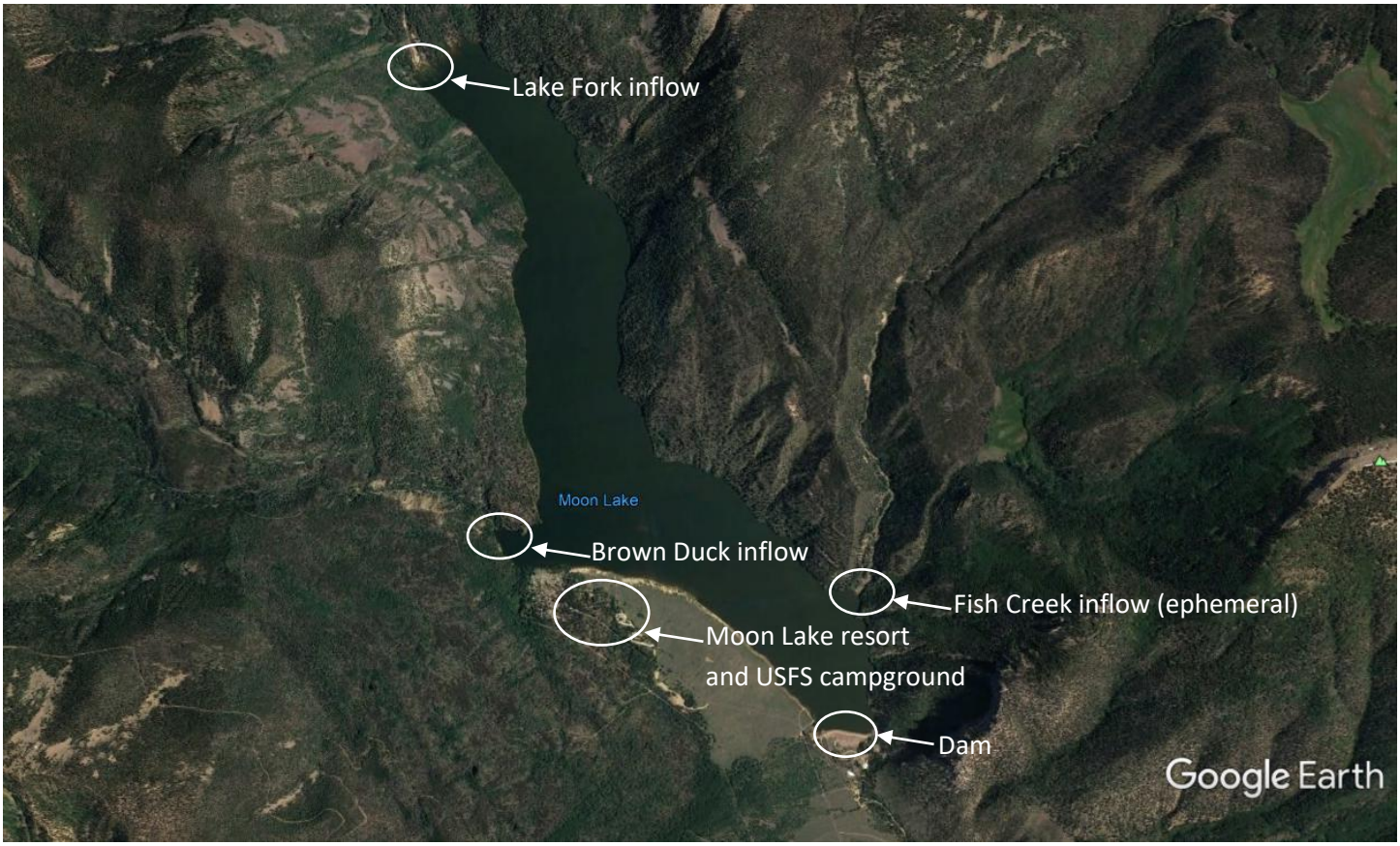

Figure 1. Aerial view of Moon Lake showing the main inflows, dam, and resort area.

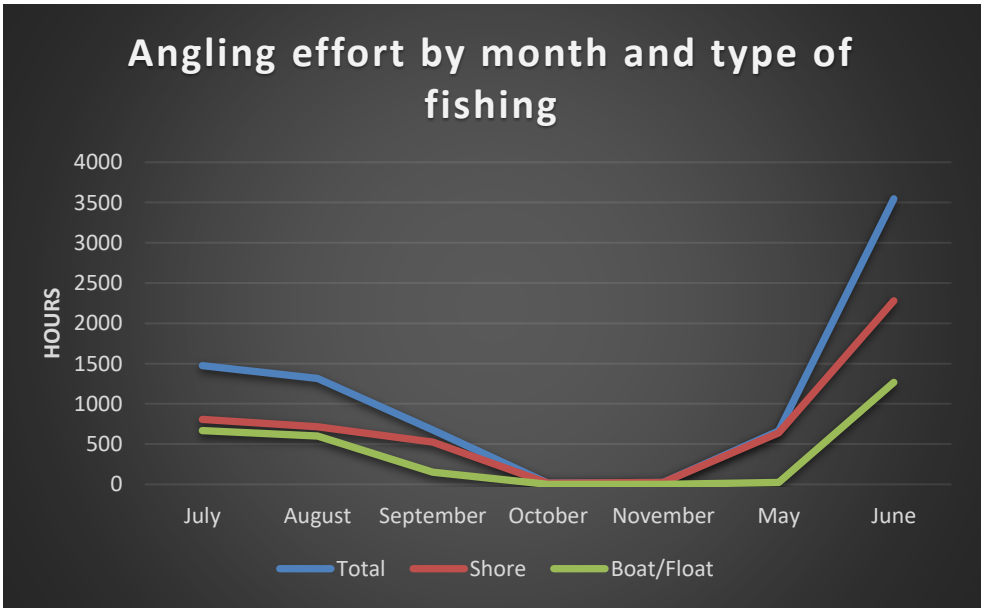

Figure 2. Total, shore, and boat/float effort by month at Moon Lake during the 2018-19 creel survey.

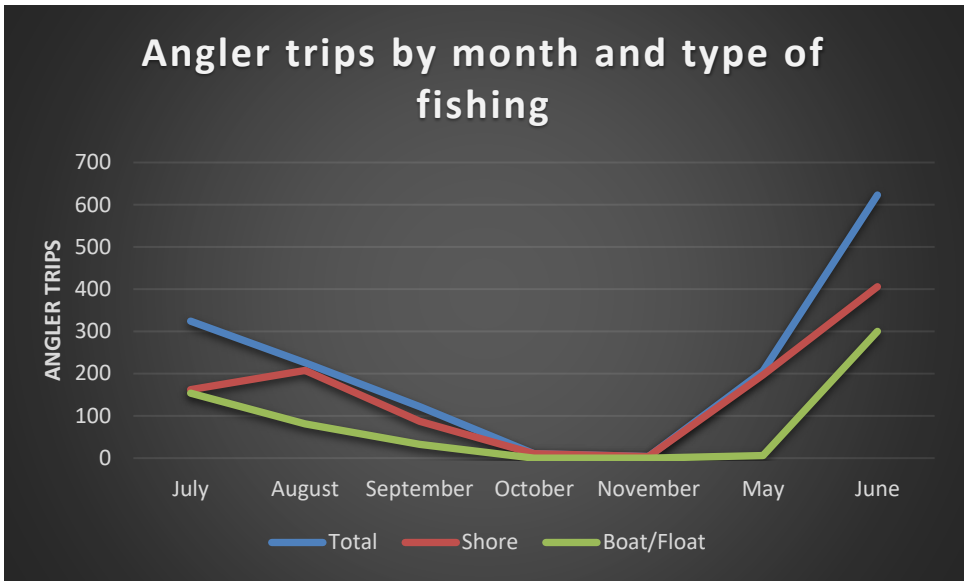

Figure 3. Angler trips by month and fishing type at Moon Lake during the 2018-19 creel survey.

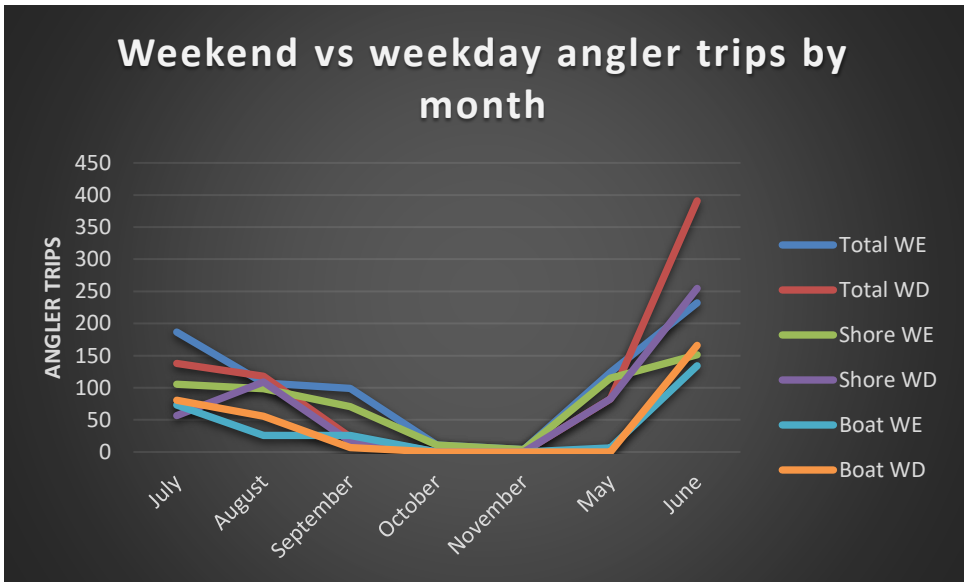

Figure 4. Angler trips by month, weekday vs weekend, and fishing type at Moon Lake during the 2018-2019 creel survey.

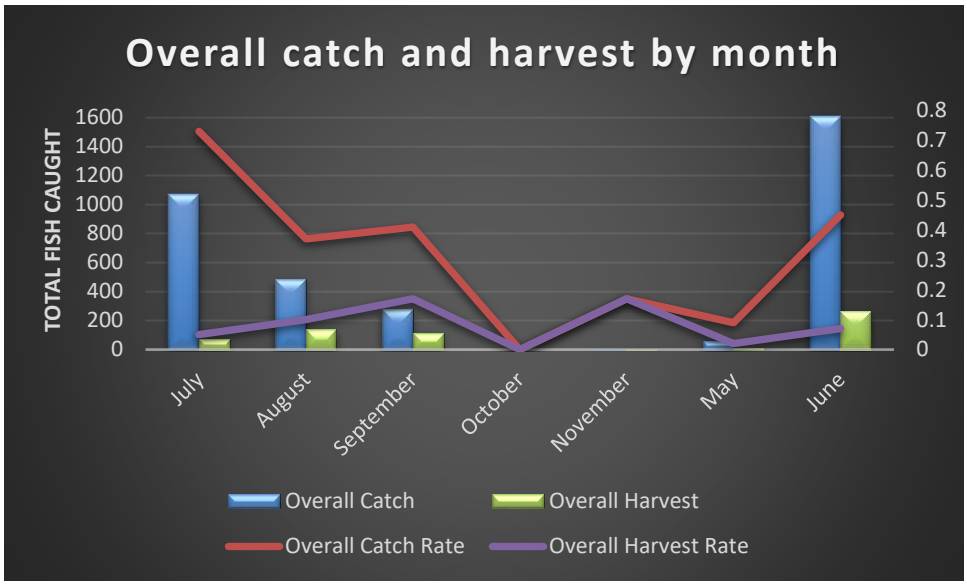

Figure 5. Overall catch, harvest, catch rates, and harvest rates by month, Moon Lake, 2018-2019.

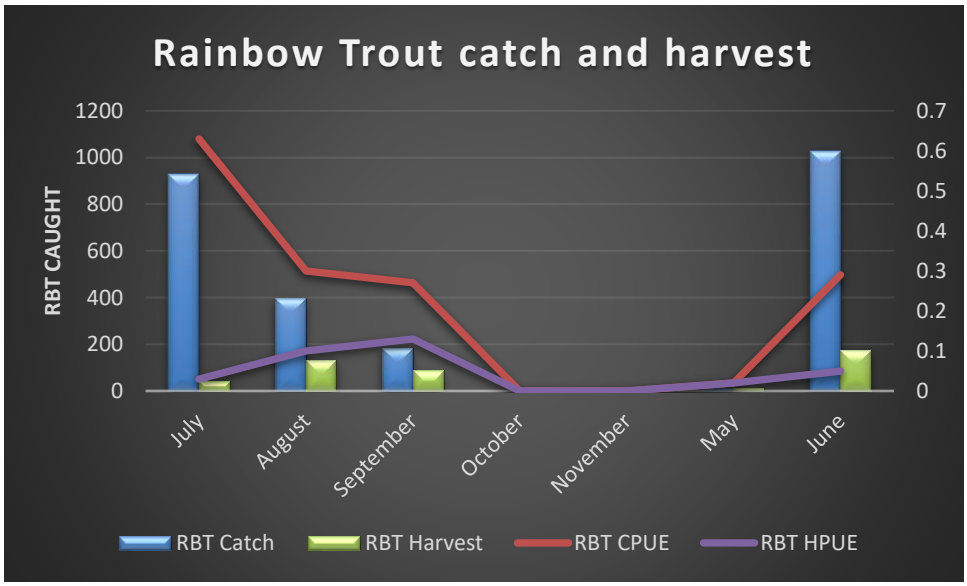

Figure 6. Rainbow Trout catch, harvest, catch rates, and harvest rates by month, Moon Lake, 2018-2019.

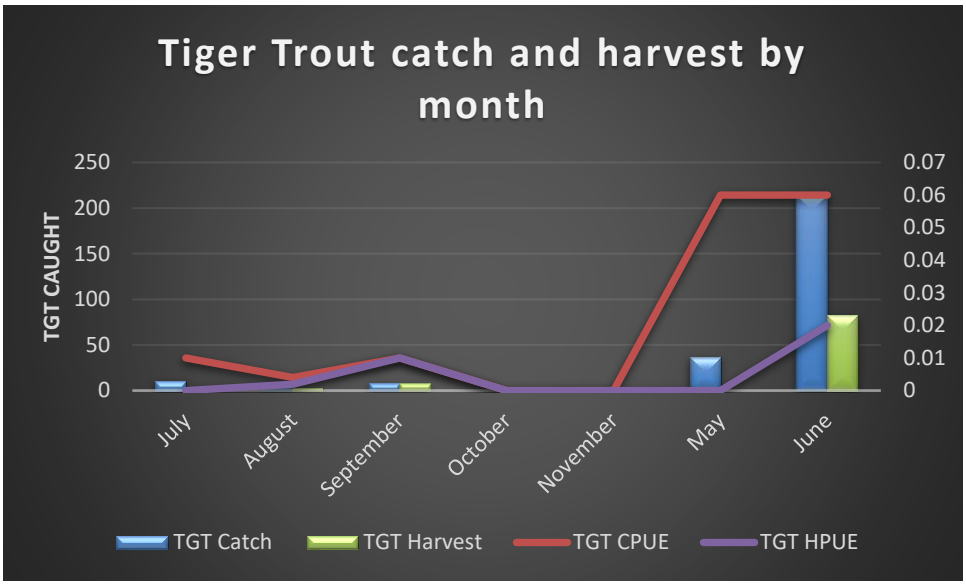

Figure 7. Tiger Trout catch, harvest, catch rates, and harvest rates by month, Moon Lake, 2018-2019.

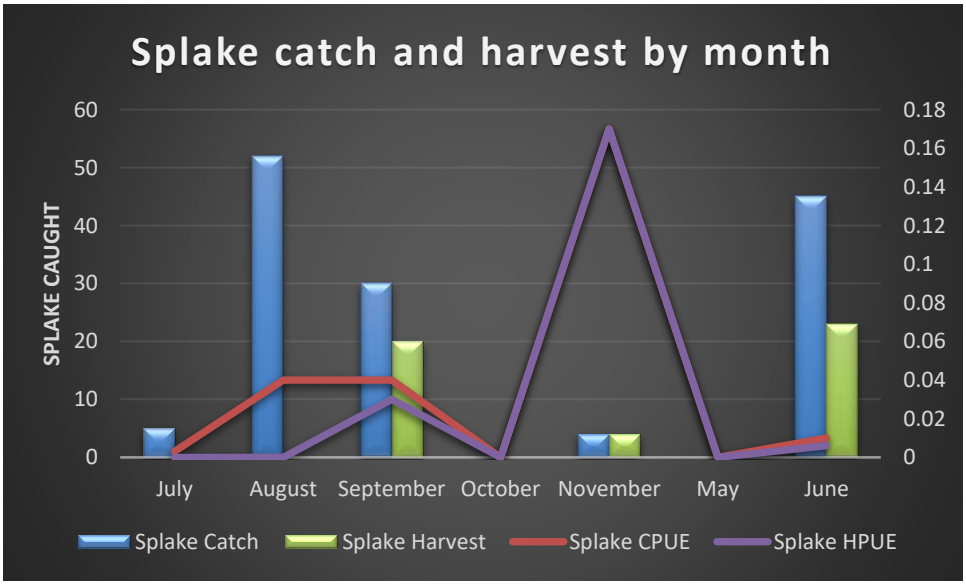

Figure 8. Splake catch, harvest, catch rates, and harvest rates by month, Moon Lake, 2018-2019.

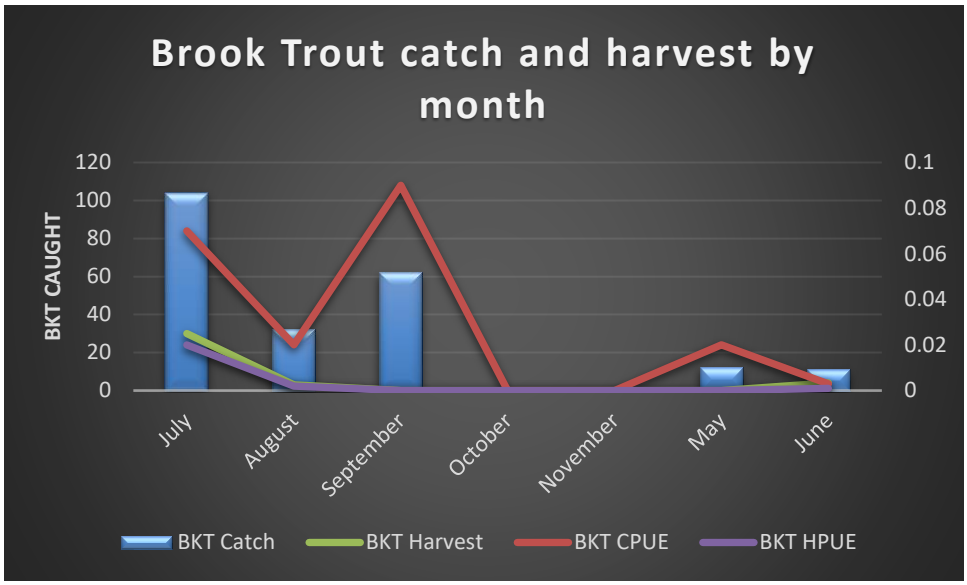

Figure 9. Brook Trout catch, harvest, catch rates, and harvest rates by month, Moon Lake, 2018-2019.

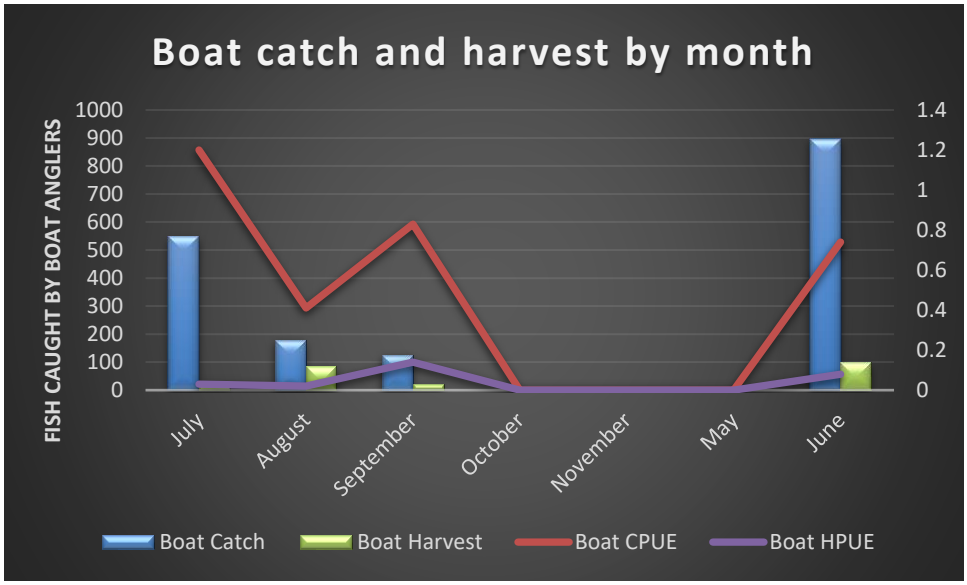

Figure 10. Boat angler catch, harvest, catch rates, and harvest rates by month, Moon Lake, 2018-2019.

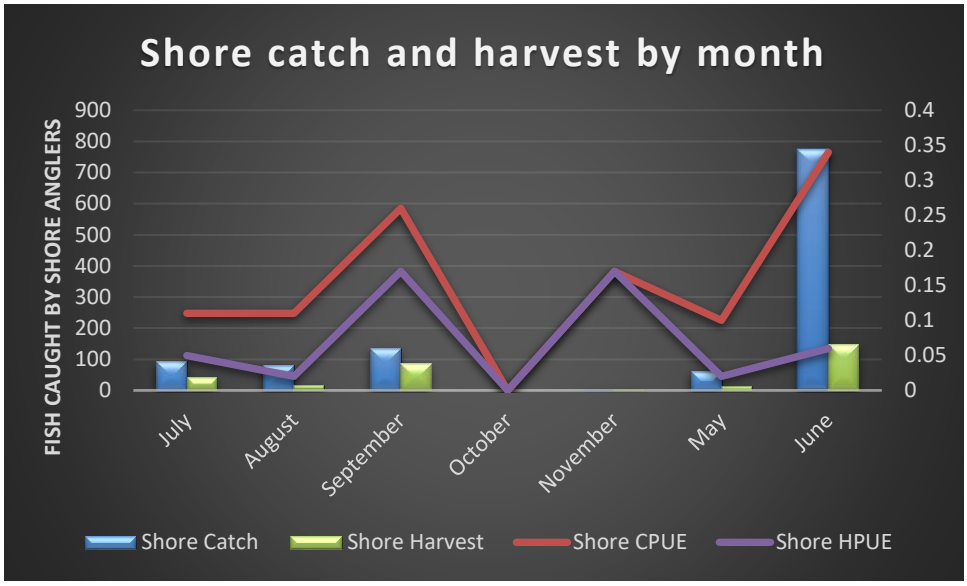

Figure 11**.** Shore angler catch, harvest, catch rates, and harvest rates by month, Moon Lake, 2018-2019.

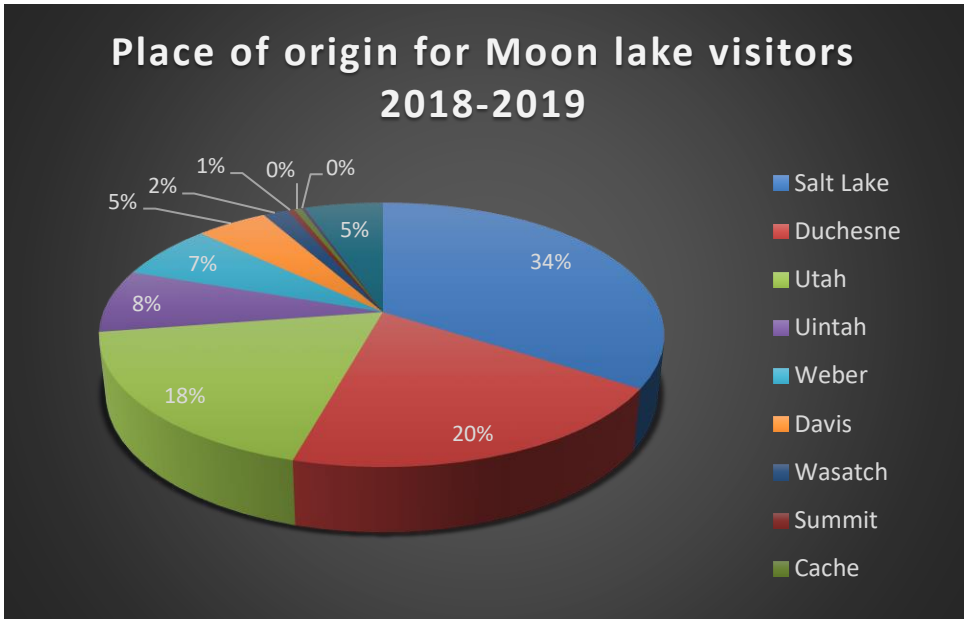

Figure 12. Place of origin for Utah residents (n=394) and non-residents (n=22) visiting Moon Lake during the 2018-19 creel survey.

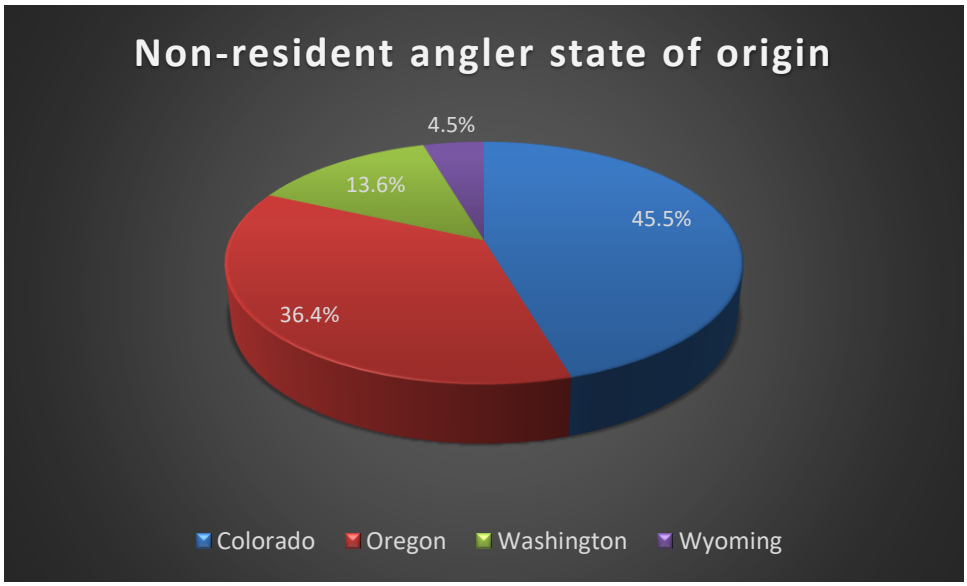

Figure 13. State of origin for non-resident anglers (n=22) visiting Moon Lake during the 2018-19 creel survey.

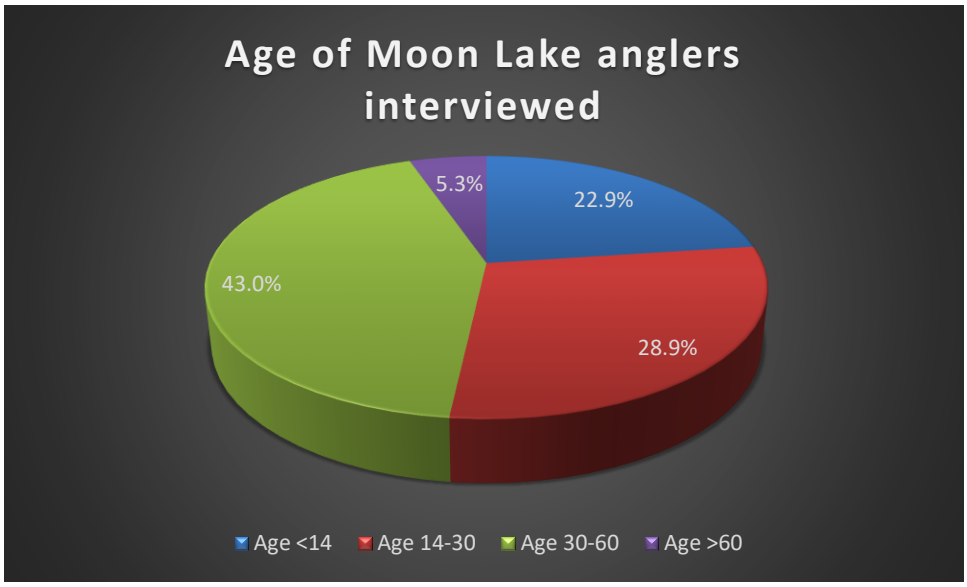

Figure 14. Age distribution of anglers visiting Moon Lake during the 2018-19 creel survey.

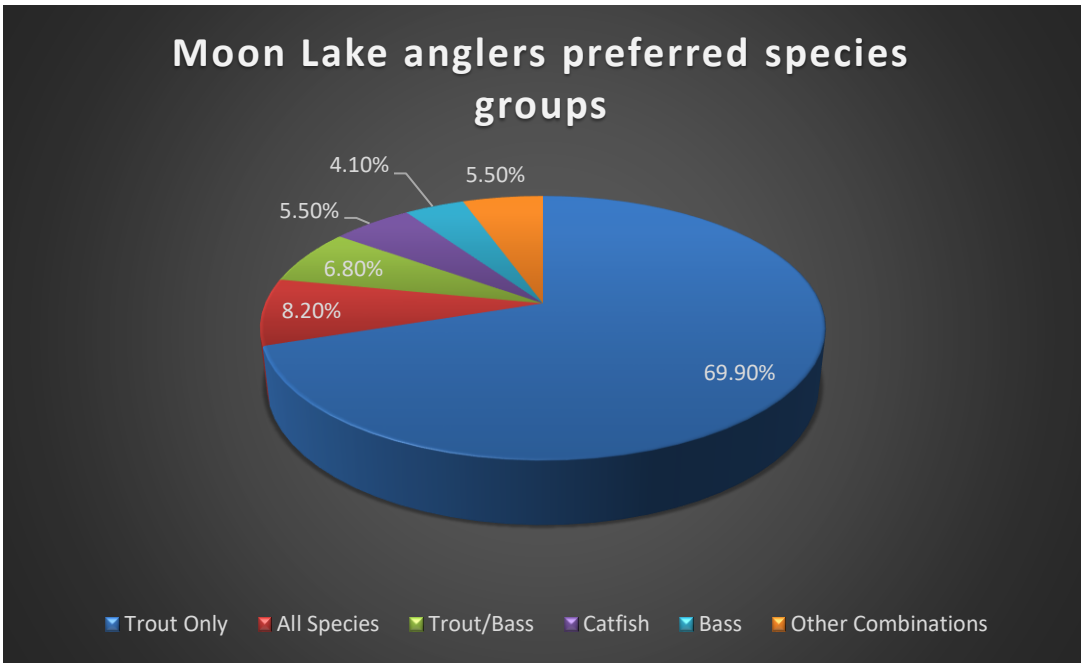

Figure 15. Angler species group preferences, including groups of preferences, Moon Lake, 2018-2019.

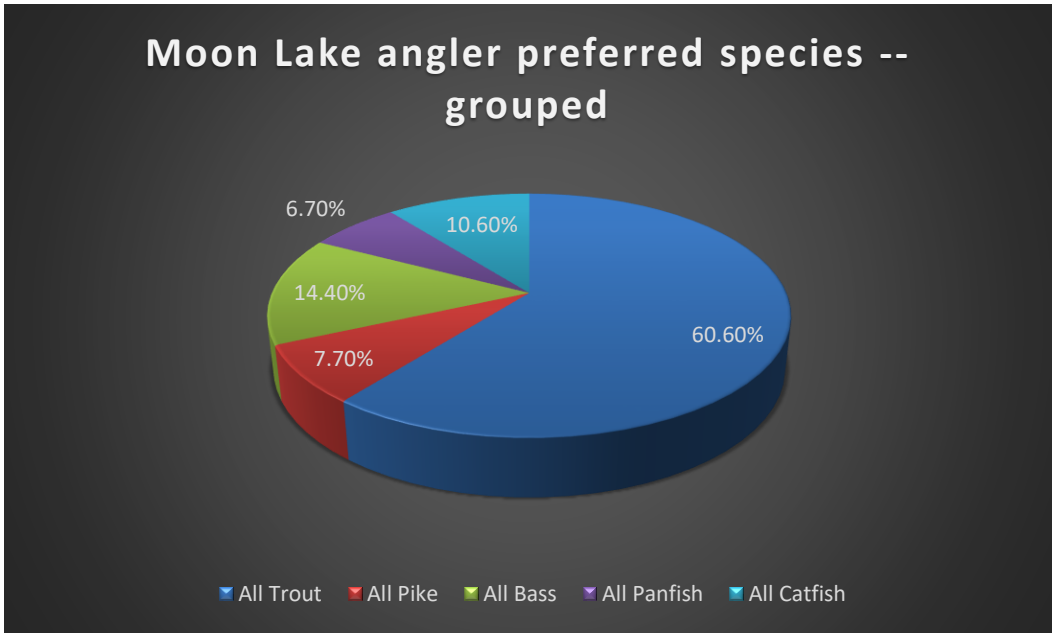

Figure 16. Species preference responses from anglers interviewed during the 2018-2019 Moon Lake creel survey. This figure lumps all multi-species responses to the same question asked for Figure 17.

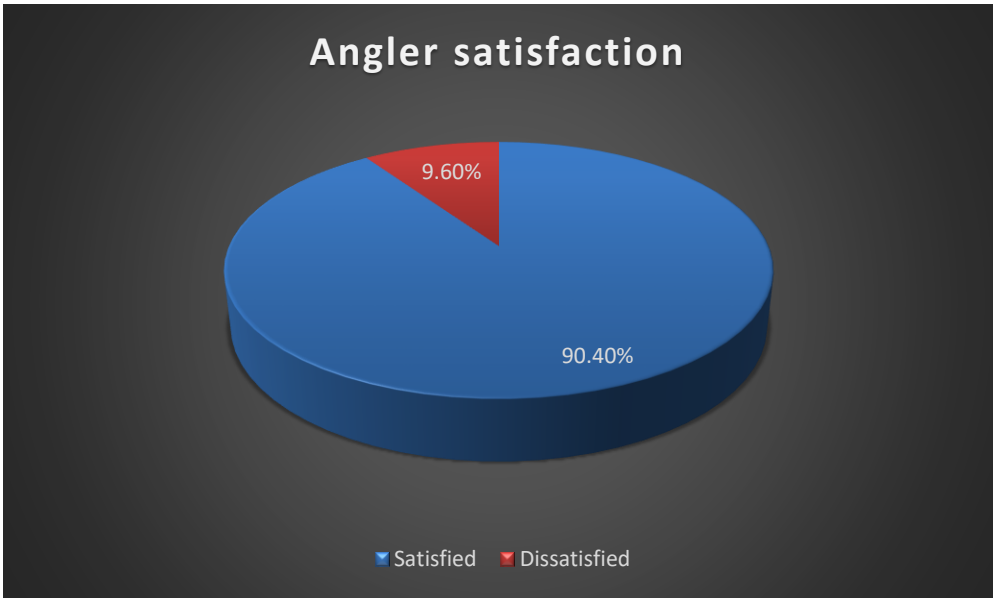

Figure 17. Angler satisfaction with their trip to Moon Lake during the 2018-2019 creel survey.

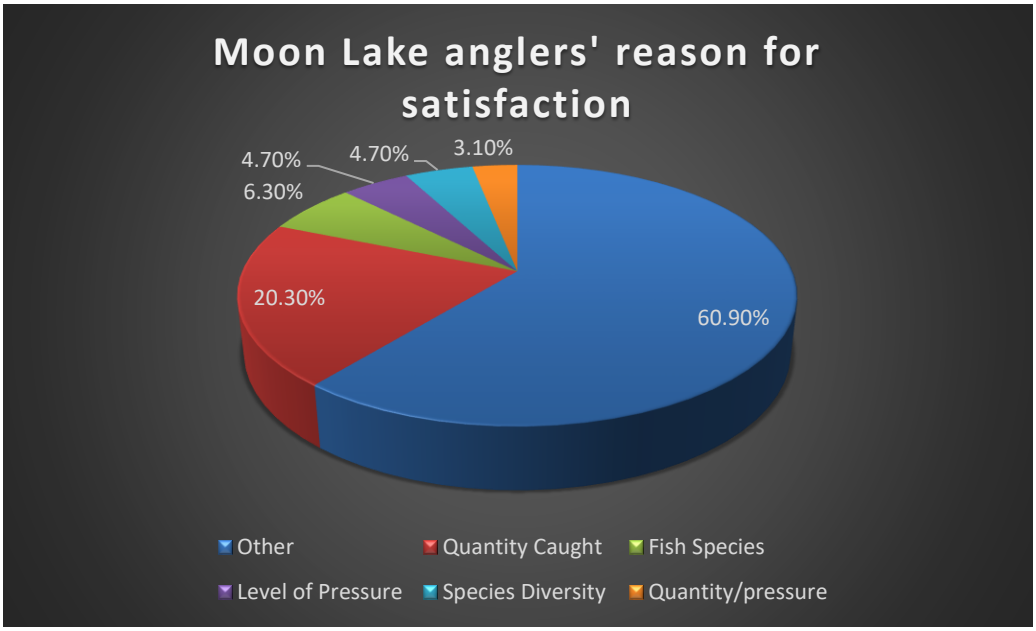

Figure 18. Reasons for angler satisfaction with their trip to Moon Lake during the 2018-2019 creel survey.

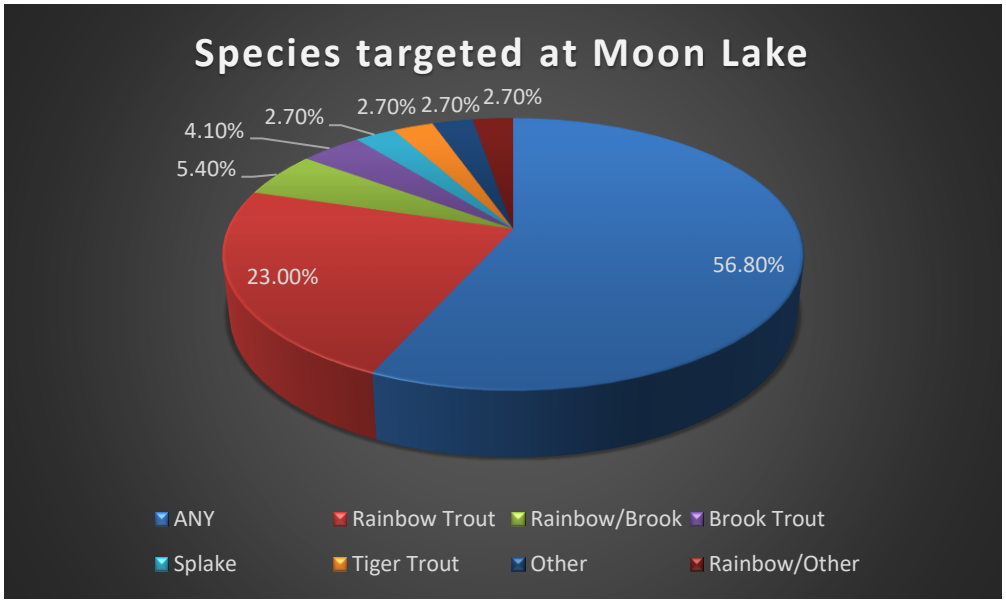

Figure 19. Angler species preferences specifically at Moon Lake during the 2018-2019 creel survey.

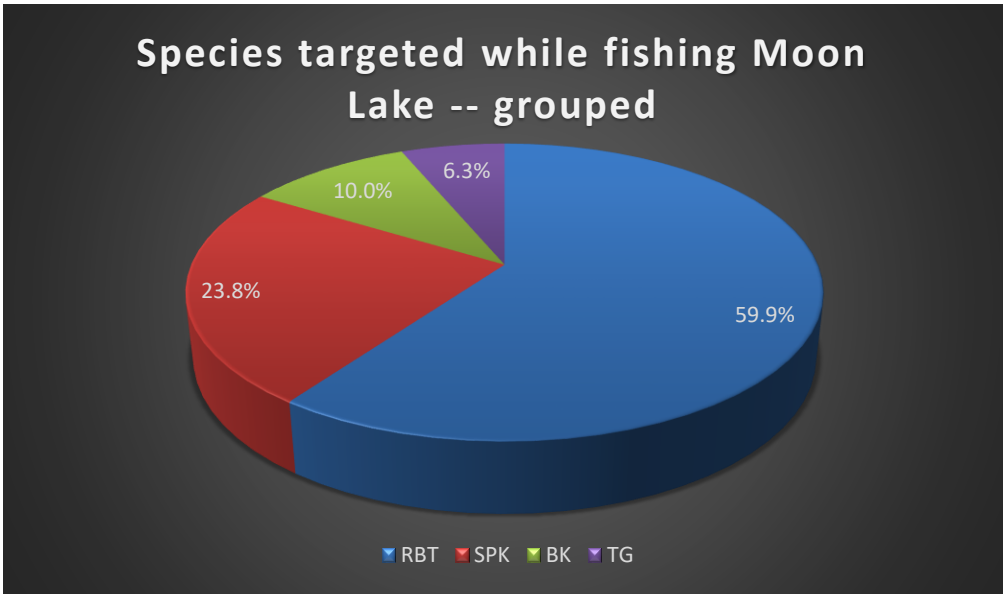

Figure 20. Angler species preferences at Moon Lake including anglers targeting multiple groups during the 2018-2019 creel survey.

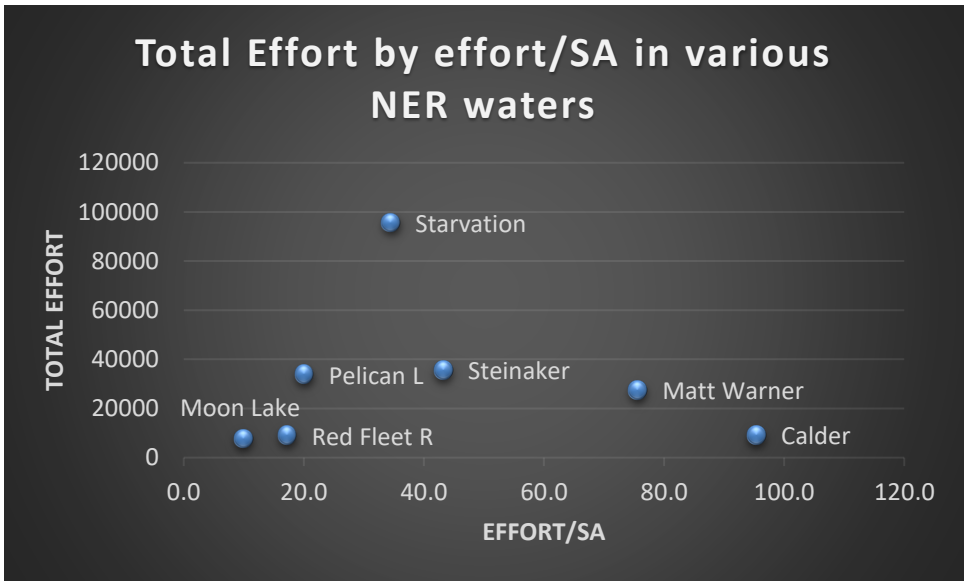

Figure 21. Comparison between total effort fishing and effort/surface acreage (SA) at seven Uintah Basin waters. These variables are not correlated (R^2=-0.09), which implies there are other variables at work.

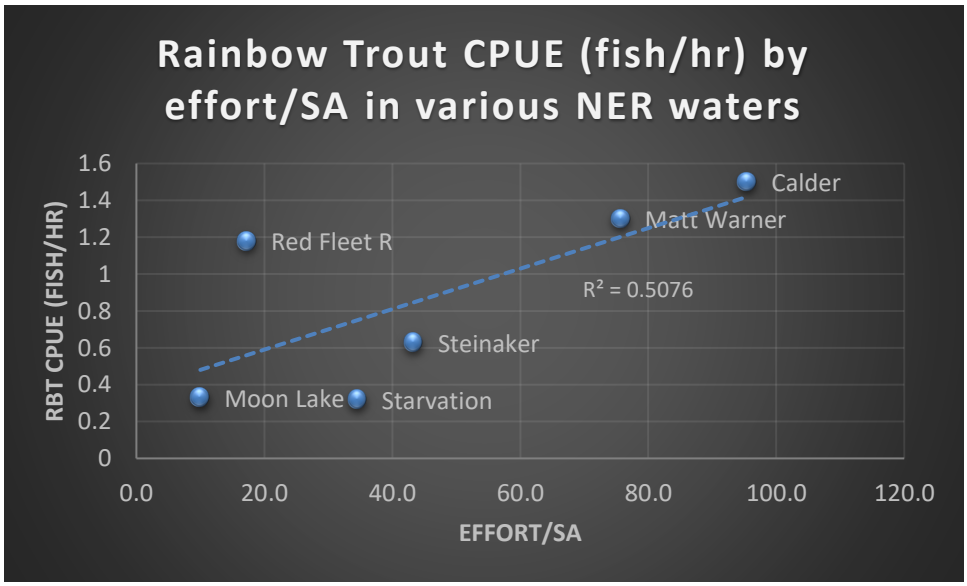

Figure 22. Effort based on size of waterbody compared to RBT CPUE at six Uintah Basin waters.

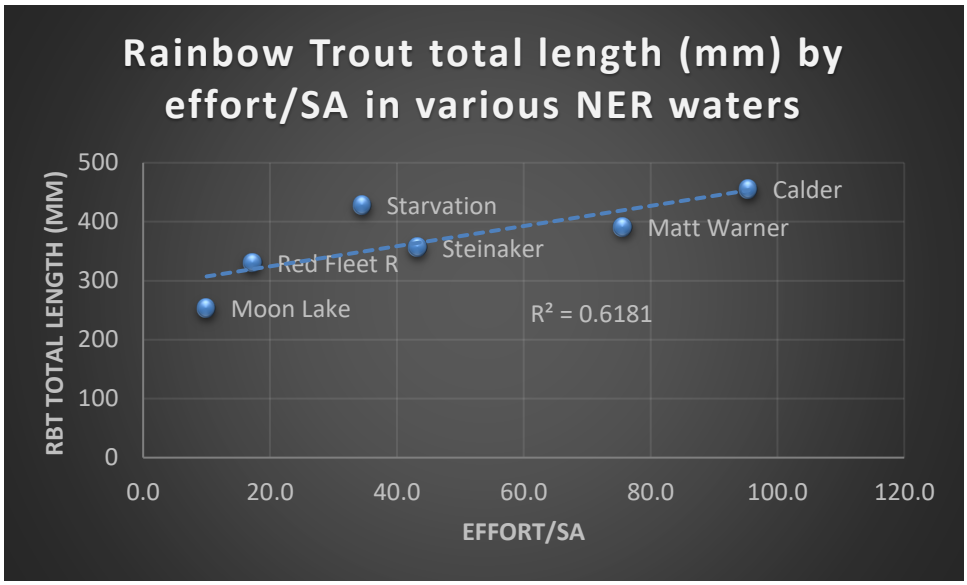

Figure 23. Effort/SA compared to RBT mean TL at six Uintah Basin waters.

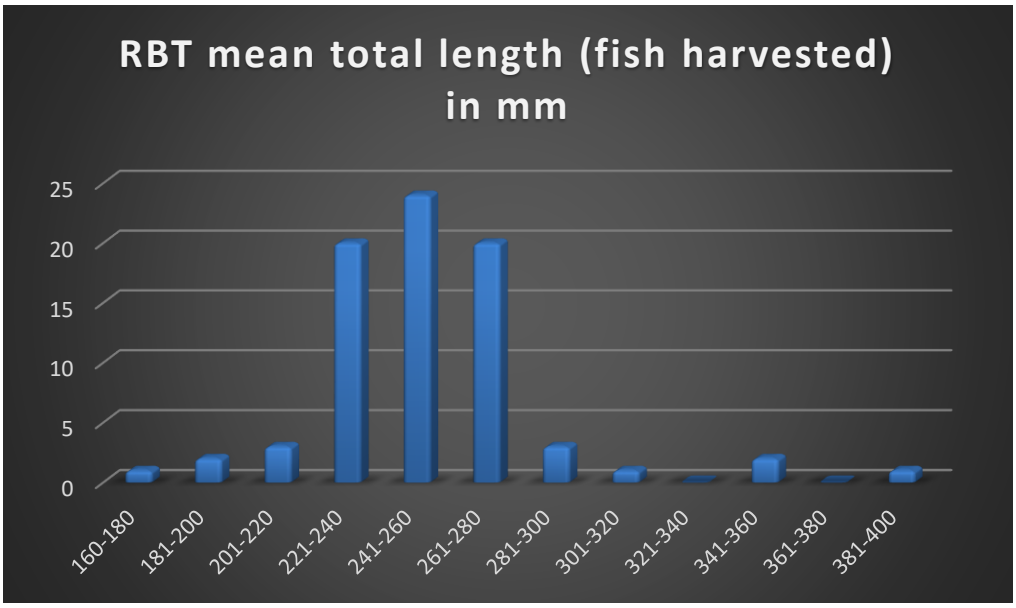

Figure 24. Average TL of RBT harvested (in 20 mm size bins) during the 2018-2019 Moon Lake creel survey.

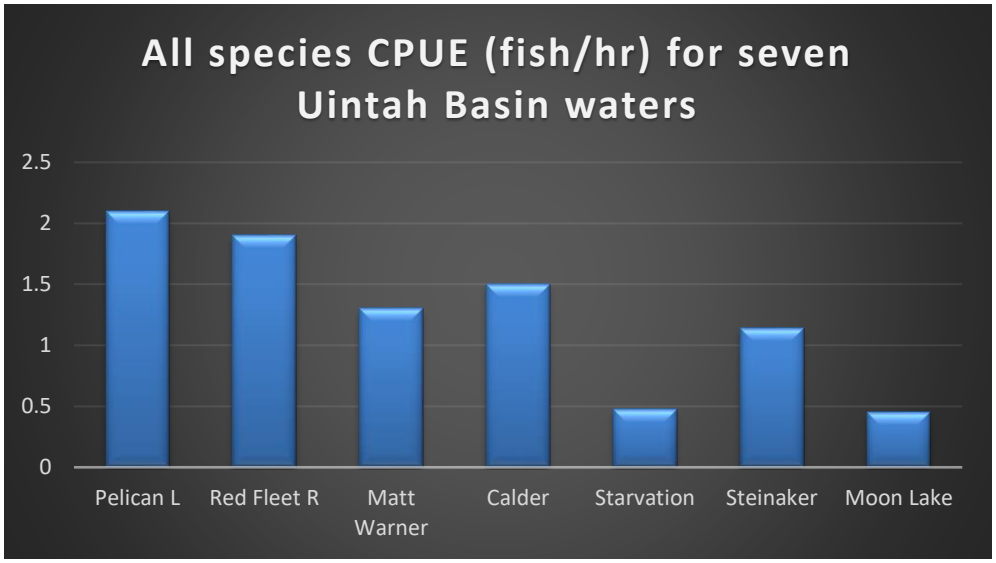

Figure 25. Overall CPUE from creel surveys done at seven Uintah Basin waters.

Appendix 1 – Creel design for Moon Lake.

Moon Lake Creel Design
July 2018 – June 2019
Roving Creel Survey
Creel dates: July 2018 – November 2018 and April 2019 – June 2019

The creel will be stratified by weekday and weekend days and will not include time of day (TOD) stratification. This will require at least four survey days each month. We will randomly select three weekdays and three weekend days to survey with the goal of sampling all six days; one additional alternate day will be scheduled for each stratum. These alternate dates will be used if an emergency prevents the clerks from conducting a creel on a scheduled date.

Since we will not be using TOD, sampling summer days will be long for creel clerks. Clerks will be instructed to be at the lake 30 minutes before sunrise and stay 30 minutes after sunset. Sampling day hours will be as follows for each month:

April	14 hrs
May	15 hrs
June	16 hrs
July	15 hrs
August	14 hrs
September	13 hrs
October	11 hrs
November	10 hrs
December	9 hrs
January	9 hrs
February	11 hrs
March	13 hrs

Angler counts will be conducted four times each sampling day at the reservoir. The times will be systematically sampled based on a random start time that allows adequate time (minimum 30 minutes) to complete the four counts within a day. For example, April surveys will run from 6:00 am to 8:00 pm. The first count is randomly chosen as 2:00pm. This allows for the three remaining counts to be spaced two hours apart; 4:00, 6:00 and 8:00 pm.

In between angler counts creel clerks will interview anglers to gather information of effort, catch and harvest. Clerks will be roving to interview anglers and when possible they will also have a boat to conduct interviews and counts. In addition to this basic angling information we will also ask anglers to answer some of the standard creel questions developed by the Salt Lake staff given below.

Which of the following “species groups” do you prefer to fish for?

“Trout species” (e.g., cutthroat trout, brown trout, rainbow trout etc.)
"Bass species"
"Panfish species"
"Pike species" (walleye, northern pike, or tiger muskellunge)

"Catfish species"

Which of the following best represents your overall level of satisfaction with your experiences on this fishing trip?

Completely dissatisfied
Mostly dissatisfied
Neutral
Mostly satisfied
Completely satisfied

If satisfied, why are you satisfied?

Number of fish caught
Species of fish caught
Level of pressure
Species diversity
Both quantity caught and level of pressure
Fish size
Other

Are you aware that Splake are stocked into Moon Lake?

What species of fish do you target when you fish Moon Lake?

Rainbow trout
Splake
Tiger Trout
Brook Trout
Other

Data will be entered into standard excel files contact.xlsx, count.xlsx and specomp.xlsx as described in the SAS creel manual.

We will use SAS to work up the data using programs developed by Heather Thomas and are described in the SAS creel manual. For this creel we will use Option 1, which will produce statistics by month and DOW.