Dispelling misperceptions of native lampreys (*Entosphenus* and *Lampetra* spp.) in the Pacific northwest (USA)

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Abstract

Native lampreys continue to be misunderstood by some citizens in the Pacific Northwest (PNW; USA). This misunderstanding is caused by persistent misperceptions reinforced in media and exacerbated by a long-running (mid-1900s to present) and pervasive outreach campaign on the control of the invasive sea lamprey (*Petromyzon marinus*) in the Laurentian Great Lakes, Lake Champlain and the Finger Lakes of New York. The use of outreach to encourage conservation of native lampreys in the PNW has been comparatively recent. Along with other native non-salmonid fishes, lampreys were perceived by Euro-American settlers as “undesirable”, “coarse” or “trash” fish that parasitized desirable trouts and salmon (*Oncorhynchus* spp.) and competed with them for environmental resources. These concerns have been magnified by the seemingly physical and ecological similarities between native and invasive sea lampreys. To dispel the misperceptions of native lampreys, we recommend a multi-prong approach that: sharpens the specificity of outreach materials on sea lamprey control; develops outreach media that distinguishes invasive and native lampreys, includes recognition of the multiple ecosystem benefits that native lampreys offer, and includes hands-on, place-based learning led by or in collaboration with local tribes that can provide cultural context, and employs a broad outreach campaign to facilitate conservation of native lampreys.

KEYWORDS

conservation, education, fishes, native, outreach, sea lamprey

1 | INTRODUCTION

Whereas the conservation of some species is enhanced by their perceived charisma, the public perception of others is a barrier to conservation. This includes misperceptions of native lampreys (Cochran, 2004). A college textbook on ichthyology articulated the sentiment on lampreys well: “Their habit of latching onto the sides of fish and sucking their blood and other body juices has caused them to be placed in the ‘nasty creature’ category, along with vampires and leeches. This is despite the fact that their prey often survives the attack, which is not true of the prey of more conventional predators” (Moyle & Cech, 1996). Additionally, native lamprey species have been confused with the invasive/nuisance sea lamprey (*Petromyzon marinus*) of the Laurentian Great Lakes,
Lake Champlain and the Finger Lakes of New York (“Great Lakes”; Marsden & Siefkes, 2019). Mixed messaging in outreach on control of sea lamprey in the Great Lakes (mid-1900s—present; e.g., GLFC, 2020) has influenced the confusion of invasive Great Lakes sea lamprey with native lampreys (Clemens et al., 2017; Close, Fitzpatrick, & Li, 2002; Cochran, 2004; Luzier et al., 2009). These types of outreach can confuse the average citizen who may not be informed of the importance of lampreys to ecosystems or the differences in the biology and management of invasive sea lamprey in the Great Lakes and lampreys elsewhere (e.g., Clemens et al., 2017, 2020; Clemens, Binder, Docker, Moser, & Sower, 2010). Many people may be surprised that various native lamprey species are valued for food and culture throughout the world (Docker, Hume, & Clemens, 2015).

Confusion among the public on lamprey control (i.e., sea lamprey in the Great Lakes) versus conservation of native lampreys can lead to a lack of public support for conservation efforts for native lampreys.

By contrast with the outreach efforts for controlling invasive sea lamprey in the Great Lakes, outreach efforts for the conservation of native lamprey species of the Pacific Northwest (PNW) of the United States (Table 1) are recent. These efforts were initiated by Native American tribes in the 1990s on the Pacific lamprey (*Entosphenus tridentatus*) because of its great cultural significance to them (Close et al., 1995; Close et al., 2002; CRITFC, 2011). The tribes have led the conservation and outreach for Pacific lamprey. Over time, more entities became involved in the conservation of native lampreys in the PNW with a focus on Pacific lamprey (reviewed in Clemens et al., 2017; Clemens, 2017).

### TABLE 1  Native lampreys of the Pacific Northwest (USA): Washington (WA), Idaho (ID), Oregon (OR), and northern California (CA; Potter, Gill, Renaud, & Haoucher, 2015), and their state status, arranged by latitudinal distribution, north to south

| Species                                      | Life history | Range                                                                 | Status                                                                 |
|----------------------------------------------|--------------|----------------------------------------------------------------------|------------------------------------------------------------------------|
| Pacific lamprey (*Entosphenus tridentatus*)  | A, P         | Alaska south to California                                             | WA: Critically imperiled; Monitor (WDFW 2015)                           |
|                                              |              |                                                                     | ID: Critically imperiled; Endangered (IDFG 2005, 2011, 2020)            |
|                                              |              |                                                                     | OR: Sensitive (ODFW, 2020a)                                            |
|                                              |              |                                                                     | CA: Moderate concern (Moyle, Quiñones, Katz, & Weaver, 2015)           |
| Western river lamprey (*Lampetra ayresii*)   | A, P         | Southeast Alaska to Southern California                              | WA: Imperiled; Candidate (WDFW 2015)                                    |
| Western brook lamprey (*Lampetra richardsoni*| R, N         | Southeast Alaska to northern California                              | OR: Sensitive (ODFW, 2020a)                                            |
| Pacific brook lamprey (*Lampetra pacifica*)  | R, N         | Lower Columbia (Washington and Oregon) and Willamette River basin (Oregon); coastal rivers (Oregon) | OR: Sensitive (ODFW, 2020a)                                            |
| Miller Lake lamprey (*Entosphenus minimus*)  | R, P         | Upper Klamath River basin, Oregon                                    | OR: Sensitive species (ODFW 2020b)                                    |
| Klamath Lake lamprey (*Entosphenus spp.*)    | R, P         | Klamath River basin (upper Klamath Lake), Oregon                      | OR: Data gap species (ODFW 2020b)                                     |
| Klamath River lamprey (*Entosphenus similis*)| R, P         | Klamath River basin (Oregon and California)                           | OR: Data gap species (ODFW 2020b)                                     |
| Goose Lake lamprey (*Entosphenus spp.*)      | R, P         | Goose Lake (Oregon and California)                                    | OR: Data gap species (ODFW 2020b)                                     |
| Pit-Klamath brook lamprey (*Entosphenus lethophagus*) | R, N         | Klamath River basin (Oregon); goose Lake (Oregon and California); pit river (California) | OR: Data gap species (ODFW 2020b)                                     |
| Northern California brook lamprey (*Entosphenus folletti*) | R, N         | Klamath River basin (California)                                      | CA: High concern (Moyle et al., 2015)                                  |
| Kern brook lamprey (*Lampetra hubbsi*)       | R, N         | Merced River and Friant-Kern Canal (California)                       | CA: High concern (Moyle et al., 2015)                                  |

*“A” = anadromous; “R” = resident; “P” = parasitic; “N” = non-feeding (do not feed as adults).*
This increased involvement culminated in the establishment of the Pacific Lamprey Conservation Initiative which is a consortium of tribes, federal, state and local agencies working together to conserve Pacific lamprey, their habitats, and tribal cultural use throughout their historic range in the United States. Nevertheless, these conservation efforts for native lampreys in the PNW have been much more limited in scope and confounded by negative perceptions of invasive sea lamprey. We provide information on native lamprey species and their ecosystem benefits to counteract misperceptions in the PNW. The goals of this paper are to dispel the persistent misperceptions of native lampreys and their confusion with sea lamprey for use by educators, administrators, and biologists.
Lamprey species of the PNW (Table 1) are ecologically and culturally significant and are listed on state, federal, and international sensitive species lists (Clemens et al., 2017, 2020; Maitland, Renaud, Quintella, Close, & Docker, 2015; Moyle, Brown, Chase, & Quiñones, 2009; ODFW, 2020a; USFWS, 2019). However, the importance of native lampreys is lost on many citizens and even biologists. Most people are unaware of the diversity of lamprey species in the PNW (Table 1) and exactly what they contribute to the communities and ecosystems to which they belong. A common question among citizens and natural resource professionals seeking an inroad to funding in competitive proposals commonly ask, “What good are native lampreys?”, to which one can answer by pointing to many examples of Native American uses of Pacific lamprey, including cultural, ceremonial, food, and medicinal benefits (Close et al., 2002; Petersen-Lewis, 2009), and ecosystem benefits (reviewed in Docker et al., 2015). We provide a tabulated “inventory” of ecosystem benefits provided by native lampreys that can be used by educators (Table 2). The historical, cultural, evolutionary, scientific importance of lampreys is beyond the scope of this paper and has been reviewed elsewhere (see Docker et al., 2015).

3 | MISPERCEPTIONS

Fisheries science is predicated on public perception and use of desirable fishery resources. Fisheries management has historically been directed towards species-specific goals (e.g., Lagler, 1969). Historic actions towards these goals have been undertaken to benefit species perceived as desirable (e.g., trouts and salmon; *Oncorhynchus* spp.), and to remove species perceived as undesirable (e.g., non-game fishes). Desirable species are a matter of personal preference, which can be related to cultural experiences, harvest, use (e.g., Close et al., 2002; Downey et al., 1996; Petersen-Lewis, 2009), and socio-economic status of anglers (Brown, 2014). Desirability can also be related to aesthetic preferences among humans for “cute” and charismatic species (e.g., Colléony, Clayton, Couvet, Saint Jalme, & Prévot, 2017; Ducarme, Luque, & Courchamp, 2013; Estren, 2012; Stokes, 2007). Lampreys are sometimes identified as non-charismatic (e.g., Close et al., 2009) and non-fishes (Docker et al., 2015). In combination with their snake-like bodies and parasitic mode of feeding (Renaud & Cochran, 2019), it is easy to see why lampreys often have not fared well in public relations.

In the recent past it was common for non-game fishes to be reviled as competitors with or predators on game fishes (e.g., Brown, 2014; Holey et al., 1979; Lagler, 1969; Scarnecchia, 1992). Public perception of fishery resources has been influenced by Euro-Americans during the late 1800s—late 1900s (Brown, 2014; Close et al., 2002). During this time, native and non-native stocked trouts and salmon were perceived as desirable species in Western North America whereas other native species were viewed as “coarse,” “undesirable” or “trash” fish that competed with trouts and salmon for environmental resources (Brown, 2014). Native Pacific lamprey and western brook lamprey (*Lampera richardi*soni) in Oregon were lumped into the same mental bin as “undesirable” (e.g., Reeher, Hewkin, & West, 1965; Swan, 1965) and perceived as non-native, non-salmonid fish assemblages that needed to be removed as part of “habitat improvements” to increase rearing capacity for salmonids. Crude and uninformed historic fisheries “management” practices were conducted to remove native, non-salmonid species in western states (USA; Brown, 2014).

As early as the 1940s and as late as the 1980s, piscicide (rotenone) application was commonly used to remove lampreys and other undesirable fishes throughout Oregon. This included the Umatilla and John Day rivers (Close et al., 2004; Kostow, 2002; Reeher et al., 1965; Sheoships, 2014), Willamette drainage (Swan, 1965), Miller Lake in the Cascade Mountains (Gerlach & Borovichka, 1964; Lockwood, 1951), and possibly the coast and elsewhere (Downey et al., 1996; Sheoships, 2014). The elders interviewed from the Confederated Tribes of the Siletz (CTS; Downey et al., 1996) and from the Confederated Tribes of the Umatilla (Close et al., 2004; Sheoships, 2014) associated the rotenone treatments with the decline of Pacific lamprey. The interviews of CTSI tribal elders also indicated that angler concern over Pacific lamprey-induced mortality on adult salmonids in the ocean may have stimulated subsequent control actions against Pacific lamprey (Downey et al., 1996; Sheoships, 2014). Fishery concerns over lamprey-induced mortality on stocked rainbow trout (*O. mykiss*) in Miller Lake in the Cascade Mountains of Oregon precipitated management actions to remove the native Miller Lake lamprey (*E. minimus*). This species natural occurrence was historically viewed as an “infestation” that needed to be controlled (Gerlach & Borovichka, 1964; Lockwood, 1951). Control and removal efforts through construction of barrier dams and piscicide (toxaphene) application led to the presumptive eradication of that species by 1959 (Gerlach & Borovichka, 1964). The Miller Lake lamprey has since been rediscovered and re-described over four decades later (Lorion, Markle, Reid, & Docker, 2000). These removals of native fishes are counter to current conservation practices,
and agencies outside of the Great Lakes no longer use piscicides to remove native species, including lampreys. The foregoing suggests native lampreys in Oregon were viewed as undesirable at best, and as a nuisance at worst.

Observations of wounds and scars caused by lampreys to host fishes and attachments of lamprey to hosts have raised concerns over direct killing of non-native, stocked trouts and native salmon desired by anglers (Beamish & Neville, 1995; Lockwood, 1951; Wydoski & Whitney, 1979). Lamprey wounds on trouts and salmon were historically viewed as reductions to their aesthetic value for anglers (Lagler, 1969).

We commonly field questions or see letters to the editor in local newspapers from citizens questioning lamprey conservation efforts in the PNW. Often these citizens admit to having moved from states adjacent to the Great Lakes that are working to control sea lamprey. Finally, we encounter citizens that are worried about being attacked by lamprey when swimming—a concern that is unfounded but often promoted in the media.

## 4 | INVASIVE SEA LAMPREY OF THE GREAT LAKES

The sea lamprey invaded the Great Lakes during the late 1800s to late 1930s (Eshenroder, 2014; Smith & Tibbles, 1980; Sullivan et al., 2003), where it had access to plentiful spawning habitat, and small-bodied prey that had not co-evolved with the sea lamprey (Cochran, 2004; Renaud & Cochran, 2019). This was a unique situation where an anadromous lamprey accessed previously inaccessible freshwater habitats through human-made canals and caused extensive damage to desirable fish species (Eshenroder et al. 2014; Marsden & Siefkes, 2019). The invasive sea lamprey, along with a number of other factors, contributed to the collapse of whitefish (Coregonus spp.) and lake trout (Salvelinus namaycush) fisheries in the Great Lakes (Smith, 1968).

The sea lamprey proliferated throughout the Great Lakes during the mid-1900s. The growing threat of the sea lamprey stimulated the formation of the Great Lakes Fishery Commission (GLFC) to coordinate and organize research and control efforts of this species, and prevent collapse of vulnerable native fish stocks in the region (Fetterolf Jr., 1980). This control effort has been recognized as one of the largest control efforts of a vertebrate species in the world, and consists of coordination of research and management efforts between two countries (Canada and USA), multiple provinces, states, agencies, academia, and tribes (Fetterolf Jr., 1980; Smith, 1980). The outreach of the GLFC and various other partnering entities has been wide-spread and persistent since the mid-1900s (e.g., Applegate, 1951, 1955; SLIS I, 1980; SLIS II, 2003). Outreach materials developed by partners in the sea lamprey control program include graphic images of lamprey wounds on sport fishes, pictures of lampreys attached to grimacing humans, and a plethora of “wanted” signs and other images anthropomorphizing sea lampreys into criminals (Brant, 2019).

## 5 | EDUCATION AND OUTREACH

“One of the most important tools of resource management is public education, and management agencies can do much to address the cultural bias against lampreys with appropriate communications to the general public. These efforts may be ineffective if the information provided to the public is not edited for accuracy, or if the public’s ability to handle sophisticated natural history is underestimated.” (Cochran, 2004).

Internet web pages and social media allow for unprecedented outreach around the world. Much of this outreach may not carry clear context to foster deeper understanding among media consumers. A quick web search reveals web page titles with the words “sea lampreys”, “sea lamprey”, “lampey”, etc.: this superficial lack of specificity could suggest to the public that there is only one species of lamprey that is parasitic and detrimental to other fishes (the invasive sea lamprey of the Great Lakes), and that species is problematic outside of the Great Lakes. Additionally, negative and often sensational information about lamprey natural history and behavior is published online in social and mainstream media. Public interaction with these types of media may have influenced contemporary perceptions of native lampreys in the PNW.

To dispel the misperceptions of native lampreys, we recommend a multi-prong approach that: sharpens the specificity of outreach materials on sea lamprey control; develops outreach media that distinguishes invasive and native lampreys; includes recognition of the multiple ecosystem benefits that native lampreys offer (Table 2), includes hands-on, place-based learning led by or in collaboration with local tribes (to provide cultural context; see for example, Lumley, Goudy, Beals, Saluskin, & Lampman, 2020), and employs a broad outreach campaign to facilitate conservation of native lampreys. Outreach programs for invasive sea lamprey in the Great Lakes could benefit native lampreys by including more specificity in web page titles and text, and including caveats and references to other sources for information.
on native lampreys. Similarly, outreach efforts aimed at conservation of native lampreys could reciprocate by providing caveats and references to other sources for information on control of invasive sea lamprey. In this way, focal geographic areas for control of invasive sea lamprey and conservation of native lampreys could reinforce each other’s missions. The development of joint outreach materials including photos of native and invasive lamprey species, facts about each, and how partners on both sides are working together with the goal of ecosystem health could promote education. Our suggestion of collaborating to achieve reciprocity in diverse messaging on control and conservation of lampreys will be challenging because of the nuances needed to execute strong and accurate messaging for what may appear as conflicting goals.

Information technology has enabled an unprecedented ability to share and promote the conservation of lamprey species. The use of “amusing internet memes” was positively correlated with increasing interest in other non-charismatic species (Lenda et al., 2020). The U.S. Fish and Wildlife Service (USFWS) used this marketing tactic in their social media campaign that follows the life and interests of “Luna the Lamprey” (USFWS, 2020). Luna has been a spokesfish for the USFWS since 2012, charming kids and adults alike while educating and changing negative opinions about lampreys. Including amusing memes in a traditional conservation marketing plan could increase donations to fundraising campaigns (Lenda et al., 2020) and more importantly hook an audience that is new to native lampreys. Enticing promotional material draws people into zoo and aquarium exhibits where carefully crafted interpretive messaging can be used to educate people on the ecological and cultural importance of native lampreys and what they can do to help conserve them (e.g., Figure 1). We hope this paper fosters communication between outreach efforts for control of invasive sea lamprey and conservation of native lampreys. A collaborative effort will be essential to changing misperceptions of native lampreys.

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CONFLICT OF INTEREST
The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS
Benjamin J. Clemens: Devised the idea for the manuscript, created the outline, contributed writing and editing. Christina J. Wang: Contributed writing and editing.
DATA AVAILABILITY
With the exception of the references cited, no other data was generated or used.

ETHICS STATEMENT
This paper is the result of literature reviews. No animals were handled and no questionnaires or surveys were administered to humans.

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