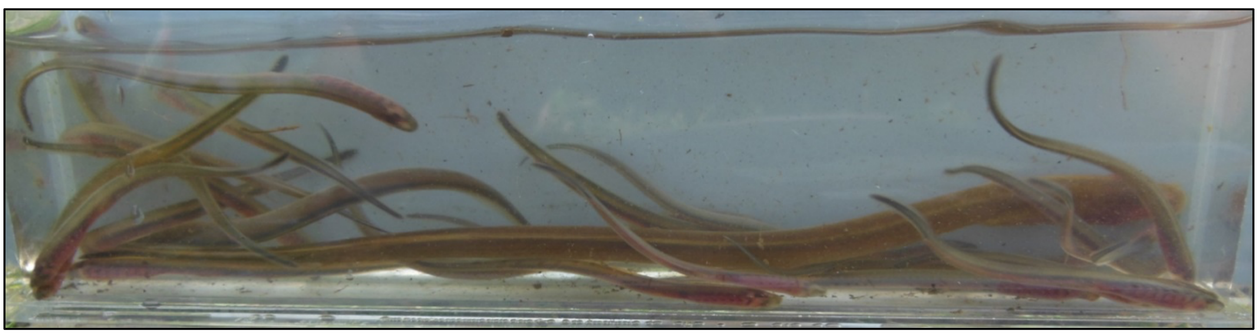
2022 Regional Implementation Plan

for the

Alaska Regional Management Unit



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Introduction

Five species of lamprey are known to occur in the Alaska Regional Management Unit (RMU): Arctic lamprey *Lethenteron camtschaticum*, Pacific lamprey *Entosphenus tridentatus*, Western river lamprey *Lampetra ayresii*, Western brook lamprey *Lampetra richardsoni*, and Alaskan brook lamprey *Lethenteron alaskense*. Previous research efforts within the Alaska RMU have primarily focused on Arctic lamprey because of their value as a subsistence and commercial resource; however, our understanding of their basic biology (e.g., time spent at sea, migration timing, abundance, etc.) remains limited. Unfortunately, even less is known about the four remaining lamprey species within the Alaska RMU. Developing management plans for lampreys are primarily inhibited by our limited understanding of lamprey status and distribution in Alaska. In addition, procuring funds for directed lamprey research is difficult considering their relatively limited consumptive uses and low priority classification by many state and federal agencies. Although five species of lamprey are present within the Alaska RMU, this document will focus on synthesizing available information for (1) Arctic lamprey, due to ongoing harvest pressures within the RMU; and (2) Pacific lamprey, a high priority species of conservation concern within other areas of their distribution (Wang and Schaller 2015).

I. Status and Distribution of Lamprey Species in the RMU

A. General description of the RMU

The Alaska RMU encompasses the entire state of Alaska, an area of approximately 632,000 square miles (USGS 2019). The Alaska region is divided into six subregions which are further subdivided into hydrologic units (HUs): southeast (4 HUs), southcentral (7 HUs), southwest (5 HUs), Yukon (8 HUs), northwest (4 HUs), and Arctic (5 HUs; USGS 2019; Fig. 1). Major Alaskan rivers within these subregions includes, the Yukon River (3,185 km), Kuskokwim River (1,130 km), Stikine River (610 km), Susitna River (504 km), Copper River (470 km), and Kobuk River (451 km). Alaska’s rivers drain into the Beaufort, Chukchi, and Bering seas as well as the Gulf of Alaska (GOA). While the current implementation plan does not subdivide the Alaska RMU into multiple regions, future plans might consider using subregions defined by the USGS (2019) to assess the status of lamprey at finer regional scales.

Figure 1. The Alaska region subdivided into its six subregion hydrologic unit boundaries. Map adapted from the U.S. Geological Survey (https://water.usgs.gov/wsc/reg/19.html).

B. Status of Species

Arctic lamprey

Conservation Assessment and New Updates

Arctic lampreys are afforded no formal protection in Alaska. Baseline information is needed on the distribution, abundance, and life history for all life stages of this species. Although there has been recent research on the genetic structure, distribution, relative abundance/density, and biology of larval *Lethenteron* spp. in spawning tributaries within the Yukon River drainage (Sutton 2017; Shink et al. 2018), similar studies need to be conducted in other Alaskan tributaries of the Yukon River as well as the Kuskokwim and Susitna River drainages. Larval lampreys serve as ecological engineers in their freshwater environments. Their burrowing and feeding behaviors increase oxygen conditions in the streambed, maintain the relative softness of the streambed, and increase the abundance of fine-particulate-organic matter on the streambed surface (Shirakawa et al. 2013).

Given this importance, studies on the abundance, age structure, growth rates and patterns, and movements and distribution are essential for a more complete understanding of larval lampreys. Research that focuses on the juvenile and adult life stages (e.g., migration rates and patterns, timing of downstream and upstream migrations, spawning habitats and locations, population dynamics, etc.) is also necessary. Additional research is also needed to examine the role of Arctic lamprey in marine and freshwater ecosystems (Sutton 2017; Shink et al. 2019). Further, it remains unclear if Alaskan brook lamprey is truly a distinct species or if it is a life-history variant (i.e., freshwater resident) of Arctic lamprey (Docker et al. 2009; Sutton 2017; Shink et al. 2018). By developing a more thorough understanding of Arctic lamprey, fisheries scientists in Alaska will be able to develop sustainable harvest regulations and conservation plans within the context of ongoing anthropogenic and climate changes.

Yukon River

Arctic lamprey subsistence and commercial harvests are restricted to the lower and middle Yukon River. Historically, subsistence fishers primarily used dip nets and eel sticks from the beach or the edge of shorefast ice to harvest Arctic lamprey during their upstream spawning migration under the ice from late October to early December (Brown et al. 2005). These harvests were not only important to supplement summer and fall salmon harvests for human consumption and dog food, but lamprey skins and oil have functional uses such as small bags for holding fish and conditioning for animal skin boots (Brown et al. 2005). Subsistence harvest was, on average, one or two buckets per family or between three and five buckets for households with dogs. Relative run strength indexed by commercial harvests have indicated poor returns since 2015, and subsistence users have expressed difficulty in meeting their subsistence needs in the same time period (Estensen et al. 2018a, 2018b; Jallen 2021; Decker 2022).

Since 2003, the Alaska Department of Fish and Game (ADF&G) has annually issued a Commissioner's permit for an Arctic lamprey commercial fishery in the lower Yukon River. Commissioner's permits are issued for the commercial harvest of species not managed under existing State of Alaska commercial fishing regulations. The Arctic lamprey commercial fishery started with the purpose of determining gear characteristics, biological information, and to a lesser extent, abundance. Annual permits have allocated between 5,000 and 49,080 pounds (2.27 and

22.26 metric tons) of Arctic lamprey for commercial harvest to the main buyer. Fishing gear is restricted to one hand dip net, eel stick, fyke net, or hoop net per Freshwater Commercial permit holder. Any individual possessing a valid Crewmember's License or a current year limited entry commercial fishing permit may assist the freshwater commercial permit holder and participate in fishing activities. As per permit stipulations, lamprey harvest and fishing location are recorded on a fish ticket and sent to ADF&G. In addition, a sub-sample of harvested Artic lamprey are sent to the department for biological sampling (Hayes and Salomone 2004; Brown et al. 2005; S. Garcia, ADF&G, unpublished data). Lamprey harvested in the Alaskan fishery have been primarily sold to Asian pharmaceutical markets, Eurasian food markets, and research institutions (Renaud 1997, 2011). Despite the commercial and subsistence harvest of Arctic lamprey in Alaska, the status of Arctic lamprey populations and ancestral genetic relationships among aggregations in different drainages within the state and throughout its distribution in North America are currently unknown (ADF&G 2006; Thorsteinson and Love 2016).

In an attempt to learn more about Arctic lamprey and facilitate lamprey harvests, the Yukon Delta Fisheries Development Association (YDFDA) has operated a test fishery for Arctic lamprey since 2013 in the lower Yukon River. The objectives of the test fishery were twofold: to evaluate river entry and run timing and to generate catch-per-unit-effort (CPUE) data to serve as an index of abundance (Hayes et al. 2004; Bower 2014). Six index sites established in 2013 have been fished consistently through 2021 (Fig. 2). Catches from test fish index sites have been highly variable among years, ranging from 263 – 9,008 lamprey (Jallen 2021). The mechanisms driving inter-annual run size variability are unknown. In 2016, a mark-recapture project was initiated at the test fish sites to generate an estimate of in-river Arctic lamprey abundance. Despite multiple years of effort, no reliable population estimates have been possible using mark-recapture techniques due to the low number of recaptures (Garcia 2017). Without an estimate of population abundance, the sustainability of the lamprey harvest within the Yukon River is difficult to assess.

To assist in this effort, a laboratory study was conducted at the University of Alaska Fairbanks from 2020-2022 to evaluate survival, incision healing, tag retention, changes in body size, and short- (24 hours) and long-term (43 days) swim endurance for prespawn Arctic lamprey ($N = 216$) collected from the lower Yukon River (Spanos 2022). Six treatment groups were evaluated:

control, sham surgery, external t-bar anchor tag, and small (0.30 g; 0.1–0.4% tag burden [the ratio of transmitter weight to Arctic lamprey body weight]), medium (0.57 g; 0.2–0.8% tag burden), and large (1.50 g; 0.6–1.9% tag burden) internal radio transmitters. While all Arctic lamprey survived tagging and surgical procedures, the mortality hazard of Arctic lamprey was significantly greater for the large transmitter treatment group compared to the control, t-bar, and sham surgery treatments. Internal scar tissue production, displacement of eggs, and breaks in male testes were found in individuals in all internal transmitter treatment groups. Over the 14-week experimental period, only one t-bar anchor tag and one small transmitter were shed by tagging-evaluation Arctic lamprey. While no significant differences in healing were found among surgical treatment groups, persistent inflammation was observed at surgical incision sites as well as erosion of the skin at antenna-protrusion locations. Most Arctic lamprey declined in total length (mean relative change = -5.02%) and wet weight (mean relative change = -9.65%) over the experimental period, with no differences among treatments. While treatment group was not a significant predictor of swim endurance, higher tag burden resulted in reductions in swim duration at 24-hours, but not 43-days post-treatment. These results indicated that t-bar anchor tags and internal radio transmitters (maximum tag burden = 1.3%) do not impact survival, changes in body size, or swimming endurance of prespawn Arctic lamprey and can be used to monitor spawner abundance and migratory patterns in the Yukon River.

Kuskokwim and Susitna rivers

Although Arctic lampreys are known to occur within the Kuskokwim and Susitna river drainages, a population estimate is not available for either system. Consequently, we do not know if Arctic lamprey populations in those systems are increasing, stable, or decreasing. Unlike the Yukon River, neither of these systems support a commercial fishery (Shelden et al. 2016). However, the Kuskokwim River does support a small-scale subsistence fishery for Arctic lamprey some years (N. Smith, Alaska Department of Fish and Game, personal communication). There are currently no assessment projects occurring within the Kuskokwim drainage. However, a recent assessment project within tributaries of the Susitna drainage documented spawning-phase Arctic lamprey and Alaskan brook lamprey (T. Sutton, UAF, unpublished data). Funding has been secured for additional lamprey surveys in this drainage for 2023 and 2024.

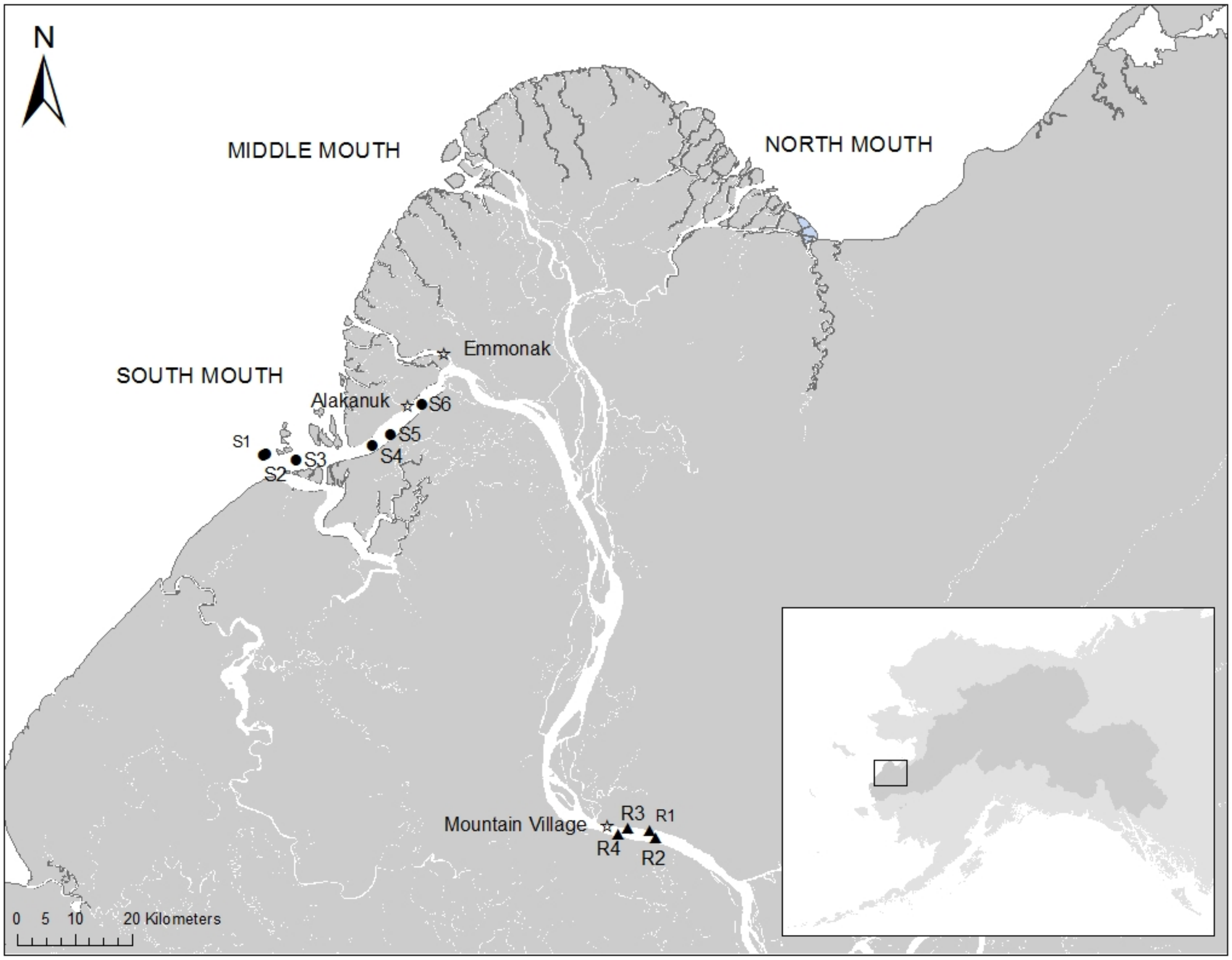

Figure 2. Fyke net test fishing locations (black circles), S1–S6, used as tagging sites for Arctic lamprey in the lower Yukon River from 2016–2018. Fyke net recapture sites (black triangles), R1-R4, used to intercept tagged lamprey. Lower Yukon River communities of Alakanuk, Emmonak, and Mountain Village denoted by stars.

Distribution and Connectivity

In Alaska, Arctic lamprey spawn in the Yukon, Kuskokwim, and Susitna River drainages (Morrow 1980; Mecklenburg et al. 2002; Sutton 2017; Shink et al. 2018; Fig. 3). The population structure within and among Alaskan spawning tributaries and drainages is largely unknown. Shink et al. (2018) examined genetic variation within and among three aggregations of *Lethenteron* spp. larvae in the Yukon River drainage using microsatellite genotypes and found that gene flow was restricted but continuous among aggregations, which is in agreement with observations of gene flow among

Lethenteron spp. populations throughout their geographic range (Artamonova et al. 2011; Yamazaki et al. 2011, 2014; Artamonova et al. 2015).

Pacific lamprey

Conservation Assessment and New Updates

The population status of Pacific lamprey in the Alaska RMU is unknown. Due to the absence of both subsistence and commercial fisheries for Pacific lamprey in Alaska, this species has not been a management priority for state or federal agencies. As a result, monitoring and survey efforts have only recently (June 2019) been initiated on Susitna River tributaries. Although no spawning-phase Pacific lampreys were collected during sampling surveys in 2019, water samples were collected for the examination of environmental DNA (results were inconclusive of lamprey DNA despite the presence of larval lamprey). In addition, there have been observations of spawning Pacific lamprey in the Gulkana River at two separate locations in 2021 (near the outflow of the Gulkana River from Paxson Lake) and 2022 (between Paxson Lake and Sourdough Campground) and in the Susitna River drainage in 2022. There have also been collections of adult Pacific lamprey by commercial fishers using fish wheels in the mainstem Copper River in 2020 (near Chitina, Alaska) and adult and larval Pacific lamprey by Cook Inlet Aquaculture in 2022 from the Kasilof River and Shell Creek (a tributary of the Susitna River).

For the Alaska Regional Management Unit (RMU), an assessment questionnaire was administered in spring 2022 to assess the status and threats impacting Pacific lamprey in the Susitna River. Unfortunately, there has been little research or sample collections conducted on this species to date in this drainage. Consequently, only three respondents participated in the survey. The consensus was that the current population status of Pacific lamprey in the Susitna River drainage is unknown. While there little to no data on the threats impacting Pacific lamprey in this drainage, the following threats were listed as potential concerns that could impact Pacific lamprey: culvert passage (particularly if the West Susitna Access Road goes forward) and any associated dewatering due to blocked culverts, predation (particularly from invasive northern pike *Esox lucius*), and climate change/warming. The largest threat that was noted and agreed upon by all participants was a general lack of baseline information and awareness of Pacific lamprey in the Susitna River drainage.

Distribution and Connectivity

The distribution of Pacific lamprey in the Alaska RMU is poorly understood. Specimens have been documented near Nome and St. Matthew Island, but are thought to be rare north of the Alaska Peninsula (Mecklenburg et al. 2002; Fig. 3). Pacific lamprey have been observed in the Gulf of Alaska (e.g., Copper River) and drainages in southeast (e.g., Stikine, Unuk, Chilkat, and Naha rivers) and southcentral (e.g., Copper, Susitna, Kasilof, and Kenai rivers) Alaska. To date, no comprehensive larval or adult Pacific lamprey surveys have been conducted in the Alaska RMU. Unlike areas of the Pacific Northwest (PNW), passage barriers, except for poorly designed culverts, are not believed to be a major threat to Pacific lamprey populations in Alaska because major river drainages remain relatively unobstructed by man-made dams and artificial barriers.

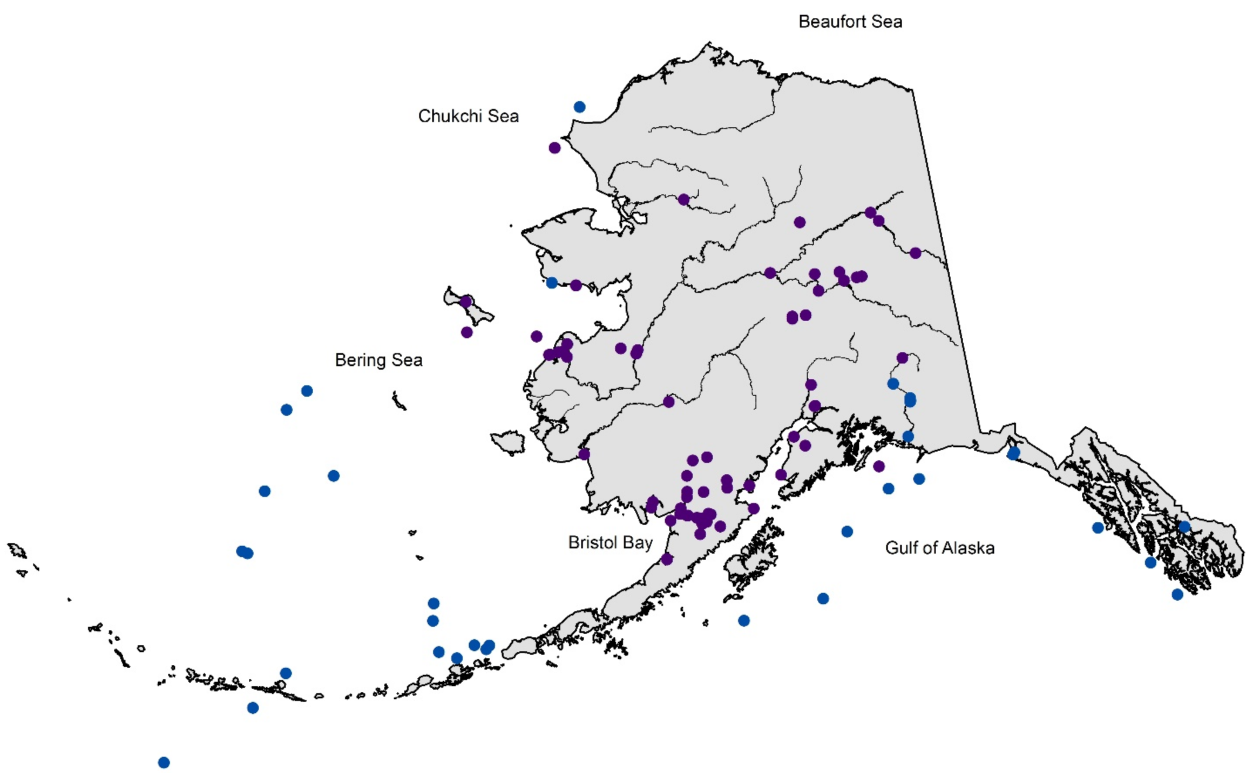

Figure 3. Global Biodiversity Information Network (GBIF) specimen records of Arctic lamprey (purple) and Pacific lamprey (blue) in the Alaska RMU.

C. Threats

Summary of Major Threats

Given our limited knowledge on the distribution, abundance, and life history of Arctic lamprey, the greatest threat to this species currently is a lack of information (Sutton 2017; Shink et al. 2018, 2019). Unfortunately, our knowledge of Pacific lamprey in Alaska is even less than what is known for Arctic lamprey. This limited knowledge is particularly problematic due to the lack of baseline ecological information as freshwater and marine ecosystems are altered by ongoing environmental changes due to rapid warming in high-latitude ecosystems (Serreze et al. 2000; Reist et al. 2006; Solomon et al. 2007). For example, climate warming is a potential threat for the distribution of larval life stages of Arctic lamprey. Arakawa et al. (2018) estimated that the upper lethal water temperature of larval Arctic lamprey larvae was 29.3°C and that growth rate declined with increasing water temperatures, with peak growth occurring at 18°C. In a river located at the southern limit of their distribution in Japan, summer water temperatures already exceed 30°C, and larvae have been detected burrowing in the cooler fine sediments as refugia to avoid warmer surface waters. In addition, high water temperature promotes the activity of harmful microorganisms which results in sediments becoming anaerobic in depositional areas with slow water, and larval Arctic lamprey do not inhabit areas where sediments have become excessively anaerobic (Arakawa and Yanai 2017). Further, food webs in the North Pacific and Arctic oceans are complex, dynamic, and support important fisheries, yet the role of marine-phase lampreys as both predator and prey are poorly understood (Aydin and Mueter 2007; Yamazaki et al. 2014; Alabia et al. 2018; Shink et al. 2019). It remains unclear if current harvest levels for Arctic lamprey in the lower Yukon River are sustainable and how this might impact the relationship between the Arctic lamprey-Alaskan brook lamprey species complex (Hayes and Salomone 2004; Sutton 2017; Shink et al. 2018). Although there are numerous other threats for lampreys elsewhere in North America (e.g., upstream passage, dewatering and flow management, watershed degradation, water quality, predation, competition, etc.), it is not clear what role and degree of impact these stressors may have on Arctic and Pacific lampreys in Alaska.

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II. Selection of Priority Actions

A. Prioritization Process

Proposals were solicited for consideration of prioritization.

B. High Priority Proposed Project Information

The projects below have been submitted by RMU partners for the Alaska RMU.

C. Alaska RMU Priority Projects

Project Name	Project Proponent and Organization	Project Type(s)	Funding Requested	Brief Description
Distribution, Habitat Use, and Life History of Pacific Lamprey in the Susitna River Drainage, Alaska	Trent Sutton, UAF Sabrina Garcia, ADF&G	Assessment	$25,000	Examination of the larval and spawning adult distribution, abundance, habitat use, and other life-history characteristics in the Susitna River drainage
Distribution and Life History of Larval and Spawning-Stage Pacific Lamprey in the Susitna River Drainage, Alaska	Trent Sutton, UAF Sabrina Garcia, ADF&G	Assessment	$25,000	Continuation of the aforementioned project (2023-2024) to include additional study Susitna River sites and expand our knowledge of distribution and abundance in this drainage