Examining Herbivory at Coeur d’Alene Lake, Idaho

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Herbivory of the invasive Eurasian watermilfoil by native caddisflies in Coeur d’Alene Lake, Idaho

Introduction

Coeur d’Alene (CDA) Lake, located in the panhandle of Idaho is known locally as the “gem” of north Idaho – a nickname reflecting its clear blue water and the surrounding emerald hills. The lake is central to the Coeur d’Alene Tribe’s culture and homeland. It serves also as a recreational summer getaway for families and vacationers across the western United States. However, as is the case for an increasing number of lakes across the United States, Eurasian watermilfoil (*Myriophyllum spicatum*, referred to as milfoil from here), has invaded the native flora and hybridized with native northern milfoil (*Myriophyllum sibiricum*), which has generated a bit of a management nightmare. In CDA Lake, about 73 percent of the milfoil in a 2015 survey was the hybrid (*M. spicatum* × *M. sibiricum*), which likely is more vigorous than its parent species (Thum 2017).

As with many invasive species, milfoil is difficult to control and continues to expand, especially throughout the southern part of the lake which is shallower, warmer, and more productive than the northern part. So far, the application of aquatic herbicides has been the primary method of control. Other control options such as mechanical harvesting are currently being evaluated in field trials.

Regular aquatic surveys by the Lake Management Department of the Coeur d’Alene Tribe revealed an interesting pattern of damage in some milfoil beds resembling herbivory. Concurrently, many individuals of a case-building caddisfly also were observed leading to the hypothesis that the caddisflies contributed to the damage. This naturally led to further questions such as rates of herbivory, life history and timing of occurrence of the caddisfly, and most importantly, could this caddisfly naturally limit milfoil? These questions came to form the focus of the first author’s MS thesis.

Background

Originally, the southern end of Coeur d’Alene Lake was segmented and composed of a series of shallow floodplain lakes including Chatcolet Lake, Round Lake, and Benewah Lake connected by the St. Joe River. The lakes are now inundated and connected throughout the year, due to the advent of lake level regulation resulting from the installation of the Post Falls dam on the Spokane River, the outflow of CDA Lake located at the northern end of the lake. Parts of the St. Joe River channel and levees remain in the southern lake, but much of it is now submerged. The remnant levees and channel remain as a loose barrier between Chatcolet and Round lakes, but overall, the former water bodies at the southern end of Coeur d’Alene Lake are inundated and part of the main lake (Figure 1).

Invasive species have disrupted ecosystems for centuries but have become more common with the advent of increased travel and globalization. Biodiversity is threatened in all types of ecosystems, including freshwaters. Aquatic invasive species can disrupt entire ecosystems through biotic and abiotic means. Alterations include changing water chemistry and nutrient cycling, initiating or disrupting trophic cascades, and impairing human enjoyment of a water body. In general, Pimentel et al. (2005) estimated that in 2005, approximately $100 million dollars (U.S.) was spent in the United States to combat invasive aquatic species, with the cost expected to increase as more species introductions occur. Because of the high cost of removing or reducing invasive species and the addition of unwanted chemicals for their control in many cases, preventing their introduction and establishment should be the first priority of any management plan. If prevention is not an option, management strategies are generally used to attempt to control their abundance. Biocontrol, using biota to control an unwanted non-native species, is an established management practice (e.g., Debach 1964) although sometimes with unintended and unforeseen consequences (e.g., introduction of cane toads to Australia to control native beetles that negatively affected the production of sugar cane). Thus, implementation of biocontrol agents must proceed with caution.

In the case of watermilfoil which reproduces via fragmentation, tolerates littoral zones deeper than most other plants, grows quickly, and often becomes a nuisance for both the public and lake managers, the water veneer *Acentria ephemerella* which is primarily limited to the U.S. east coast, and the weevil *Euhrychiopsis lecontei*, which often suffers from heavy predation are two biocontrol agents that have been examined extensively. The Lake Management Department of the Coeur d’Alene Tribe in their normal monitoring of milfoil in Chatcolet Lake noticed damage to the milfoil and other macrophytes including *Elodea canadensis,* indicative of

Figure 1. The study site, Chatcolet Lake, Idaho.

herbivory, not damage from the herbicide control used previously. Leaves had been stripped from the stems in large patches of both plants (Figure 2). Often, abundant caddisfly larva of the species *Nectopsyche albida* were found concurrently in the damaged patches of vegetation.

Nectopsyche albida (Figure 3) has been previously documented across Canada and the upper Midwest and East in the United States (Haddock 1977) and its presence in CDA Lake is the first recorded occurrence in Idaho. It is mostly observed in the southernmost area of Coeur D' Alene Lake called Chatcolet Lake. To feed, the caddisflies climb over the plants or secrete a silky substance to anchor themselves to the stem or leaf and use their mandibles to remove pieces of plant material (Haddock 1977). The pieces that the caddisflies remove are small, and we have found no evidence to suggest that these fragments regrow into new plants. Regardless if the caddisflies assimilate the plant material, it appears they can inflict considerable damage. Thus, understanding the ability of the caddisfly to damage both native and invasive plant species contributes to informing of its possibility as a biocontrol of milfoil. This also requires understanding the biology of the caddisfly species, such as how its life cycle and life history coincide with the annual cycle of growth and senescence of macrophytes.

Methods and results

To examine changes in macrophyte biomass, density and diversity, we collected samples every other week between April and October at six sites in Chatcolet Lake that are part of the Tribe's regular monitoring program. Overall, timing of macrophyte growth, and their density and diversity varied greatly between 2017 and 2018. The peak macrophyte biomass in 2017 occurred approximately one month earlier (August) compared to 2018 (September), which was likely related to the colder and wetter spring in 2018. In addition, some areas that had abundant macrophytes in 2017, had little to no growth in 2018. While such variation in macrophytes at the southern end of CDA Lake has been noted in long-term surveys conducted by the Coeur D'Alene Tribe, it is unsettling when one's short-term MS thesis research is centered around the presence of macrophytes and caddisflies and they nearly cease to exist during the second field season. However, with patience and extensive sampling, we did find the larva again in August. Interestingly, we did not find caddisfly larva in areas without vegetation, resulting in a spatial shift in the patches of high caddisfly abundance between 2017 and 2018.

To examine the life history of the caddisflies, we collected individuals at the same time and sites as the macrophyte collections. We measured between 52 and 124 individuals on each sampling occasion to observe growth, and development over time. In 2017, small individuals starting at a size of 0.52 mm were sampled in August. These grew rapidly to a size of 0.81 mm by September, after which size remained relatively constant until the caddisflies undergo physical changes and emerge as adults in early June of 2018 (Figure 4). Given the low densities of macrophytes at our usual sampling sites, we did not manage to collect newly hatched individuals until August 2018. The growth pattern was similar to that in 2017 (Figure 4).

We used three controlled laboratory experiments in August, September, and October of 2018 to determine the rate of consumption and plant preference of *N. albida*. Individual trial chambers each

Figure 2. Damage to Elodea canadensis *(left) and* Myriophyllum spp *(right) from Chatcolet Lake.*

Figure 3. Anterior end of Nectopsyche albida *larva outside of its case under a dissecting microscope showing markings on head capsule case.*

contained one gram of either *M. spp* or *E. canadensis*, as well as other containers with different ratios of each plant. The experimental chambers had one caddisfly each, while the controls contained only plants. Each experiment was run for one week, during which only lake water was replenished to maintain a constant water volume. The consumption of *E. canadensis* remained relatively consistent among trials and ranged from approximately 14 to 20 mg · individual^{-1} · day^{-1} (Figure 5). However, the consumption of milfoil ranged from 0 to 27 mg · individual^{-1} · day^{1} (Figure 5). For the trials with different ratios of the two plant species, no consistent trends were found (Table 1). This may be related in part to the use of different sized caddisflies because we were limited to field-collected individuals which grew over time. The different experiment times may also have influenced the palatability of macrophytes, as they were field-collected for each trial, and may have undergone seasonal changes.

Management Implications

In Coeur d'Alene Lake, individuals of *N. albida* overwinter as large larvae that pupate in late spring and emerge as adults in late June and early July when they lay their eggs. The new generation of small larva hatch from the eggs and grow rapidly until October before over-wintering. The onset of macrophyte growth generally coincides with the time

Table 1. Plant preference (in percent) of *Nectospyche albida* feeding experiments when presented with different ratios of *Elodea canadensis* (EL) and *Myriophyllum spp.* (MS).

Trial	*Plant Species*	*Ratio MS:EL*		
		75:25	50:50	25:75
1	MS	0	100	0
	EL	100	0	100
2	MS	0	37	18
	EL	100	63	82
3	MS	54	100	75
	EL	46	0	25

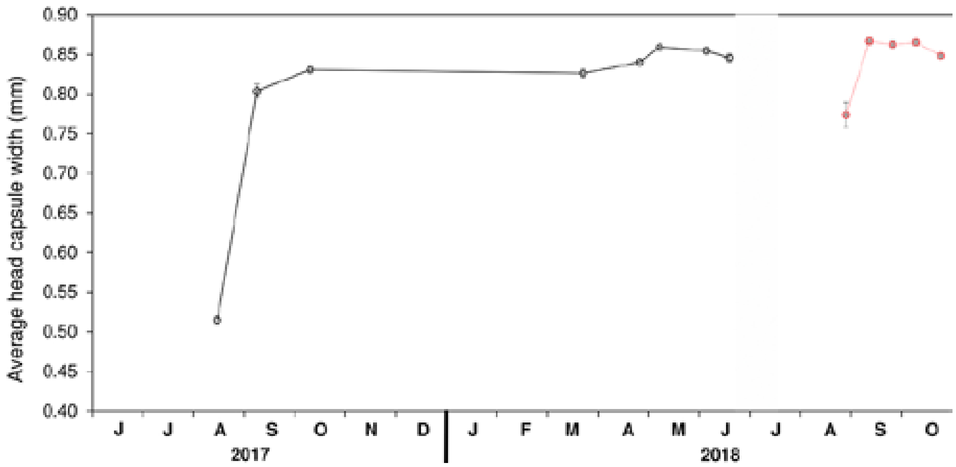

Figure 4. Head capsule length of Nectopsyche albida *larva as a function of time. The dots represent an average of head capsule length from a single sampling occasion. The black dots represent one generation, and the red dots represent the larva from the next generation.*

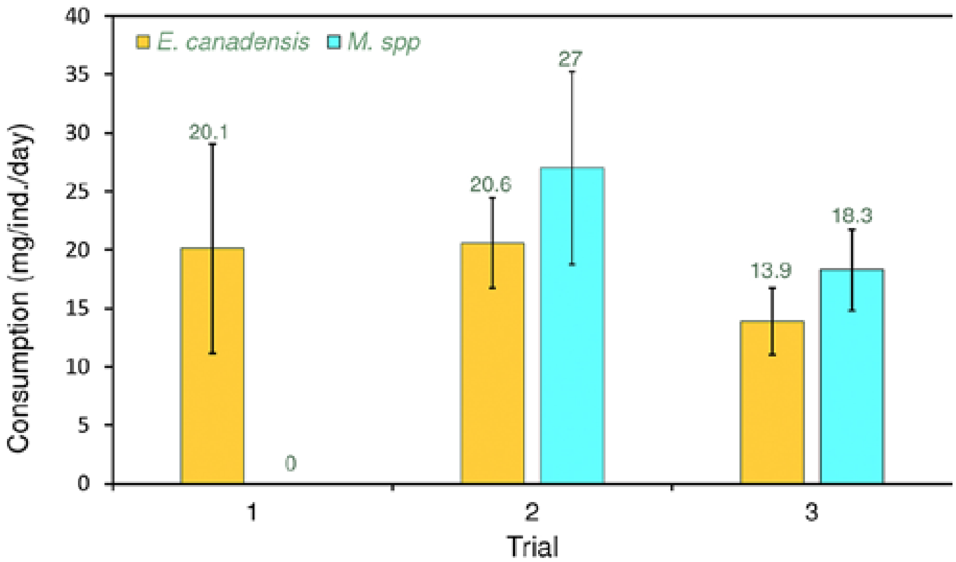

Figure 5. Mean mass of Elodea canadensis *(orange bars) and* Myriophyllum spp. *(blue bars) consumed by individuals of* Nectopsyche albida*. Numbers of top of bars represent means of five replicates, while error bars indicate standard errors.*

of adult emergence, meaning that the caddisflies are unlikely to curb the onset of growth of macrophytes in late spring. However, heavy herbivory in August and September by the new generation could result in an earlier than normal onset of macrophyte senescence. The high abundance of caddisflies we observed at the study sites in 2017 possibly may have damaged the macrophytes sufficiently to impair their overwinter survival and contributed to the low density we observed in 2018. However, this requires further study as multiple other factors such as interannual variation in water temperature and rate of warming could also negatively affect vigorous macrophyte growth.

Our data clearly show that *N. albida* consumes both *E. canadensis* and *M. spp.* present in CDA Lake trending toward a preference of *E. canadensis* even when *M. spp.* is present at a high density. We recommend continued monitoring to establish the effects the caddisflies have on macrophyte beds from year-to-year, with particular attention to observe if high caddisfly density correlates with low macrophyte density the following year. Overall, our current data indicate that caddisflies will not control macrophyte biomass in a given year.

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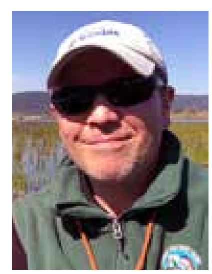

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