FISH PASS

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FishPass: Project Overview

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1. Introduction

In the Great Lakes basin, more than 250,000 dams, weirs, culverts, and other significant obstructions prevent the movement of species both between the Great Lakes and rivers, and within rivers themselves. Moreover, throughout the planet, such obstructions are dominant features of many riverscapes. On the one hand, obstructions thwart connectivity, reduce species richness, fragment habitat, block the movement of desirable fish, impound water, increase stream temperature, and trap sediments. On the other hand, obstructions stop the movement of invasive species (most notably the sea lamprey in the Great Lakes), prevent the transfer of contaminants and diseases, halt deleterious genes, provide recreational opportunities, and generate power. The Selective Bi-directional Fish Passage project (FishPass) seeks to end tension between connectivity and invasive species control. **The mission of FishPass is to provide up- and down-stream passage of desirable fishes while simultaneously blocking and/or removing undesirable fishes.** To achieve this mission, FishPass has three overarching objectives:

- ***Obj. #1*** develop and implement selective bi-directional fish guidance, sorting, and passage techniques and technologies;
- ***Obj. #2*** determine protocols for implementing selective passage solutions within the Boardman River and throughout the Great Lakes Basin; and
- ***Obj. #3*** set solutions in a global context so the approach can be exported.

Achieving these objectives will address one of the greatest fishery management challenges of our time.

FishPass will be located on the Boardman (Ottaway) River, Traverse City, MI at the current Union Street Dam site. The Union Street Dam will be replaced by a facility with an adaptive sorting channel (north bank) to allow for optimization of an integrated suite of technologies and techniques for selective fish passage and invasive species control, all while incorporating a nature-like river channel (south bank) into the design. Water velocity barriers, light guidance, video shape recognition, naturally occurring chemosensory and alarm cues, and eel ladder style traps are just some technologies that could be integrated at the facility to sort invasive fishes and effectively pass desirable fishes. The result will be a world-class technology and research center in a park-like setting (Fig. 1).

The project is an example real-scale adaptive management in that scientists will conduct pre-construction surveys of fish numbers and habitat use above and below the facility to better understand the ecosystem, engineers will design and construct sorting channels to restore controlled connectivity where the barrier formerly existed, and researchers will apply treatments within the channel to optimize fish sorting and passage efficacy. To reduce risks of unintended escapement, optimization will occur below a secondary barrier. After each annual cycle, the system will be re-surveyed for animals above and below the facility. On the basis of survey results, the arrangement of sorting methods will be manipulated to further optimize selection. Assessment of contaminant movement and potential effects on upriver fish population genetics will inform the future optimization and operation of FishPass in terms of species and numbers of animals passed. Ongoing public consultations led by Michigan Department of Natural Resources (MIDNR) will identify “desirable” species, thereby prioritizing needs for passage. Once optimized (~10-year maximum), the system will be converted to a permanent long-term selective fish passageway. Lessons learned from this novel project will be applied to similar rivers and optimized to create selective fish passage at new sites. The project could have regional, national, and global implications.

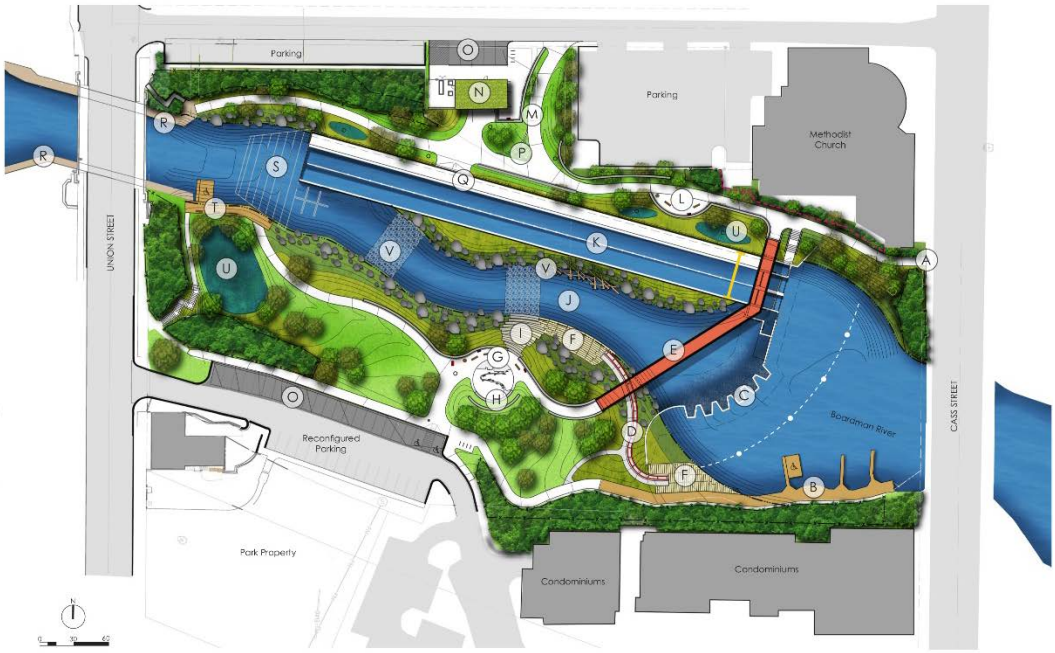

Figure 1. Conceptual rendering of the FishPass facility. The Boardman River flows from bottom to top. Site features include: (A) new pedestrian connection to Cass St.; (B) rehabilitated boardwalk and accessible kayak launch; (C) labyrinth weir; (D) kayak portage rail; (E) pedestrian bridge; (F) kayak shore access; (G) interpretive overlook 1; (H) outdoor classroom and amphitheater; (I) fishing area; (J) bypass channel with boulder armoring and native vegetation; (K) fish-sorting channel; (L) interpretive overlook 2; (M)) service drive/pedestrian walk on city easement; (N) FishPass researcher building/public restrooms; (O) pervious pavers; (P) Turfstone vehicular access; (Q) research access way and security fence; (R) future boardwalk; (S) tailwater entrance pad; (T) boardwalk overlook and accessible kayak launch; (U) rain garden to manage building/parking runoff; and (V) stream habitat.

Three workshops of fishery biologists and engineers were hosted in 2016-2018 to identify site-specific needs and design elements to allow bi-directional selective passage on the basis of the ecology of target species. The workshops also facilitated evaluation of four alternative concept designs to identify a solution that is maximally flexible to accommodate various fish sorting technologies and techniques. A public open house was hosted in 2017 to gain input on current use of the site and what infrastructure, greenspace, and educational features to include in site design and a workshop was hosted in 2018 with the angling community to hear about their concerns and interests.

FishPass is currently funded by the Great Lakes Restoration Initiative and led by the Great Lakes Fishery Commission (GLFC) in partnership with the City of Traverse City, the Grand Traverse Band of Ottawa and Chippewa Indians (GTB), the Great Lakes Fishery Trust (GLFT), the Michigan Department of Natural Resources (MIDNR), the U.S. Army Corps of Engineers (USACE), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Geological Survey (USGS). Governance of the FishPass project will be conducted by an Advisory Board consisting of at least one representative from each partnering agency and experts in fish passage.

The goal of this document is to provide a concise account of the project background, integration into ongoing restoration activities on the Boardman River, and research facility features. Key project elements and goals, aside from scientific research goals, are also outlined.

2. Background

2.1. Site Selection

Site selection for the FishPass project was accomplished through a structured decision analysis. In April 2016, a project planning team was formed and consisted of GLFC staff, 8 fish passage and behavior experts, and 2 USFWS sea lamprey biologists. The team generated a list of 17 site selection criteria, including: river size, consistent runs of sea lamprey, existing infrastructure and access, agency support, controls/replicates, dam attributes, native lamprey upstream, upstream populations to protect, available land, representativeness of the site, gradient, habitat inventory data, adaptability of site, turbidity, public support, ground water discharge, and proximity to biologists. A total of twelve sites were considered during the decision analysis, including the Cheboygan River (MI), Manistque River (MI), Boardman River (MI), Bad River (MI), Whitefish River (MI), Little Manistee River (MI), Ocqueoc River (MI), Conneaut Creek (OH), Grand River (OH), Thunder Bay River (MI), Tittibawassee River (MI), and Saginaw River (MI). Each site was scored relative to each site selection criteria. The planning team performed site visits of the top six sites (Cheboygan, Ocqueoc, Thunder Bay, Boardman, Little Manistee, and Grand Rivers) in July 2016. At the conclusion of this process, the Boardman River ranked highest based on the design criteria and site visit. The project team received support from the Boardman River Implementation Team in July 2016, briefed the Michigan Department of Natural Resources in August 2016, and gained unanimous support from the City of Traverse City Commission.

2.2. Boardman River

The Boardman River drains 287 square miles (743 km^2) of Grand Traverse and Kalkaska counties in western Michigan (Fig. 2) and encompasses 179 lineal miles (288 km) of perennial streams and 74 natural lakes. The large contribution of sandy soils in the watershed and groundwater source cause a remarkably stable hydrologic regime (i.e. 10% exceedance flow, 410 cfs [12 m^3/s], is less than twice the mean flow, 290 cfs [8 m^3/s]). The Boardman River sustains nearly 60 different fish species with 36 miles (58 km) designated as “Blue Ribbon” trout habitat.

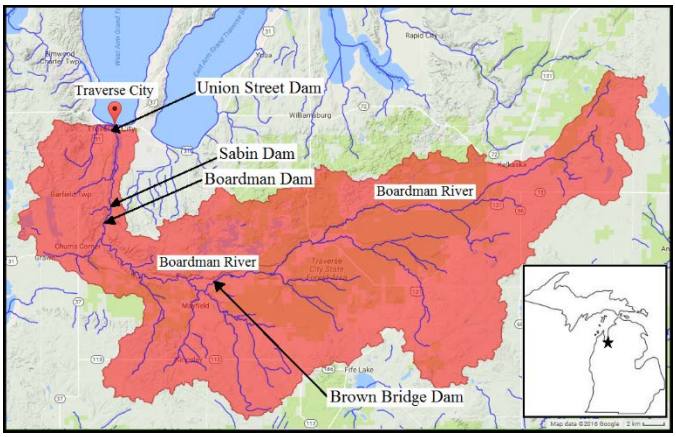

Figure 2. Boardman River watershed and dams

For nearly a century, four dams (moving upstream from Traverse Bay: Union Street, Sabin, Boardman, and Brown Bridge Dam) operated on the Boardman River and caused numerous adverse effects on fish populations and habitat. The Sabin, Boardman, and Brown Bridge hydroelectric dams provided less than <4% of power to Traverse City in 2006 and were decommissioned. Brown Bridge Dam was removed in 2012, Boardman Dam removed in 2017-2018, and Sabin Dam is slated for removal by 2019. Although the Union Street Dam was originally constructed in 1867 to supply power for a now defunct flour mill, no

power generation facility currently exists. As the primary sea lamprey barrier, Union Street Dam was not recommended for removal by the Boardman River Restoration Implementation Team (IT), but modifications have been suggested to address existing structural issues with the infrastructure and potentially to improve fish passage.

The Union Street Dam was identified for FishPass because of the needs identified by the IT as a critical site for Sea Lamprey Control, the suitability of the site for FishPass (i.e., available head and space), and the requirement to maintain water levels in Boardman Lake. The Union Street Dam is located approximately 1.1 miles above West Grand Traverse Bay, 4.1 miles below Sabin Dam and 5.0 miles below Boardman Dam. The dam operates as run-of-river and maintains a fixed water elevation of 589 to 590 feet in Boardman Lake, a naturally occurring lake within the impoundment with a surface area of 339 acres. Union Street Dam is comprised of an earthen embankment with three integral hydraulic structures (Fig. 3). The north (principle) spillway consists of a concrete overflow with five 10.5' wide stoplog bays, each draining into two 48" diameter corrugated metal pipes (CMP), equipped with separate upstream control gates. The south (auxiliary) spillway consists of a concrete overflow with three 6' wide stoplog bays, all draining into two 48" diameter CMP. The pool and weir style fish ladder has a 6' wide concrete channel with 5 stoplog weir sections cascading from headwater to tailwater elevations. The fish ladder is thought to only provide limited passage to fishes such as Pacific salmon, steelhead, and brown trout. Native species that could be positively affected by greater connectivity at the Union Street Dam include: walleye, white sucker, longnose sucker, lake sturgeon, yellow perch, muskellunge, northern pike, and smallmouth bass, among others. Although the Union Street Dam is maintained as a sea lamprey barrier, larvae have been observed upstream and periodic lampricide treatments have occurred since 1963. The abundance of adult sea lamprey below the Union Street Dam during upstream migration periods has averaged 800 individuals over the past 5 years. Although the removal of the Sabin, Boardman, and Brown Bridge Dams is extremely positive in terms of Boardman River restoration, the dam removals also increase the chances of a major sea lamprey invasion throughout the system without modifications or reconstruction of the Union Street Dam.

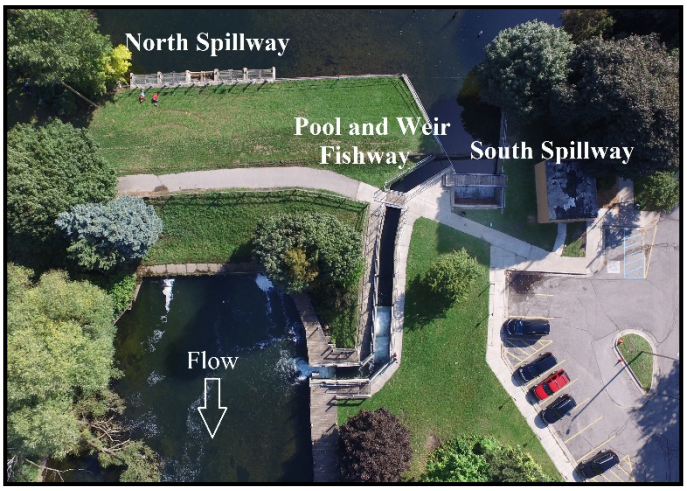

Figure 3. Aerial view of Union Street Dam. The south spillway outlet (not in view) is located immediately downstream of intake.

Approximately 0.3 miles downstream of Union Street Dam is the James P. Price Trap-and-Transfer Facility, which is owned by Traverse City and operated by Michigan Department of Natural Resources (MDNR; Fig. 4). The MDNR installs removable grates in the fall to direct migrating Pacific salmons into a fish ladder and are harvested or returned to the river. Between Union Street Dam and the Trap-and-Transfer Facility is Kids Creek, which has a perched culvert outlet structure.

Traverse City is home to an active local population and attracts tens of thousands of tourists annually. Both locals and visitors like Traverse City for the variety of outdoor activities it offers, and the Boardman River is a major attribute. Below the Union Street Dam, the Boardman River winds its way through downtown Traverse City. River-related activities include paddling, fishing, wildlife viewing, hiking, and pub-crawling, just to name a few. Any deviation from the status quo that concerns the Boardman River elicits considerable interest, both from those who seek and resist change. The river has long been the subject of a broad, comprehensive "natural river plan" that envisions dam removal, fishery improvements, better land use, and incorporation of the river into the city's goals for downtown development and livability. This "natural river plan" has been a priority for a wider range of partners including the State of Michigan, the Grand Traverse Band of Ottawa and Chippewa Indians, and the City of Traverse City. The city and chamber of commerce have promoted the Boardman as a key feature of the "cityscape," and some local businesses have incorporated the river into their business plans (e.g., a pub crawl by kayak).

3. FishPass Facility

The proposed FishPass facility comprises six primary design components (See Fig. 1 for letter references): fish-sorting channel (I), nature-like bypass channel and labyrinth weir (C, H), tailwater entrance pad (S), pedestrian bridge (E), research and education building (F), and park space (D, G, J, K, M, N, P, T). The hydraulic conveyance features (labyrinth weir, low-flow weir, and hydraulic gates) were designed so the default operation (i.e., gates closed) of the FishPass facility is a barrier to all fish. The facility will also act as a complete barrier to sea lamprey up to a 100-yr flood event.

3.1.Fish-sorting channel

The Fish Sorting channel (Fig. 1.I) is a 30' wide concrete channel with minimal slope, designed to provide a grid of anchorages for research equipment. As an integral part of the river, the fish-sorting channel will have the ability to divert between 170 – 412 cfs (4.8 – 11.7 m^3/s) to accommodate full-scale integration and testing of various upstream and downstream fish passage, traps, and barrier technologies. The channel has a removable partition wall so the channel can be principally spilt into two 15 ft (4.5 m) wide channels. The partition walls also allow for dewatering of half the fish-sorting channel, facilitating set-up for future studies. The fish-sorting channel headworks will have two

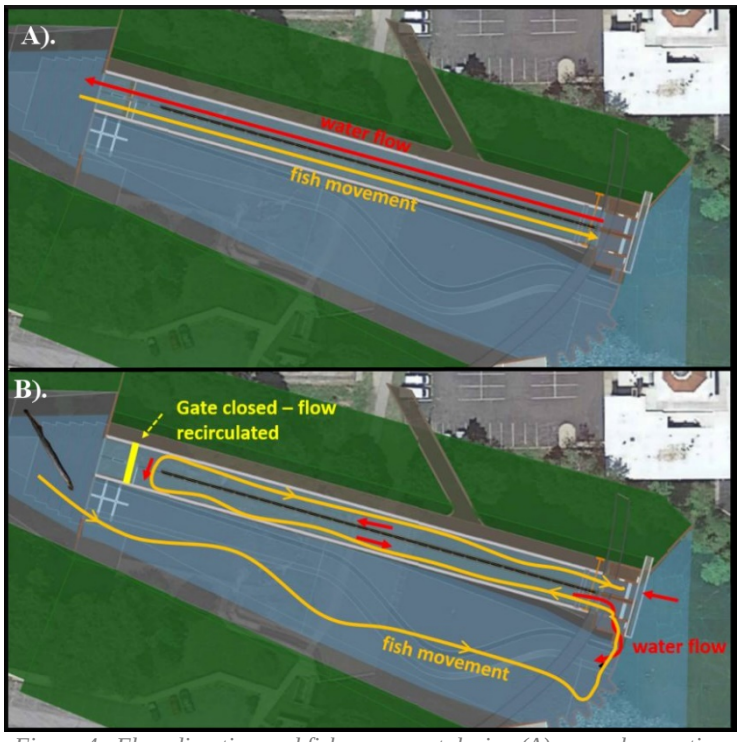

Figure 4. Flow direction and fish movement during (A) normal operating conditions and (B) operating conditions where flow is directed down one side of the fish sorting channel, up the other, and then directed out into the upstream end of the bypass channel.

sets of water control gates that can be operated as a complete barrier to fish passage, but can also be lowered to encourage volitional fish passage. Side compartments adjacent to the headworks will be used for additional sorting of fish and act as a failsafe to prevent unintended releases of fishes upstream. Downward tilting weir gates are provided at the downstream ends of the channel for isolation from the tailwater of the river.

Generally, water will enter the fish-sorting channel through the main headwork gates and exit directly downstream through the tailwater entrance pad. Under special operational conditions, when the downward tilting gates are raised and the headworks entrance gates are open and partition walls in place, water can be directed to flow down the north leg of the fish-sorting channel and up the south leg and exit through the headworks entrance pad into the nature-like bypass channel (Fig. 4).

Data collection for research projects will be collected via instrumentation installed in the channel and instrumentation located on a traveling data carriage installed to move up and down the fish sorting channel. The in-channel and data carriage instruments will allow for collecting and downloading data. A 10-ton gantry crane is mounted on tracks that allow access to the entire fish-sorting channel to assist with moving partitions and other experimental devices.

3.2.Nature-like bypass channel and labyrinth weir

Located south of the fish-sorting channel, the nature-like bypass channel (Fig. 1.H) is constructed to replicate a natural river. Rip-rap, native plantings, and a sinuous river bed are used, along with a fishing pier and kayak/canoe portage amenities. The arced-labyrinth weir and low-flow weir (Fig. 1.C) control the flow of the river into the nature-like channel, depending on flow conditions in the fish-sorting channel. The low-flow and labyrinth weirs provide improved hydraulic conveyance, recreational boat passage, sea lamprey protection, and reduced maintenance compared to the existing facility. The nature-like channel also provides an additional testing channel for both up and downstream passage, but modifications will likely be limited since the channel has an irregular profile and water flows will be minimally adjustable.

3.3.Tailwater entrance pad

Configurable entrance pads are located near the tailworks (fish enter at the downstream opening of the fish-sorting channel) (Fig. 1.S) and headworks (fish enter near the upstream end of the nature-like channel) of the fish-sorting channel (not shown in Fig. 1). The tailwater entrance pad consists of a concrete block pad that has a grid of anchorages for adaptable attachment of experimental guidance devices. The headwater entrance pad consists of a concrete slab integral to the fish-sorting channel headworks and low-flow weir. Three slide gates, mounted on the bypass channel side of the fish-sorting channel headworks, provides fish the opportunity to enter the fish-sorting channel from the upstream end of the nature-like bypass channel.

3.4.Pedestrian bridge

A pedestrian bridge (Fig. 1.E) connects the south and north sides of the park and provides up-close views of the labyrinth weir and fish-sorting channel. The bridge has a span of approximately 180 feet and is a weathered steel through-truss bridge, similar in character to the Pine Street Bridge, located about a mile

downstream on the Boardman River. The pedestrian bridge will replace the existing earthen pathway at the Union Street Dam site.

3.5.Research & Education building

The research and education building (Fig. 1.F) provides space for six researchers in an office setting with kitchenette space, fabrication area, interior storage room, ADA complaint unisex toilet room, and outside storage area. The building also houses two public ADA complaint unisex toilet rooms, a janitor's closet, and accommodations for mechanical and electrical services. The building has a green roof to reduce stormwater runoff. The architectural style is modern rustic, utilizing natural materials such as stone and brick with metal accents, which is consistent with the adjacent structures.

The research and education building will serve as the epicenter of FishPass outreach and education efforts. On the exterior of the building will be an informational display that includes a video monitor showing underwater footage, a scale model of FishPass and technologies being tested, and other educational signage. The signage at the research and education building and around the FishPass site will explain topics such as: Boardman River geography / geology, AIS and the harms they cause, sea lamprey and the destruction they cause, flora and fauna of the river, hydrology, fisheries, history of the Union Street Dam, and technology being demonstrated.

3.6.Park space

The park space surrounding the instream channels are restored to mimic a naturalistic river corridor. Park grading and sidewalk alignments use gently sinuous forms. The park is maintained by the city of Traverse City. The park area also incorporates educational opportunities such as overlooks (Fig. 1.G & J) and an outdoor classroom and amphitheater (Fig. 1.N & T). A turf area on the south bank, adjacent to the parking area, provides a maintained turf area suitable for picnics and child play. Sidewalks and boardwalks (Fig. 1.A, Q, & R) along river banks separate native seeding areas from turf areas located on upper slopes of park. Trees provide slope stabilization, restore riparian vegetation, re-naturalize the park, and provide a framework for park spaces. Over 130 native tree species plantings are included. Stormwater is managed and treated onsite with rain gardens along both sides of the river (Fig. 1.P). A kayak and canoe portage rail (Fig. 1.D) provides improved access and transport of boats from upstream to downstream of FishPass.

4. Project elements and goals

FishPass is a multifaceted project that is prominently located in downtown Traverse City and, therefore, available to its many residents and visitors. The project will have broad effects on how the existing site is accessed and used. The community has placed high value on natural resources and the health of the Boardman River and has a strong desire to integrate the river into the fabric of the city. FishPass provides an excellent opportunity to support these community values among other critical ecosystem and socio-economic values. Below are project goals organized according to core aesthetic, biological, economic, recreational, and social elements of the project. Through extensive consultation with Traverse City planners, local residents and businesses, scientists, and the community at large, project goals were articulated to reflect the values of the community and serve as guiding principles for the design, construction, and operation of FishPass. Consistent with the Traverse City Master Plan, elements refer to

major project components that together form the guiding framework for the project. Herein, goals refer to broad statements of anticipated project results. When asked in the future, "was the project successful," responses can be benchmarked against the eight project goals identified herein. If desirable, specific measurable metrics for goal achievement can be generated to support project evaluation. This document does not include scientific research goals, as those are currently in development and will be detailed in the FishPass Research Plan.

4.1. Aesthetic element

The aesthetic element provides the basis for developing a consistent and desired theme for natural resource features of the Boardman River, including river flow. Conserving the natural features of the existing site helps reduce storm water input and bank erosion. Water control structures are designed to enhance flood flow conveyance consistent with Michigan Department of Environmental Quality (MIDEQ) and MIDNR regulations. The aesthetic element goals are:

A1. *Provide a naturalized landscape consistent with public input*
A2. *Protect water quality standards and maintain stable water levels in Boardman Lake.*

4.2. Biological element

The biological element largely addresses fishery issues associated with passage of desirable species while blocking undesirable species. Research to identify technologies and techniques best suited to selective passage in the Boardman River will occur during a 5-10 post-construction optimization period. The site will then be converted into a permanent selective fishway. Biological element goals are:

B1. *No sea lamprey production requiring treatment in the Boardman River above the project site.*
B2. *Increase the fishery production in the Boardman River to a level comparable to other tributaries/streams.*

4.3. Economic element

The purpose of the economic element is to outline the long-term role of FishPass in the city's infrastructure and to support potential opportunities for local businesses. Management and operation of the FishPass facility will be consistent with the economic plan detailed in the Traverse City Master Plan. The research component of FishPass provides opportunities for local knowledge transfer that can facilitate technology development. Public attraction to the site also provides food and recreation business opportunities. The economic element goals are:

E1. *Provide enhanced, sustainable business opportunities.*

4.4. Recreational element

The recreational element provides a basis for how FishPass and the surrounding area will be accessed and used in the future. The site currently experiences a mix of fishing, boating, pedestrian, and biking use. Input from the community suggests that improvements to site accessibility and through-movement would increase the likelihood of future use. This element recognizes the desired uses of the Boardman River and potential conflicts between individual recreational uses and between recreational and research activities. The recreational element goals are:

R1. *Provide abundant, diverse, and high quality outdoor recreation amenities.*
R2. *Enhance access and use of the site for education, wayfinding, fishing, boating, and biking.*

4.5. Social element

The social element provides the framework for the FishPass design and planning to be aligned with the Traverse City Master Plan. FishPass also includes many opportunities for outreach and educational efforts to be linked with local groups/schools and existing attractions. The social element goals are:

S1. *Integrate the river into the fabric of the city by aligning the project with the City Master Plan.*
S2. *Improve public understanding of the threat from invasive species.*
S3. *Inform the public on the role of human landscape alterations on fisheries and communities.*
S4. *Promote engagement regarding broad objectives for the Boardman River, ecosystem management, and city planning.*

5. Project Support

To date, FishPass has received formal support from Canada and the United States through the Great Lakes Fishery Commission, the City of Traverse City, and Grand Traverse County. Canada and the United States supported FishPass via a Great Lakes Fishery Commission resolution (Dec 2014 Interim meeting minutes). The City of Traverse City has indicated support for FishPass on three occasions: A resolution of intent to serve as a partner in the Bi-directional Fish Passage Project at Union Street Dam (9-6-16); a resolution supporting the Planning Commission decision that the FishPass Project is found to be consistent with the City Master Plan in terms of location, extent, and character (2-5-18); and support from the Boardman River Dams Implementation Team and the member agencies and institutions of the FishPass Advisory Board. In addition, numerous angling groups, environmental organizations, and local civic organizations have expressed explicit support for FishPass.

6. Project Structure

As a multifaceted project, FishPass requires a cohesive vision to guide research, assessment of project metrics, community involvement, and general operation and regulation over the 10-yr span of research activities and beyond. The ensuing documents provide detailed descriptions of the research model, research plan, assessment plan, and communication and outreach strategy for the FishPass project. The research model outlines how research studies will be requested, selected, and implemented. In turn, the research plan outlines the primary research goals of FishPass and conceptual framework for annual research priorities. The assessment plan outlines the monitoring program designed to support research goals and evaluate overall project success. Finally, the communication and outreach strategy outlines broad communication goals, connects audiences to messages and methods of communication, lists education and outreach features at the FishPass site, describes key partnerships, and discusses how the communication effort can be evaluated.