Tiger Muskie in New Mexico
Bluewater and Quemado Reservoirs Management Brief

2014

New Mexico Department of Game and Fish

Fisheries Management Division

Introduction

The New Mexico Department of Game and Fish has used tiger muskies (*Esox masquinongy X Esox lucius*) as a biological control tool against undesirable fish species for the past ten years in Bluewater and Quemado Reservoirs. Tiger muskie have successfully controlled the undesirable fish species in both reservoirs, but stocking tiger muskie has had mixed results in meeting other management goals. The purpose of this management brief is to inform the public on the history of each fishery, current status, and planned fisheries management strategies at each reservoir to attain management goals.

Bluewater Reservoir

Background

Bluewater Reservoir is located in Cibola and McKinley Counties at Bluewater State Park near Thoreau, New Mexico. The reservoir has a maximum capacity of 38,500 acre feet or 1,700 surface acres. Fisheries management strategies at Bluewater Reservoir have primarily focused on maintaining a put grow and take Rainbow Trout and Channel Catfish fishery. The reservoir historically supported a healthy population of Rainbow Trout until the late 1990s when a declining trout population and increasing numbers of Goldfish and White Suckers were evidenced through fisheries surveys conducted by New Mexico Department of Game and Fish (NMDGF). In addition, a decrease in angler satisfaction and public concern about an overabundance of Goldfish and White Suckers potentially contributing to a declining Rainbow Trout fishery became apparent in 2001. The general public expressed interest in primarily maintaining a Rainbow Trout fishery while expanding angling opportunities for warm water fish.

In response to public concern, NMDGF introduced tiger muskie to Bluewater Reservoir as a tool to attain fisheries management goals. Goals included managing undesirable Goldfish and White Sucker populations while maintaining a Rainbow Trout fishery with added angling benefit of tiger muskie. Various predatory fish species were given careful consideration including Largemouth and Smallmouth Bass prior to deciding on use of tiger muskie. NMDGF decided to use tiger muskie for two reasons. First, tiger muskie are the sterile hybrid of Northern Pike and Muskellunge. Because these fish are sterile, NMDGF could control recruitment, population size, and the ability to stop or modify treatment if it was deemed detrimental to other fisheries management objectives. Second, tiger muskie are highly

piscivorous and cool water adapted. This means they likely start preying on Goldfish at a young age and can continue to feed for a greater portion of the year than warm water adapted species such as Largemouth Bass.

NMDGF drafted a five year management plan in 2002 which included maintaining a Rainbow Trout and Channel Catfish fishery in conjunction with a population of tiger muskie sufficient to control Goldfish and White Suckers. Tiger muskie were initially stocked into Bluewater Reservoir in 2004 and stocking continued annually until 2009 then periodically until 2012. Approximately 350,000 tiger muskie ranging in size from fry (1”-3”) to fingerlings (3”-5+”) were stocked during that timeframe. Approximately 1,000,000 fry (1”-3”), 14,400 sub-catchable (5”-8”), and 7500 catchable (8”) size Rainbow Trout were stocked into Bluewater Reservoir in 2004. Rainbow Trout stocking was inconsistent from 2005 to 2010 which was related to closing Los Ojos State Fish Hatchery due to whirling disease. Approximately 290,000 fingerlings (3”-5”), 102,500 subcatchable (5”-8”), and 107,000 catchable ($\geq$8”) size Rainbow Trout were stocked into Bluewater Reservoir from 2007 to 2013.

Tiger Muskie Population Surveys

It is difficult to estimate population size of tiger muskie in Bluewater Reservoir due to low recapture rates. A total of 18 fish of 584 marked since 2006 have been captured thus far. All mathematical populations based on this are subject to a high degree of uncertainty. The population estimate for 2014 is approximately 7,168 tiger muskie and the 2013 estimate is 8,834 fish. These population estimates in conjunction with an appreciable reduction in total number of fish captured during fall 2013 and 2014 surveys indicate a notable decline in population size. The population appears to be exceeding carrying capacity as indicated by a uniform size distribution of fish with decreasing relative weights, i.e. poor condition (Fig. 1 and 2). Relative weight of 100 indicates an average healthy fish while relative weight of less than 90 indicate skinnier, less healthy fish. The current density of tiger muskie in Bluewater Reservoir is approximately 26 fish/surface acre exceeding the goal of 4 fish/surface acre.

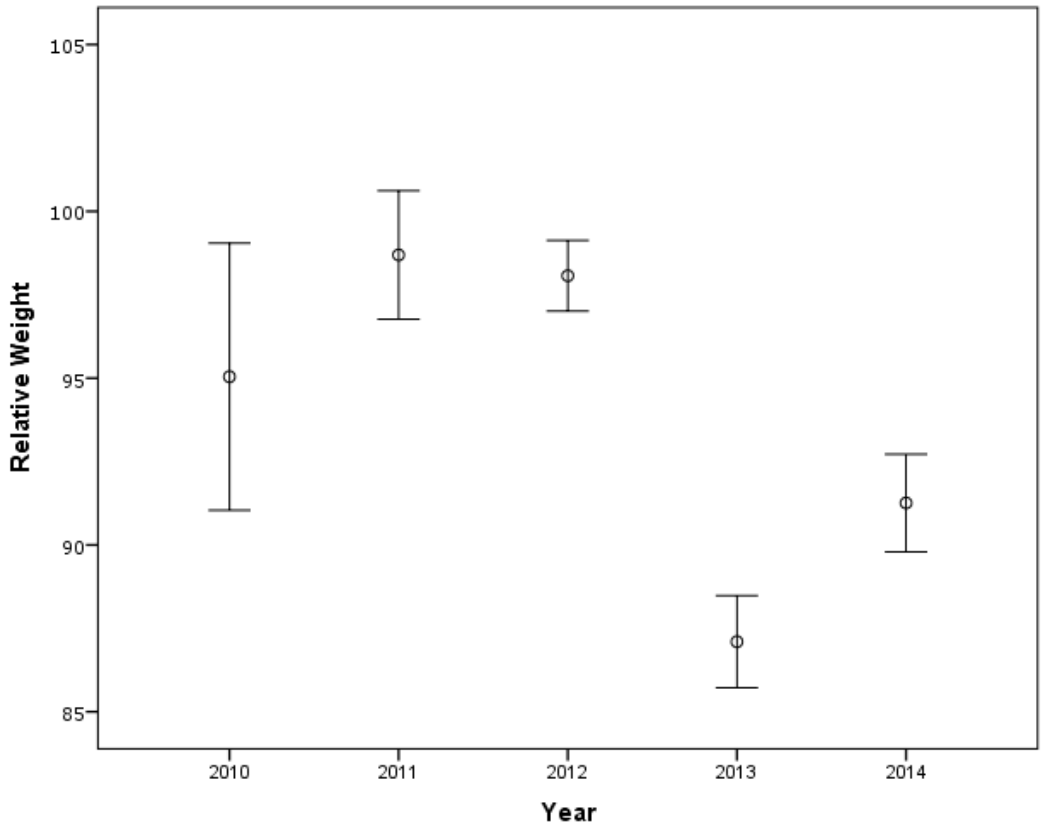

Figure 1. Relative weight of Tiger Muskie captured at Bluewater Reservoir, 2010-2014 (with 80% confidence intervals).

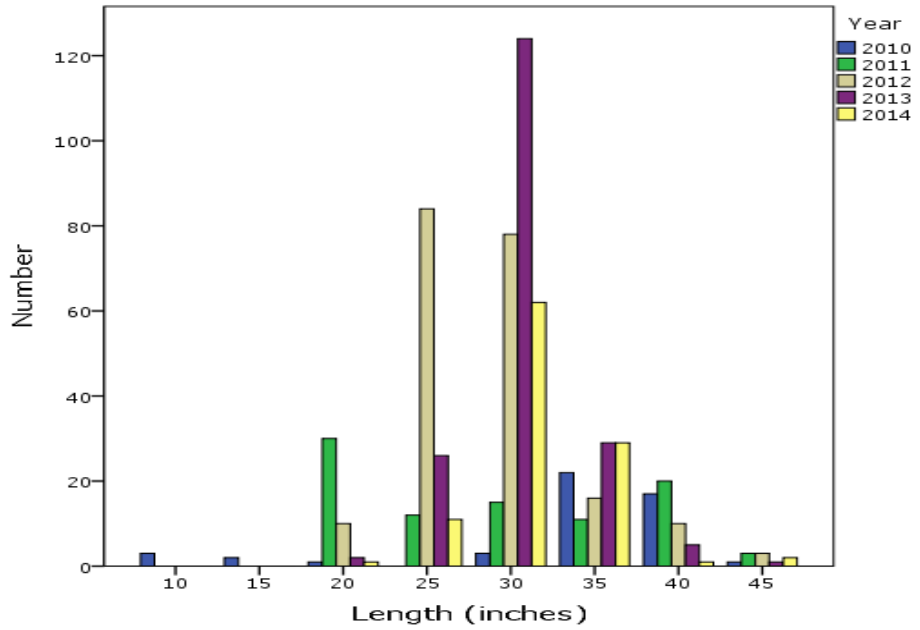

Figure 2. Length frequency histogram of Tiger Muskie captured at Bluewater Reservoir, 2010-2014.

White Sucker and Goldfish Populations

White Sucker and Goldfish numbers decreased to nearly zero and have remained low subsequent to introducing tiger muskie in Bluewater Reservoir as evidenced during recent population surveys (Fig. 3 and 4).

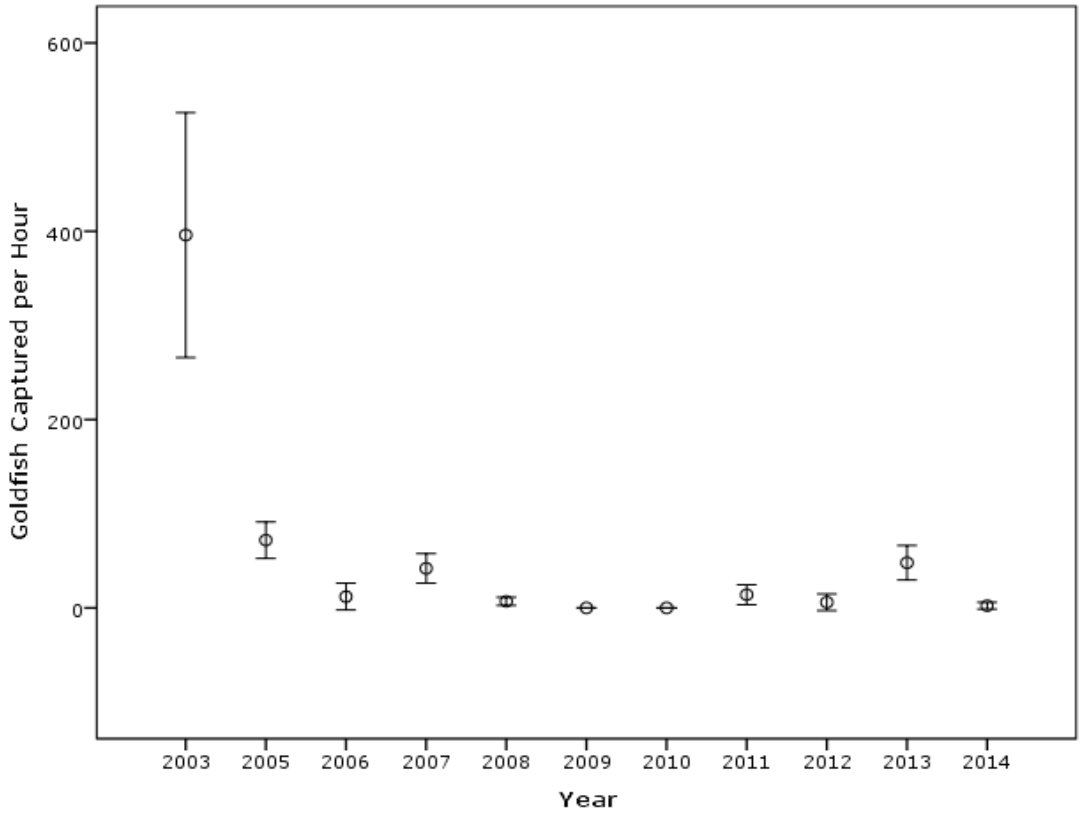

Figure 3. Number of Goldfish captured per hour of electrofishing at Bluewater Reservoir during spring surveys, 2003-2014 (with 80% confidence intervals).

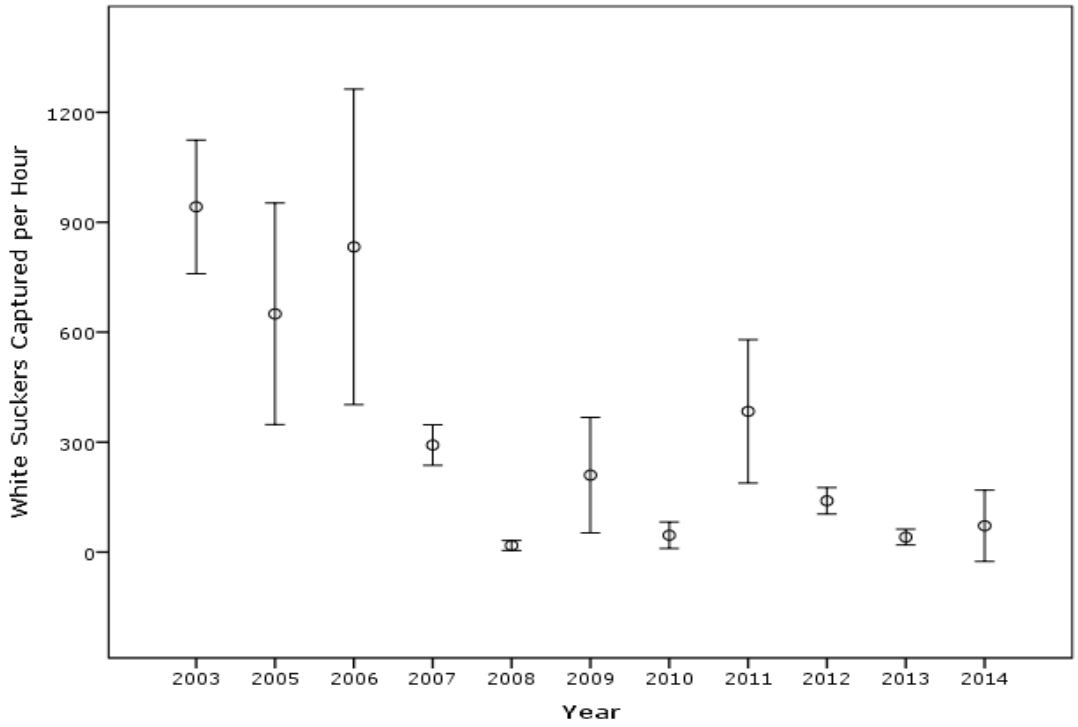

Figure 4. Number of White Suckers captured per hour of electrofishing at Bluewater Reservoir during spring surveys, 2003-2014 (with 80% confidence intervals).

Current Fishery Status

Tiger muskie are currently abundant in Bluewater Reservoir subsequent to consistent stocking and good survival which has contributed to an extremely popular fishery since 2008. The uniform size distribution and decreasing relative weights (condition) indicate this population has a high potential for instability. Goldfish and White Suckers appear to be controlled, but the Rainbow Trout population has not recovered. Impacts to the trout fishery are likely due to several contributing factors including inconsistent stocking and persistent drought conditions resulting in below average water levels in recent years. The lack of Rainbow Trout observed during routine population surveys conducted from 2012-2014 indicates a significant decline in the population from historic levels. The angling public has expressed concern to NMDGF personnel that the Rainbow Trout fishery is suffering due to predation by tiger muskie.

Based upon survey results since 2010, stocking fingerling sized Rainbow Trout was discontinued and replaced with only catchable sized fish. Adjusting the size and number of stocked Rainbow Trout was an attempt to decrease predation by tiger muskie while improving angling opportunity for Rainbow Trout. Additionally, stocking tiger muskie was suspended until current recruitment dynamics is better understood.

Approximately 91,000 catchable size Rainbow Trout were stocked between March and June 2014. Creel surveys were conducted from May to June 2014 to determine angler satisfaction, measure exploitation of stocked trout, correlate angler satisfaction with exploitation of stocked catchables, and to determine angler expectations about fisheries management. Initial creel survey results indicate the majority of anglers at Bluewater targeted tiger muskie. Follow-up creel surveys may be implemented in the future to confirm 2014 results as well as potentially pursuing additional public outreach channels to further assess angler desires for fisheries management at Bluewater Reservoir.

Quemado Reservoir

Background

Quemado Reservoir was constructed by the NMDGF in 1971 for recreation and is approximately 130 surface acres in size. The reservoir is located approximately 14 miles south of the town of Quemado, New Mexico in Catron County. It lies entirely on U.S. Forest Service property and the Department holds a special use permit for the operation, maintenance, and recreational use of the lake. Quemado Reservoir was designed and intended to provide a quality "put and take" trout fishing experience for anglers. The quality of trout fishing declined at Quemado during the late 1990's due to a decrease in trout numbers as evidenced by low angler catch rates. During this time period stocking was changed primarily to a put, grow and take strategy which likely contributed to the decrease in trout abundance. Goldfish were present in Quemado Reservoir for a number of years but dramatically increased in numbers and size (of individual Goldfish) in 1998 and 1999. A mark-recapture estimate of the Goldfish population in the summer of 1999 indicated there were still in excess of 70,000 mature Goldfish in the reservoir. This occurrence, in combination with a failed trout stocking strategy, resulted in the perception that Goldfish were the cause of poor fishing.

In response to public concern, NMDGF and U.S. Forest Service personnel undertook an intensive Goldfish removal operation at Quemado Reservoir beginning spring 1999. Goldfish were captured via electrofishing and trap netting with an estimated 13 tons of Goldfish removed from the reservoir (approximately 100,000 fish). Less intensive Goldfish removals occurred in 2001 and 2002 with little apparent effect on the overall Goldfish population and then, from 2003 to 2007, more intensive removal operations resulted in approximately 57 tons of goldfish removed from the reservoir. In addition to mechanically removing goldfish, NMDGF introduced tiger muskie as a biological control in 2003. Approximately 147,000 tiger muskie fry (1"-3")

and/or fingerlings (3”-5+”) were stocked into Quemado Reservoir from 2003 to 2012.

Tiger Muskie Population Surveys

The 2014 population estimate of tiger muskie in Quemado Reservoir is 639 fish compared to 633 in 2013 and 676 in 2012. These estimates are composites of a number of different models assuming differing distributions so confidence is not reported. These estimates yield approximately 5 fish/surface acre when the reservoir is at full capacity which is close to our management goal of 4 fish/surface acre. The tiger muskie population at Quemado Lake continues to be stable and show good condition indices and size distribution, the plurality with relative weight between 95-110 (Fig. 5 and 6).

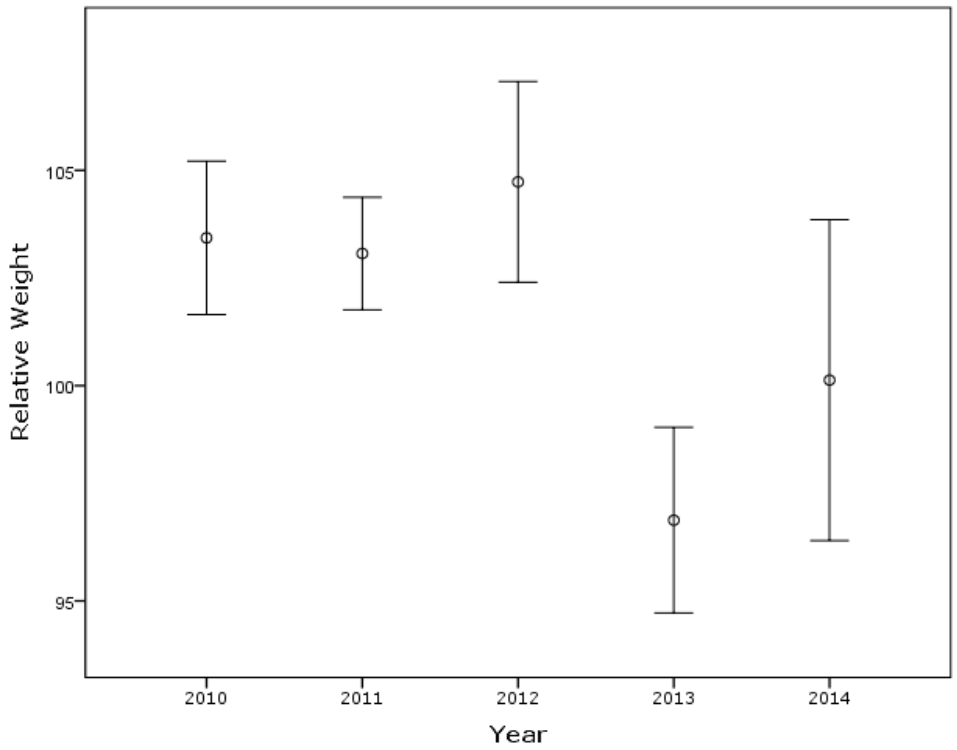

Figure 5. Relative weight of Tiger Muskie captured at Quemado Reservoir, 2010-2014 (with 80% confidence intervals).

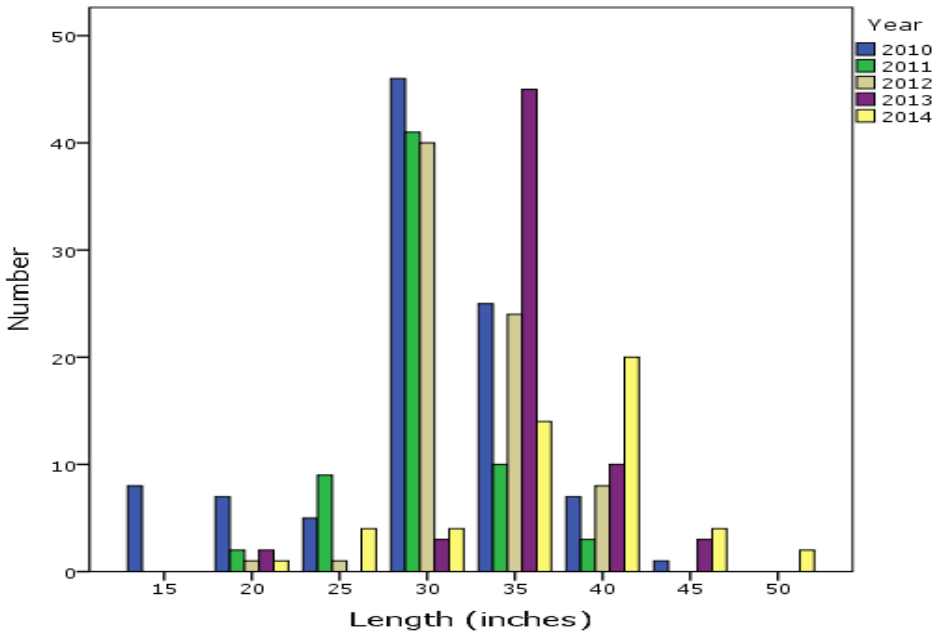

Figure 6. Length frequency histogram of Tiger Muskie captured at Quemado Reservoir, 2010-2014.

Goldfish Population

The Goldfish population appears to be under control and has consistently declined in Quemado Reservoir as evidenced by catch-per-unit-effort data derived from electrofishing surveys conducted periodically since 1999 (Fig. 7). In addition, gut content analysis of 14 tiger muskie during the fall 2014 survey indicated three muskie contained Rainbow Trout and the remaining 11 had empty stomachs with no apparent signs of Goldfish.

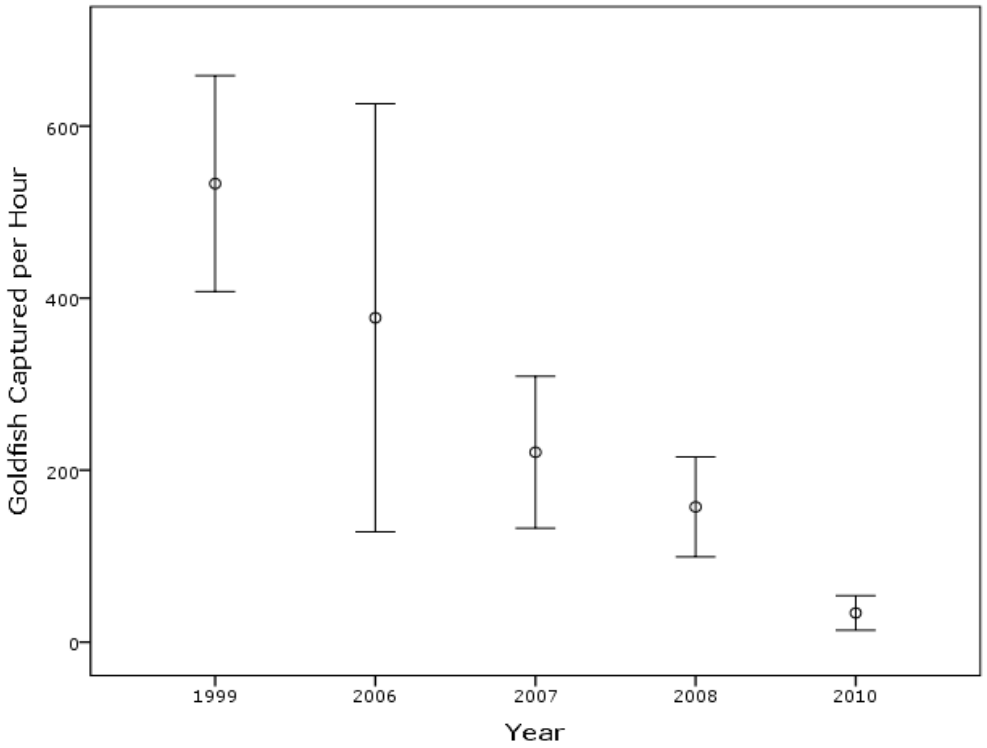

Figure 7. Number of Goldfish captured per hour of electrofishing at Quemado Reservoir during summer and fall surveys, 1999-2010 (with 80% confidence intervals).

Rainbow Trout Population

The Rainbow Trout fishery appears stable and abundant at Quemado Reservoir. Ancillary data collected from 95 Rainbow Trout captured during our fall 2014 survey gives some indication that a significant number of healthy fish ranging in size from approximately 7 to 18 inches exist at Quemado Reservoir (Fig. 8).

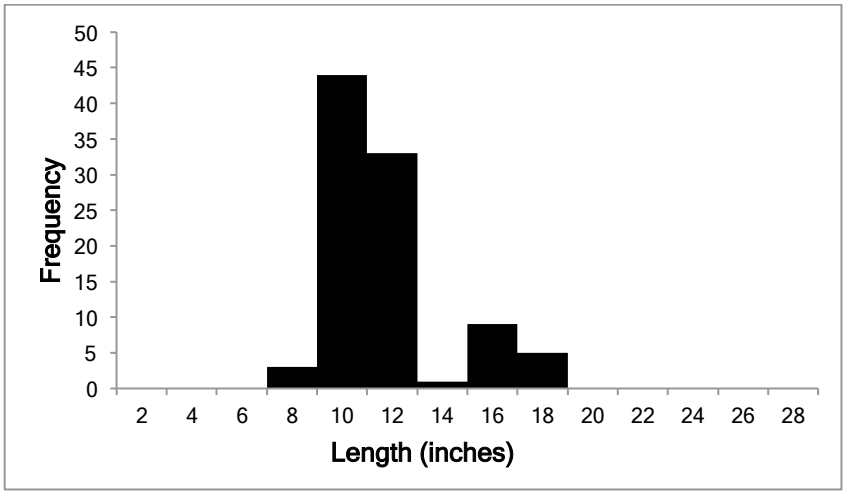

Figure 8. Length frequency histogram of Rainbow Trout (n=95) captured by electrofishing and gill netting at Quemado Reservoir from October 14, 2014 to October 16, 2014.

Fishery management goals have been attained at Quemado Reservoir. Mechanical removal provided initial control of Goldfish numbers and had no negative effects on the trout fishery. It aided in reducing reproductively mature Goldfish and reduced their recruitment. Introducing tiger muskie provided additional control of Goldfish, particularly when Goldfish dispersed throughout the reservoir during the summer months. By maintaining the tiger muskie density at an appropriate level, Goldfish numbers were drastically reduced and angling opportunities enhanced for both Rainbow Trout and tiger muskie.

Conclusion

The use of tiger muskie yielded mixed results at Bluewater and Quemado Reservoirs (Table 1). The tiger muskie population in Bluewater Reservoir is too high and not sustainable at current densities contributing to potential for severe decline despite currently being an excellent fishery. Reducing the tiger muskie population is necessary to ensure sustainability similar to the tiger muskie population in Quemado Reservoir which is healthier, in a more balanced state, and is meeting management goals. An incremental reduction in density will be closely monitored to determine the appropriate level for Bluewater Reservoir. A higher density of 12-15 tiger muskie per surface acre may be suitable for attaining management goals at both reservoirs while providing quality tiger muskie fishing opportunity. NMDGF recognizes stocking tiger muskie has provided a successful biological control while also creating a popular recreational sport fishery. Fisheries management plans for Bluewater and Quemado Reservoirs will continue to include tiger muskie

in the future. Future plans for fisheries management at each reservoir is summarized in (Table 2).

Table 1. Summary of current fisheries management at Bluewater and Quemado Reservoirs. Tiger muskie density is reported as number of fish per surface acre.

Reservoir	Rainbow Trout Fishery Provided?	Preferred Tiger Muskie Density?	Current Tiger Muskie Density	Current Density of Tiger Muskie Sustainable?	Established Control of Unwanted Fish?
Bluewater	No	4	26	No	Yes
Quemado	Yes	4	5	Yes	Yes

Table 2. Summary of future fisheries management strategy at Bluewater and Quemado Reservoirs.

	Bluewater	Quemado

Rainbow Trout	• Postpone stocking until tiger muskie population becomes more balanced based on continued spring and fall surveys.	• Stock 30,000 catchables (>8") annually.
		  ○ 10,000 in May
		  ○ 5,000 in June
		  ○ 5,000 in July
		  ○ 10,000 in September

Tiger muskie	• Stock 15,000 fry or 1,000 fingerlings spring 2015 and 2016. Adjust stocking rate based on the status of muskie population, prey base, and reservoir level. • Continue spring and fall surveys and revise stocking strategies as needed based on survey results and/or reservoir conditions. Increase effort during surveys to improve mark-recapture results thus improving reliability of population estimates.	• Stock 10,000 fry or 1,000 fingerlings every other year depending on reservoir level. The next stocking will be spring 2015. • Continue spring and fall surveys and revise stocking strategies as needed based on survey results and/or reservoir conditions.