Progress Report: Miller Lake Lamprey

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INTRODUCTION

Miller Lake (Figure 1) is home to the Miller Lake Lamprey (Figure 2), a native species that occurs only in the Klamath Basin and was first discovered in Miller Lake. Miller Lake is also known for its trophy Brown Trout fishery, in addition to Rainbow Trout, Brook Trout, and kokanee fisheries. The resident Miller Lake Lamprey is the smallest predatory species of lamprey in the world, averaging 3 to 6 inches in total body length (Bond and Kan 1973; Lorion et al. 2000). In the 1950s, Miller Lake Lamprey parasitized introduced trouts and Tui Chub in Miller Lake. The Oregon Game Commission was concerned that Miller Lake Lamprey compromised trout fisheries in the lake, and in 1958 applied the chemical toxaphene to the lake to eradicate them. The toxaphene application successfully eradicated Miller Lake Lamprey in Miller Lake. In 1959, the Commission constructed a barrier in Miller Creek approximately one half mile downstream of the lake outflow to prevent lamprey from migrating back into the lake.

Figure 1. Miller Lake is a deep, coldwater lake in the Cascade Range north of Crater Lake (Klamath County, west of Chemult).

Figure 2. Adult Miller Lake Lamprey, *Entosphenus minimus.*

The Miller Lake Lamprey is now on the State of Oregon's Sensitive Species List. The Oregon Department of Fish and Wildlife (ODFW), recognizing that Miller Lake Lamprey are native to Oregon and do not exist outside of Miller Creek and the upper Williamson and Sycan river drainages, created the Miller Lake Lamprey Conservation Plan (OAR 635-500-3885; ODFW 2005). This plan formed the basis of ongoing management for Miller Lake Lamprey, and this report fulfills requirements to periodically report the status of Miller Lake Lamprey and the effectiveness of management actions to the public.

MANAGEMENT

The Miller Lake Lamprey Conservation Plan (herein, "plan") called for the reconnection of habitats in Miller Lake and Miller Creek through the removal of the human-made barrier in Miller Creek that was installed by the Commission. Other long term conservation strategies in the plan include management of other species — not stocking hatchery trout into streams that Miller Lake Lamprey inhabit to prevent predation on them, and maintaining or providing more opportunities for habitat access and sufficient water quantity. The plan further identified re-establishment of Miller Lake Lamprey into Miller Lake and upper Miller Creek, above the original barrier and a large cascade. The conservation plan for Miller Lake Lamprey also called for scientific studies to fill information gaps, and periodic surveys to assess and evaluate population status. The plan identified a desired status for the Miller Lake Lamprey *"…to be distributed widely throughout its historic range, with populations robust enough to withstand stochastic environmental events, and with both the populations and their habitat secure from anthropogenic threats."*

Figure 3 provides a high-level summary of years when particular management and survey actions were conducted and when scientific information was published. Table 1 reports survey data and Table 2 reports information on translocations of lamprey into Miller Lake, Evening Creek, and upper Miller Creek that were undertaken to re-establish lamprey into Miller Lake.

The plan identified the formation of a technical team (the Miller Lake Lamprey Technical Management Team; TMT) to monitor Miller Lake Lamprey and manage attempts to reintroduce them back into the lake. This team includes biologists from the Oregon Department of Fish and Wildlife (Roger Smith [retired], Ben Ramirez, Bill Tinniswood, Stephanie Gunckel, Ben Clemens); Western Fishes (Dr. Stewart

Reid); the U.S. Forest Service (Terry Smith [retired]), and Oregon State University (Dr. Doug Markle and various students). The TMT removed the barrier between Miller Lake and Miller Creek in 2005. Following removal of the barrier in Miller Creek (Figure 3), various locations of the Miller Lake Basin were surveyed for the presence/absence of Miller Lake Lamprey. Survey results informed subsequent decisions by biologists in the TMT for translocation numbers and destinations.

Table 1. Survey results and observations for Miller Lake Lamprey. Locations referenced can be viewed in Figure 4. ML = Miller Lake; MC = Miller Cr; LMC = lower Miller Cr; UMC = upper Miller Cr; Evening Cr = EC; Tipsoo Cr = TC; Gideon Cr = GC. Counts do not reflect all observations (e.g., some larvae escaped capture).

Year	Survey locations	No. lamprey	Notes
2004	12 locations from ML down into LMC	~266	69.6 mins of surveys — lamprey in 4 sites of LMC. None in ML or UMC.
2008	4 locations in MC	29	63 mins of surveys — all in 3 sites of lower MC. No lamprey found in UMC.
2010	LMC	700	over 0.4 km; *collected for translocations — see Table 2*
2011	LMC	632	*Collected for translocations — see Table 2*
	EC	7	Likely from 2010 translocation.
2012	LMC	626	*Collected for translocations — see Table 2*
	UMC	1	Below Miller Lake Rd
	ML	0 [a]	
	EC	Present	
2013	LMC	600	*Collected for translocations — see Table 2*
	TC	1	Small larvae (29 mm)
2014	EC, UMC	Present	
	TC, GC	0 [a]	
2015	LMC	400	*Collected for translocations — see Table 2*
	TC, GC	0 [a]	
	EC	Present	Many larvae found in all years subsequent to introduction. Also found spawned out female (6 July).
2016	UMC	0 [a]	one young-of-year larva (< 20mm) found above culvert in UMC, larger larvae also below culvert
	EC	Present	Low abundance, larger size classes
2017	LMC	610	Highest apparent density observed to date at this location. *Collected for translocations — see Table 2*
	UMC	4	3 young-of-the year larvae (20-30 mm — indication of successful spawning), plus 1 larger larvae (~95 mm)
	EC	33	Larvae found at confluence of EC and ML The larvae were very large and were likely from past translocations.
2018	LMC	401	High density; largest proportion of adults (~66) observed to date at this location. *Collected for translocations — see Table 2*
	UMC	>35	Larvae present just above former dam site (~60 – 95mm); also below lake outlet above and below road culvert.
	EC	16	Very large larvae. Two larvae were observed in Miller Lake, off mouth of Evening Creek.

[a] Finding no lamprey implies that none occurred at these locations. However, it cannot be ruled out that lamprey may have occurred in very low densities or in locations that were not surveyed, or that detection efficiencies were low.

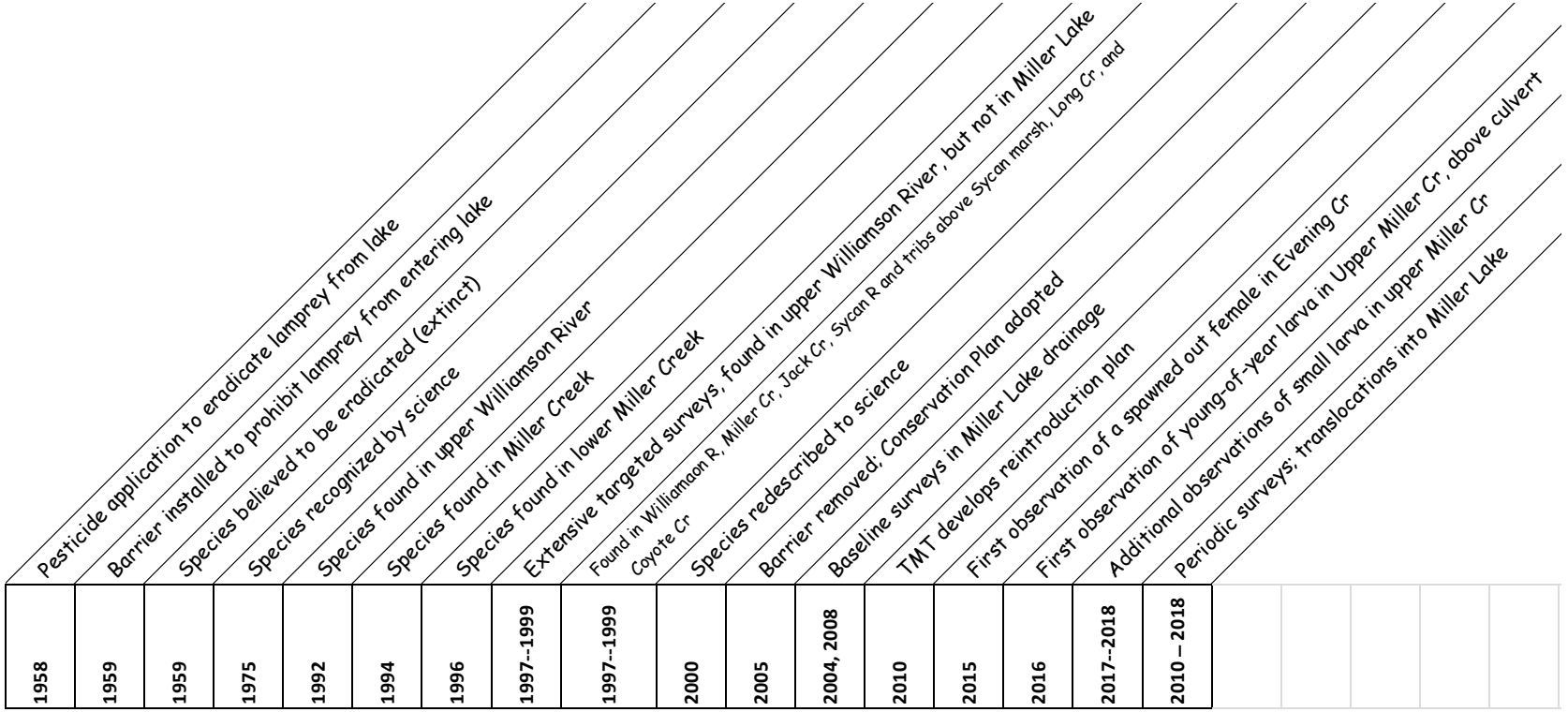

Figure 3. Timeline of management actions and scientific results for Miller Lake Lamprey. Baseline surveys in Miller Lake drainage in 2004 and 2008 found no lamprey in Miller Lake, its inflow tributaries, or the uppermost portion of the outflow tributary, Miller Creek, within the vicinity of the location of the site of the former barrier, approximately a half mile downstream of the outlet of Miller Lake. For more information, refer to Table 1. TMT = Miller Lake Lamprey Technical Management Team.

Table 2. Reintroduction efforts (translocations) by the Miller Lake Lamprey TMT to re-establish Miller Lake Lamprey in Miller Lake. All translocated lamprey were taken from lower Miller Creek. Locations referenced can be viewed in Figure 4. Translocated lamprey were primarily larvae, but ranged from young-of-the-year to adults. See Table 1 for abbreviations.

Year	Dates	Number of lamprey	Lamprey translocated to	Notes
2010	3, 4 Aug	700	ML (300), EC (300), and UMC (100)	Included 2 adults
2011	16, 17 Aug	632	ML (200), EC (232), UMC (200)	
2012	25 Sep	626	ML, EC, and UMC	
2013	28, 29 Aug	600	ML, EC, and UMC	
2015	6, 7 Jul & 26 Oct	400	EC and UMC by NF-9972 road culvert crossing	20 Oct survey (none translocated)
2017	30, 31 Aug	610	ML at outlet into UMC	Included 3 adults
2018	13, 14 Sep	401	UMC	~66 adults

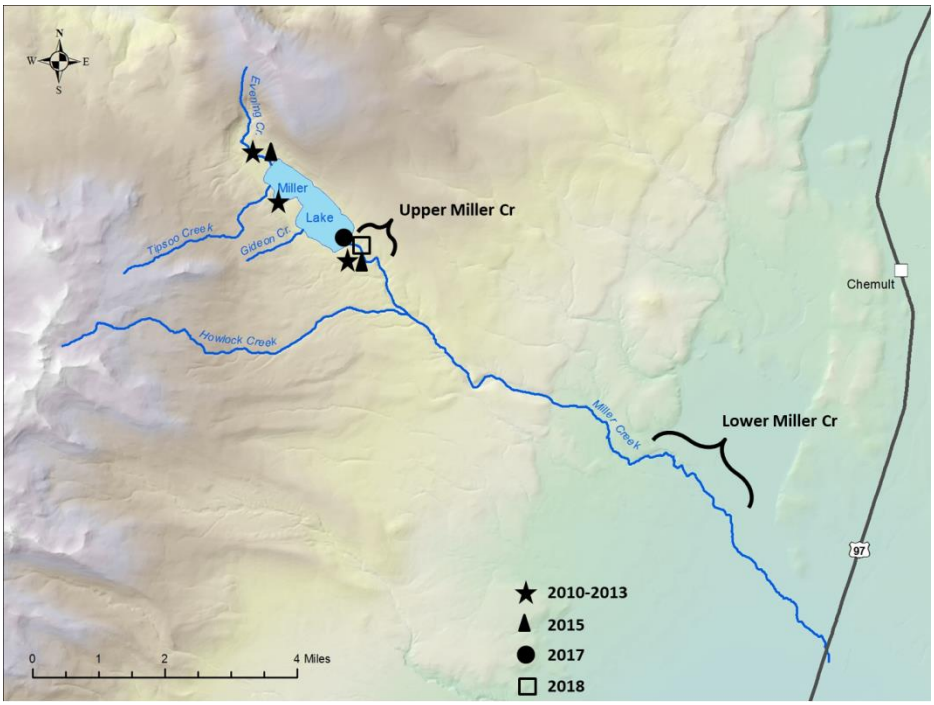

Figure 4. Map of Miller Lake, showing tributaries flowing into the lake from the north and west, and the outflow tributary, Miller Creek. Lower Miller Creek has been used as a donor source for translocations of Miller Lake Lamprey (Table 2). Symbols indicate release sites and years. Evidence of successful reproduction from past translocations into upper Miller Creek was found in 2016 and 2017 (Table 1; Figure 3).

INTERESTING OBSERVATIONS FOR 2018

- Water levels throughout the Miller Creek Basin were low, and a large algal bloom was observed in Miller Lake.
- More adult lamprey were found in lower Miller Creek than in the past (Table 1; Figure 5). This observation may be the result of any number of different factors, and the annual surveys were not designed to elucidate the cause.

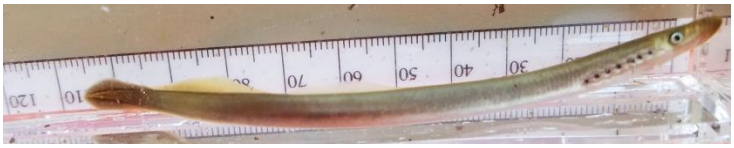

Figure 5. Adult Miller Lake Lamprey (feeding stage), captured in Lower Miller Creek. This specimen is about 120 mm or 4.7 inches.

- The TMT observed predation by Miller Lake Lamprey on Brown Trout and Brook Trout in Lower Miller Creek (Figure 6). Predation has also been observed in the past, including during snorkel surveys (1998 – 1999).

Figure 6. A. Dead Brown Trout found in Lower Miller Creek with obvious lamprey wounds (two of which are indicated by arrows. **B.** Miller Lake Lamprey (indicated by arrow) actively feeding on a Brook Trout in Lower Miller Creek. **C.** The Brook Trout and Miller Lake Lamprey from B, with an arrow showing the wound made by the lamprey.

- The camp host at Miller Lake campground claimed that anglers reported observing lamprey wounds on some trout that were caught, however these claims are unsubstantiated. If true, this is the first predation by Miller Lake Lamprey on fishes in Miller Lake since Miller Lake Lamprey were extirpated in 1958 (Figure 3). However, further work is needed to verify and document these claims.
- Monitoring results indicate that lamprey translocated into Evening Creek and Upper Miller Creek survived, and larval lamprey were more readily found distributed throughout Upper Miller Creek than they have been in the past (Table 1; Figure 3), which may be partly attributed to many releases having occurred here over the years (Figure 4). Limited sampling revealed larval lamprey in Miller Lake near the mouth of Evening Creek in both 2017 and 2018 (Table 1).

CONCLUSIONS

Given the cool water temperatures of the Miller Lake drainage, the small body size and relatively low number of young produced by Miller Lake Lamprey, and generation times that may take several years, it was concluded in 2017 that a re-established connection of the lamprey population between Miller Lake and Miller Creek may take several years (Clemens 2017). Evidence reported here from 2018 suggests that more larvae are distributed more evenly in upper Miller Creek, and that larvae are found in Miller Lake off Evening Creek. These data, combined with the unsubstantiated observations of lamprey predation on trout in Miller Lake suggests that monitoring efforts for 2019 should include surveys in Miller Lake to attempt to verify whether Miller Lake Lamprey have re-established a parasitic adult population in the lake. The TMT is poised to continue monitoring the population status of Miller Lake Lamprey in the Miller Lake Basin, to evaluate the success of previous translocations, and to determine whether subsequent translocations will be necessary.

ACKNOWLEDGMENTS

The information in this report would not have been possible without all of the collaborative and committed efforts of the TMT members.

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