

**LAKE TAHOE RESTORATION PROJECTS
ESTIMATED NECESSARY EXPENSES & KEY MILESTONE DATES**

Proposal Name: Phase 3 – Preventing aquatic invasive species proliferation in Lake Tahoe using control, eradication, prevention and public education techniques.

Project #1 **Integrated Tahoe Keys Aquatic Invasive Species Eradication Project** **Agency:** U.S. Fish and Wildlife Service

Prepared by: Jody Brown **Phone:** 775-861-6320 **EIP #:** 339
SNPLMA Project #: N/A

Identify estimated costs of eligible reimbursement expenses:

1. Planning, Environmental Assessment and Research Costs (specialist surveys, reports, monitoring, data collection, analysis, NEPA, etc.)	\$	6,000	3	%
2. FWS Consultation & Coordination—Endangered Species Act		6,000	3	%
3. Direct Labor (Payroll) to Perform the Project	\$	6,000	3	%
4. Project Equipment (Passed to partners – see #7)	\$	0	0	%
5. Travel (including per diem where official travel status required to carry out project, such as serve as COR, experts to review reports, etc.)	\$	2,000	1	%
6. Official Vehicle Use (pro rata cost for use of Official Vehicles when required to carry out project)	\$	2,000	1	%
7. Cost of Contracts, Grants, and/or Agreements to Perform the Project				
	\$	162,000	81	%
8. Other Direct Costs and Contracted Labor (Agency payroll for the Contracting Officer to do project procurement, COR, Project Inspector, Sec. 106 Consultation if required, NEPA Lead, Project Manager, Project Supervisor, and subject experts to review contracted surveys, designs/drawings, plans, reports, etc.; Also covered is the cost to contract for a Project Manager and/or Project Supervisor if contracted separately from other project contracts)	\$	6,000	3	%
9. Other Necessary Expenses (See Appendix B-11)	\$	10,000	5	%
TOTAL:	\$	200,000	100	%

Estimated Key Milestone Dates:

Milestones/Deliverables:	Date:
1) Implement a program to control the introduction and proliferation of invasives. 2) Create a scientifically based, risk assessment tool. 3) Initiate/validate predictive models	September 2008 through September 2009
Final Completion Date for Round 9, 10, and 11 tasks:	September 2011

Comments: U. S. Fish and Wildlife will pass through 81% and keep 19%

**LAKE TAHOE RESTORATION PROJECTS
ESTIMATED NECESSARY EXPENSES & KEY MILESTONE DATES**

Proposal Name: Phase 3 – Preventing aquatic invasive species proliferation in Lake Tahoe using control, eradication, prevention and public education techniques.

Project #2 **Lake-wide Near Shore Habitat Improvement Project** **Agency:** U.S. Fish and Wildlife Service

Prepared by: Jody Brown **Phone:** 775-861-6320 **EIP #:** 339

1. Planning, Coordination and Assessment	\$	<u>6,000</u>	<u>3</u>	%
2. FWS Consultation & Coordination—Endangered Species Act	\$	<u>6,000</u>	<u>3</u>	%
3. Direct Labor (Payroll) to Administer the Project	\$	<u>6,000</u>	<u>3</u>	%
4. Project Equipment (Passed to partners – see #7)	\$	<u>0</u>	<u>0</u>	%
5. Travel (including per diem where official travel status required to carry out project, such as serve as COR, experts to review reports, etc.)	\$	<u>2,000</u>	<u>1</u>	%
6. Official Vehicle Use/Boat fuel (pro rata cost for use of Official Vehicles when required to carry out project)	\$	<u>2,000</u>	<u>1</u>	%
7. Cost of Contracts, Grants, and/or Agreements to Perform the Project	\$	<u>162,000</u>	<u>81</u>	%
8. Other Direct Costs and Contracted Labor: (Agency payroll for the Contracting Officer to do project procurement, COR, Project Inspector, Sec. 106 Consultation if required, NEPA Lead, Project Manager, Project Supervisor, and subject experts to review contracted surveys, designs/drawings, plans, reports, etc.; Also covered is the cost to contract for a Project Manager and/or Project Supervisor if contracted separately from other project contracts)	\$	<u>6,000</u>	<u>3</u>	%
9. Other Necessary Expenses (See Appendix B-11)	\$	<u>10,000</u>	<u>5</u>	%
TOTAL:	\$	<u>200,000</u>	<u>100</u>	%

Estimated Key Milestone Dates:

Milestones/Deliverables:	Date:
1) Actively remove source populations through hand-pulling and bottom barrier installations. 2) Monitor before and after removal activities.	September 2008 through September 2009
Final Completion Date for Round 9, 10, and 11 tasks:	September 2011

Comments: Fish and Wildlife will pass through 81% and keep 19%

**LAKE TAHOE RESTORATION PROJECTS
ESTIMATED NECESSARY EXPENSES & KEY MILESTONE DATES**

Proposal Name: Phase 3 – Preventing aquatic invasive species proliferation in Lake Tahoe using control, eradication, prevention and public education techniques.

Project #3 Watercraft Inspection Prevention Program **Agency:** U.S. Fish and Wildlife Service
 Prepared by: Jody Brown **Phone:** 775-861-6320 **EIP #:** 339

1. Planning, Coordination and Consultation	9,000	3	%
2. FWS Consultation & Coordination —Endangered Species Act	9,000	3	%
3. Direct Labor to Administer the Project	\$ 9,000	3	%
4. Project Equipment (Passed to partners – see #7)	\$ 0	0	%
5. Travel (including per diem where official travel status required to carry out project, such as serve as COR, experts to review reports, etc.)	\$ 3,000	1	%
6. Official Vehicle Use/Boat fuel (pro rata cost for use of Official Vehicles when required to carry out project)	\$ 3,000	1	%
7. Cost of Contracts, Grants, and/or Agreements to Perform the Project	\$ 243,000	81	%
8. Other Direct Costs (direct labor for agency personnel to do project procurements; COR; PI; personnel assigned as NEPA lead; etc.)	\$ 9,000	3	%
9. Other Necessary Expenses (See Appendix B-11)	\$ 15,000	5	%
TOTAL:	\$ 300,000	100	%

Estimated Key Milestone Dates:

Milestones/Deliverables:	Date:
1) Implement the guidelines of Tahoe Regional Planning Agency’s Watercraft Inspection Program Plan. 2) Facilitate a working relationship with shore zone property owners/managers basin-wide. 3) Teach the public how to inspect boats, trailers, equipment and gear for any AIS.	September 2008 through September 2009
Final Completion Date for Round 9, 10, and 11 tasks:	September 2011

Comments: Fish and Wildlife will pass through 81% and keep 19%

**LAKE TAHOE RESTORATION PROJECTS
ESTIMATED NECESSARY EXPENSES & KEY MILESTONE DATES**

Proposal Name: Phase 3 – Preventing aquatic invasive species proliferation in Lake Tahoe using control, eradication, prevention and public education techniques.

Project #4 **Development of an Environmental Education Prevention Program** **Agency:** U.S. Fish and Wildlife Service

Prepared by: Jody Brown **Phone:** 775-861-6320 **EIP #:** 339

1. Planning, Coordination and Consultation	4,000	4	%
2. FWS Consultation & Coordination —Endangered Species Act	0	0	%
3. Direct Labor to Administer the Project	\$ 3,000	3	%
4. Project Equipment (Passed to partners – see #7)	\$ 0	0	%
5. Travel (including per diem where official travel status required to carry out project, such as serve as COR, experts to review reports, etc.)	\$ 2,000	2	%
6. Official Vehicle Use/Boat fuel (pro rata cost for use of Official Vehicles when required to carry out project)	\$ 2,000	2	%
7. Cost of Contracts, Grants, and/or Agreements to Perform the Project	\$ 81,000	81	%
8. Other Direct Costs (direct labor for agency personnel to do project procurements; COR; PI; personnel assigned as NEPA lead; etc.)	\$ 3,000	3	%
9. Other Necessary Expenses (See Appendix B-11)	\$ 5,000	5	%
TOTAL:	\$ 100,000	100	%

Estimated Key Milestone Dates:

Milestones/Deliverables:	Date:
Implementing the Environmental Education and Prevention Program	September 2008 through September 2009
Final Completion Date for Round 9, 10, and 11 tasks:	September 2011

Comments: Fish and Wildlife will pass through 81% and keep 19%

**LAKE TAHOE CAPITAL PROJECT PROPOSAL
ROUND 9**

Consistency with Lake Tahoe nomination criteria:

Project nominations must qualify as an Environmental Improvement Program (EIP) project and be the responsibility of the federal government (federal share responsibility); and have a willing and ready federal sponsor.

Project nominations must be consistent with one of the focus areas in the June 2006 Federal Vision: (<http://www.fs.fed.us/r5/lbmu/documents/lbec/revised-FV-Final.pdf>) (page 8) and fit into at least one category.

Capital Focus Area: Watershed and Habitat Improvement

Circle a minimum of one category:

1. Continued emphasis on fuels reduction in coordination with projects funded under the 2006 SNPLMA amendment (the “White Pine” amendment).
 2. Continued implementation of projects approved in Rounds 5 through 8 which implement the EIP. Project proposal should clearly describe the phase/product being produced along with the consequence of not completing the project phase proposed for Round 9.
 3. Project is consistent with and contributes toward TMDL pollutant reductions within the four source categories (atmospheric, urban & groundwater, forested uplands, and stream channel).
 4. Control of aquatic invasive species and prevention of new aquatic invasive species.
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Project Name: Phase 3 – Preventing aquatic invasive species proliferation in Lake Tahoe using control, eradication, prevention and public education techniques.

EIP #: 339

Lead Agency: U.S. Fish and Wildlife Service

Contact: Jody Brown

Threshold: Fisheries (F)

Phone Number: 775-861-6320

Threshold Standard: Lake Habitat (F1)

Email address: jody_brown@fws.gov

Funding Requested in this Round: \$800,000

Total Project Cost: \$2,400,000 for 4 simultaneous projects over 3 years (\$800,000 each in Rounds 9, 10, and 11). Four, individual budget sheets that reflect estimated direct costs & key milestone dates are included.

Is this a multi-year Project? (If “Yes”, describe in the Detailed Project Description below number of years or phases and which year the requested funding will cover)

Yes. SNPLMA funds will be requested in each of Rounds 9, 10, and 11 (\$800,000 each). Four, simultaneous projects will be started in 2008, and continue for at least three years.

Round 9 funding will cover the implementation period of September 2008 through September 2009. Future requests for funding in Rounds 10 and 11 will continue project work. Specifically, Round 9 funding of \$800,000 will implement these simultaneous projects:

- Project #1) Integrated Tahoe Keys Aquatic Invasive Species Eradication Project - \$200,000
- Project #2) Lake-wide near shore habitat improvement Project - \$200,000
- Project #3) Watercraft Inspection Prevention Program - \$300,000
- Project #4) Aquatic Invasive Species Environmental Education Prevention Program - \$100,000

Project Summary (maximum 200 words): (applicable ONLY to this Round 9 project):

Phase 3 will implement projects aimed at preventing aquatic invasive species proliferation in Lake Tahoe. Objectives are: to educate the public and enlist their active participation in preventing aquatic invasive species proliferation in Lake Tahoe; and implement best management practices for each of the four projects. The projects are:

- 1) The removal, containment and reduction of existing aquatic invasive species in the Tahoe Keys Marina;
- 2) Implement control and removal activities for lake-wide curlyleaf pondweed and Eurasian watermilfoil source populations to improve near shore habitat lake-wide;
- 3) Conduct lake-wide watercraft inspections with a focus on public education;
- 4) Implement an Aquatic Invasive Species Environmental Education Program

Following the first west coast discovery of the highly invasive quagga mussel in Lake Mead in January 2007, the Tahoe Resource Conservation District (TRCD) formed a Lake Tahoe Aquatic Invasive Species Working Group (LTAISWG). The committee’s goal was to coordinate a workshop to educate stakeholders, agency staff, and decision makers about the importance of controlling and preventing aquatic invasive species in Lake Tahoe. Since then, the AIS Working Group has been meeting quarterly to best coordinate their efforts and based on stakeholder feedback, the LTBASWG partners have given their recommendations for pursuing available funding.

Detailed Project Description (what Round 9 is funding; the number of years or phases Round 9 funding will cover; if phased, briefly describe how this project links into previously phased projects including what remains for Rounds 10 and beyond).

Round 9 monies will fund **Phase 3** – implementing four projects as part of the overall project to prevent aquatic invasive species proliferation in Lake Tahoe.

Project 1) Integrated Tahoe Keys Aquatic Invasive Species Eradication Project - \$200,000

In Round 9, this project will focus on the continued implementation of Best Management Practices (BMPs) for removal of existing undesirable Eurasian milfoil, curlyleaf pondweed, and warm water invasive species in the Tahoe Keys. Removal methodologies will be based on an adaptive management approach. For example, this could involve a concentrated effort at specific locations in the Tahoe Keys where reproductive and growth success has been determined to support the spread of fish Eurasian watermilfoil and curlyleaf pondweed to other lake locations. Additional target areas are expected to include habitats where invasive fish species have been determined to immigrate and emigrate on a seasonal schedule. Periods of concentrated fish movement can provide optimal opportunities for population reduction. The relationship of these movements to macrophyte presence (and abundance) will be assessed as well.

Overall removal methods, associated monitoring protocols, equipment, and necessary permits for Eurasian watermilfoil and curlyleaf pondweed sites will utilize those obtained specifically for Lake Tahoe by the existing partners of the Bureau of Reclamation grant for aquatic weed removal and monitoring at Ski Run Marina and Emerald Bay. This project is currently coordinated and administered by the Tahoe Resource Conservation and includes the following partners; Tahoe Regional Planning Agency, California State Lands Commission, California State Parks, Remetrix Consultants, and the Tahoe Divers Conservancy. Standard control practices will include the use of bottom barriers, diver assisted hand removal, and possibly drying out techniques within the Tahoe Keys Marina. Standard monitoring techniques will include hydro-acoustic surveys to detect changes in overall biomass and volume, and ground truthing to capture photo points and specific changes over time, and regular turbidity measurements to ensure disturbance levels stay within acceptable levels.

Project 2) Lake-wide Near Shore Habitat Improvement Project - \$200,000

Round 9 funding, for lake-wide near shore habitat improvement will focus on removal activities at source populations of existing aquatic invasive weeds specifically in south shore. Removal and monitoring strategies will follow standards developed in previous projects and be modified as necessary to promote effectiveness. Historical ground truthing and hydroacoustic survey data will help determine satellite populations in need of removal. This project involves the active removal of source populations through hand-pulling and bottom barrier installations.

Project 3) Watercraft Inspection Prevention Program - \$300,000

A watercraft inspection program and plan will be funded in 2008 through Army Corps of Engineers, Truckee River Fund, Incline Village General Improvement District, private individuals and Round 8. Round 9 funding will implement the plan and fund this crucially needed program for Lake Tahoe. Methods will follow existing plans and protocols developed through Army Corps of Engineers funding and Round 8 implementation lessons learned.

Watercraft Inspections will follow guidelines developed by the Tahoe Regional Planning Agency, 100th Meridian Initiative, and recommendations developed from the Lake Tahoe Aquatic Invasive Species Integrated Management Plan commissioned by the Army Corps of Engineers. Regular correspondence will be performed with marina managers and staff to employ adaptive management logistical considerations.

The primary method of spread between watersheds for invasive invertebrate species is humans, though they may spread naturally with downstream water flow. Watercraft inspections will be an important part of the

environmental education program to be developed because the spread by humans is often the result of contaminated water from bilges, bait buckets or boats, and gear to which juveniles and adults have attached. The common element of all prevention measures is to wash and dry boats, trailers, and gear, and to empty bilges and bait buckets of potentially contaminated water. The public should be aware that boats, trailers, and gear should be inspected for any attached mud, plants and animals and removed at the lake or riverside.

Project 4) Implement an Aquatic Invasive Species Environmental Education Program- \$100,000

Since the public will be active participants in preventing the spread of aquatic invasive species, authors of this proposal believe that continuing the Environmental Education Program (originally planned using Round 8 funding) is crucial to the success of all projects.

Round 9 funding will provide for the implementation of the Environmental Education Program that will enlist the public's involvement in the overall cooperative effort to preserve, restore, and enhance the Lake Tahoe region, including the need to control and prevent aquatic invasive species. When these projects are implemented, the public will not only be an informed partner and part of future efforts to protect Lake Tahoe, but will become active participants in current restoration efforts. Funding will be used to implement a program focused on outreach and education for the purpose of actively engaging citizens of all ages in aquatic invasive species prevention.

Summary of Previous Phases 1 and 2:

Phase I (Complete):

Structural Habitat Assessment

Under contract with the Tahoe Regional Planning Agency (TRPA), the UC Santa Barbara–Donald Bren School of the Environment conducted a survey of the structural habitat of Lake Tahoe. Satellite imagery was used to map TRPA fisheries habitat classifications in the littoral zone to depth of 10 meters. Scientists were able to determine five habitat types (sand, gravel, cobble, large boulder, and aquatic vegetation) from the images. This data was coupled with existing fish survey data collected by the TERC and Utah State University (Beauchamp 1994). The combined information was used to display fish distributions in the littoral zone of Tahoe in a GIS format.

During this study the same technique will be applied to each of the aquatic invasive species of concern. Using existing literature and additional survey observations from Tahoe, the structural habitat preferences and locations of each species will be noted.

This information will be added to the GIS database, further refining site specific overlap of aquatic invasive species with native assemblages.

Thermal Habitat Assessment (Funded by Round 6 SNPLMA)

Lake Tahoe's surface water temperatures have been monitored for the past 10 years through a cooperative project between TERC, the National Aeronautics and Space Administration (NASA), and the Jet Propulsion Laboratory (JPL). Surface temperatures have been measured every two minutes, with an accuracy of 0.05⁰C, at four locations in the lake using thermal temperature recorders and infrared radiometers. These measurements have been used to calibrate thermal images collected by NASA's Terra satellite.

The satellite provides monthly thermal images of the entire lake. This data will be utilized to develop annual temperature regimes for the lake and will be incorporated into a GIS layer. The resulting information will be used to indicate when and where each species of aquatic invasive can thrive in Tahoe's littoral environment.

Additional temperature data will be collected at specific near shore locations using thermal recorders. These will be placed in areas where populations of invasive species are known to thrive. The data collected will be coupled with observational data to determine critical temperatures causing behavioral shifts (spawning, immigration, and emigration). Sites will specifically include areas with zero, moderate and dense stands of Eurasian watermilfoil, curlyleaf pondweed and native macrophytes. Temperature measurements will be conducted using arrays of probes that will provide temperature/depth profiles within and outside stands of macrophytes.

Phase 2 (Round 8 Funding - \$400,000):

Based on the GIS maps and the observed behavioral shifts in each species from the first year of assessment, a program will be initiated to remove undesirable fish species from critical lake environments in the Tahoe Keys. The methods of removal will vary with the specific habitat type and will focus on the reproductive segment of the population. Methods are expected to include fyke nets, gill nets, electro-shocking, and seining. The effectiveness of each management procedure will be evaluated based on its ability to remove invasive species while preserving natives and the time and cost associated with the procedure. The evaluation will guide project implementation toward best management practices to be used in Rounds 9, 10, and 11.

Based on data collected from the first year's assessment, a tool will also be developed to predict future areas of overlap between warm water invasive species and Tahoe's native fish. The predictive tool inputs will take into account lake temperature increases based on global warming projections. It will serve as a predictive tool for evaluating the potential conflicts with future invasive species as well as evaluating potential conflicts with reintroduced native species (i.e. Lahontan cutthroat trout).

Similarly, data from macrophyte distribution, coupled with assessments of bottom sediment characteristics and near-shore current patterns, will be used to estimate likely incursion patterns and spread of non-native macrophytes. These approaches will be used to develop a conceptual model for future aquatic invasive species interactions, and to refine implementation methods to be used for Round 9.

Finally, through Round 8 funding a watercraft inspection program will have been formally executed and logistical considerations to ensure success will have been well thought through. Inspection protocols and partnerships with shore zone property owners and/or managers will have also been formally developed.

Historic Perspective

Lake Tahoe is a high altitude, oligotrophic lake, possessing littoral and pelagic habitats favorable to fish species which thrive in clear, cool waters. Prior to the mid 1800s, the fish assemblage in the Tahoe Basin consisted of seven native fish species with Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) as the primary game fish species. The cutthroat grew to a very large size (14 kg), utilizing primarily native zooplankton and pelagic chubs (*Siphatales bicolor pectinifer*) as their food source (Vander Zanden et al 2003; Chandra 2003; Chandra et al 2005). Native aquatic vegetation include: *Ceratophyllum demersum* (coontail), *Eleocharis acicularis* (dwarf spikerush), *Potamogeton richardsonii* (Richard's pondweed), *Elodea Canadensis* (elodea), *Utricularia* sp. (bladder wort), Isoetes sp (quillwort) and various true mosses.

Throughout the 19th century, fish management agencies introduced numerous exotic species to the lake with the hope of improving recreational angling. The first series of introductions included nine species of salmonids, thought to be suited to Tahoe's environment (Cordone 1986). Only four (Mackinaw, Kokanee, Brown trout, and Rainbow trout) of these species survived and persist in the lake today. Starting around 1961, during a period of rapid development within the Tahoe basin, another wave of fish introductions occurred. For the most part, these introductions were illegal, being carried out by private citizens without the supported of state or federal fish and wildlife agencies. These illicit fish plants did not receive the scrutiny of previous introductions. As a result, many species, inconsistent with Tahoe's clear, cold water environment and incompatible with persisting native fish populations were planted. This wave of introductions resulted in ten new fish species successfully populating the lake.

Compounding the problems with introduced fish, Eurasian watermilfoil (*Myriophyllum spicatum*) was most likely introduced in the late 1960's to early 1970's, at the same time the Tahoe Keys housing and marina were developed. This non-native macrophyte has continued to disperse and establish new populations around the lake, though the largest infestation is in the Tahoe Keys area (Anderson 2006). In 2003, another non-native macrophyte was recorded for the first time: *Potamogeton crispus* (curlyleaf pondweed). Initial populations at the entrance channels to the Keys marina have begun to disperse and establish new colonies along the South Shore and eastward where the most dense populations are now at Ski Run (Anderson 2006). Both species have a history of widespread invasion in the US, and have caused losses of native macrophyte populations in several northeastern lakes.

There are several species of non-native invertebrates that are potential invaders of Lake Tahoe and other waters of the Lake Tahoe Basin. There are three species that are most likely to invade in the immediate future though the potential for other future invasions is real. These three species are New Zealand mud snail (*Potamopyrgus antipodarum*), quagga mussel (*Dreissena bugensis*) and zebra mussel (*Dreissena polymorpha*). While none of these species have been detected in Lake Tahoe, all three of these species have been found in North America, and quagga mussel and New Zealand mud snail have been found in California and Nevada.

The New Zealand mud snail is a small snail reaching no more than 1/8th inch in length. This snail is native to New Zealand and was first found in the Snake River Drainage in the 1980's. Since that time the snail has spread to many areas of the west, the closest known population to Lake Tahoe is in the Owens River in eastern California. This species has several traits that increase the likelihood of invasion including; high population growth rates, high population densities, resistance to drying (desiccation), resistance to digestion by fish, and the ability to start a population with a single individual (parthenogenic reproduction) (Kolosovich et al. 2006). Each female can produce between 20-120 offspring per brood and is known to breed up to four times a year in its native range (Winterbourn 1970).

The zebra mussel is native to the Black and Caspian Sea Drainages of the Ukraine. The first known North American population was located within the Great Lakes in 1988. By 2005, the species had spread as far west as Okalahoma, Kansas and Nebraska. Traits that make the zebra mussel a successful invader of aquatic habitats in North America include an absence of natural predators, high reproductive rates, high population densities and the resistance of adults to drying (desiccation). The initial life stages of the zebra mussel, before juveniles settle on a hard substrate and grow into adults, are planktonic. Adult zebra mussels range from 6 to 45mm in length, and live up to 5 years (USFWS 2007). Zebra mussels normally are found in less than 12 meters of fresh water, with adequate saturated oxygen (25%), not subject to freezing. Other limiting factors to distribution include calcium, pH and salinity. Adult zebra mussels have the potential to produce millions of offspring in a single spawning.

The quagga mussel is a congener of the zebra mussel and is native to the Dneiper River Drainage in the Ukraine. Quagga mussels invaded North America more recently than zebra mussels. The current range in North America includes the Great Lakes, the Mississippi River near St. Louis and most recently Lake Mead, Lake Havasu and Lake Mohave, the Colorado River, and reservoirs in San Diego County. The same traits that make the zebra mussel a successful invader are also present in the quagga mussel since it is physically and ecologically similar to the zebra mussel. The habitat requirements of the quagga mussel and the factors limiting its distribution are not fully understood at this time. The water temperature and chemistry tolerances are likely similar to the zebra mussel but more research is needed.

The greatest potential impact from the New Zealand mud snail is to the natural aquatic invertebrate community and the fishery of Lake Tahoe. Mud snails may be able to out compete native invertebrate species and are not a good food source for trout and other fishes. The zebra and quagga mussels have been demonstrated to have economic and ecological effects. These mussels can clog the intakes of water systems and negatively affect recreation by attaching themselves to boats, piers and docks. Zebra mussels are filter feeders and thought to undermine the food web in waters where they are present by removing large quantities of plankton.

The ability of warm-water fish species to establish reproducing populations was largely the result of anthropogenic features in the Tahoe shoreline and habitat created by Eurasian milfoil. The establishment of the Tahoe Keys and other marinas created “ponded” water within the littoral zone of the lake and increased water temperatures for prolonged periods of time. Warm water fish species thrive in this environment, reproducing within the window of opportunity, and thus increasing their abundance. The dense biomass produced by Eurasian watermilfoil and more recently, curlyleaf pondweed provide canopy structure that elevates surface water temperatures and protects warm water fish species potentially provide suitable habitat for new invasive invertebrate invaders.

Distribution of Invasive Species

During the 1980s, the California Department of Fish and Game conducted annual fish collections in the Tahoe Keys. As late as 1990, warm water species were rare while native minnows remained abundant in the samples. By the end of the decade, large mouth bass (*Micropterus salmoides*) were common while Lahontan reidside shiner and Lahontan speckled dace populations declined or were virtually eliminated from the Tahoe Keys (DFG, unpublished data). The change in fish structure was substantiated by fishing guides operating out of the Tahoe Keys. Within a decade they could no longer collect minnows commonly used as bait during fishing charters on the lake.

Fish observations conducted by the UC Davis, Tahoe Environmental Research Center (TERC) and the University of Nevada- Reno have shown the spread of warm water species around the lake and lagoonal habitats. As early as 1999, large mouth bass were observed in marinas along the Southern, Western, and Northern parts of the lake during the summer months. It is unclear whether these populations have persisted throughout the year; however they displayed a great degree of habitat overlap with native species assemblage. Similarly, native and introduced macrophytes often overlap in some areas and their relative abundance undergoes seasonal fluctuations. However, the trend since at least the mid-1990's has been toward gradual dominance by Eurasian watermilfoil, and since 2003, by curlyleaf pondweed in the South Shore littoral zones.

Changes in Lake Tahoe's Thermal Structure

Scientists from TERC have measured an increase of 0.5 °C degrees in the deep water of Lake Tahoe (Coats et al. 2005). This incremental change at depth is consistent with other large lakes around the world and could be expected to represent greater temperature shifts in the shallow regions of the lake. Eurasian milfoil and warm water fishes have been shown to proliferate with small changes in thermal regime thus these temperature changes could have a dramatic effect on how successfully warm water invasive species utilize the near shore habitat of Lake Tahoe. In Lake Opeongo (Canada) for example, scientists have tracked the slow expansion of invasive bass species during the latter half of the 20th century. They attributed the species success to changes in surface water temperatures and habitat structure presumably due to global warming and habitat disturbance (Shuter and Ridgeway, 2002). These processes are similar to those occurring in Lake Tahoe. Since it is early in the invasion process however, scientists believe there is a strong potential to control warm water fish species before they proliferate the entire lake. The tendency for Eurasian watermilfoil to produce dense foliage in the upper meter of the water column will exacerbate and probably magnify the gradual increase in lake water temperatures on a local scale. Therefore, reduction in abundance and prevalence of Eurasian watermilfoil and curlyleaf pondweed, and prevention of their incursion into uninfested sites should help retard the spread of warm water fish.

What remains for Rounds 10 and 11:

Round 9 will continue and expand upon Round 8 projects. Additional funding to continue each of the four projects will be submitted in Rounds 10 and 11.

Describe the goals and objectives of the project (those applicable ONLY to this Round 9 project):

Goals of Project 1) The primary goal of the Integrated Tahoe Keys Aquatic Invasive Species Eradication Project for Round 9 is to minimize and control the proliferation of existing aquatic invasive species within Lake Tahoe. This goal will be achieved by the following objectives:

- a) Implement a program to control the introduction and proliferation of invasive Eurasian milfoil and curlyleaf pondweed and warm-water fish species within the Tahoe Keys by targeting a primary source population.
- b) Create a scientifically based, risk assessment tool (based on monitoring) to minimize costs to the agency associated with invasive species control by predicting locations of range expansion within the lake due to changes in thermal regime from global warming.
- c) Initiate validation of predictive models regarding interactions between invasive macrophytes and warm-water fish habitat, population characteristics (e.g. size class)

Goals of Project 2) The primary goal of the Lake-wide near shore habitat improvement Project for Round 9 is to impede further spread of existing aquatic invasive weeds by removing the source populations. This goal will be achieved by the following objectives:

- a) Actively remove source populations through hand-pulling and bottom barrier installations.
- b) Monitor before and after removal activities to ensure success and determine extent of future control needs.

Goals of Project 3) The primary goal of the Watercraft Inspection Prevention Program is to implement a comprehensive lake-wide inspection program to help prevent future AIS introductions into Lake Tahoe. This goal will be achieved by the following objectives:

- a) Implement the guidelines of Tahoe Regional Planning Agency's Watercraft Inspection Program Plan, recommendations of the Lake Tahoe Integrated Aquatic Invasive Species Management Plan, and take into account the logistical feedback of launch facility operators.
- b) Facilitate a positive working relationship with shore zone property owners/managers basin-wide by providing technical assistance and a venue for input.
- c) Teach the public how to inspect boats, trailers, equipment and gear for any attached mud, plants and animals and instruct them how to remove them at the lake or riverside.

Goals of Project 4) The primary goal of the Aquatic Invasive Species Environmental Education Program is to implement a comprehensive AIS Education Program that inspires public participation in the prevention of AIS into Lake Tahoe. This goal will be achieved by the following objectives:

- a) A Fish and Wildlife Service biologist will work with the Tahoe Resource Conservation District to implement the Environmental Education Program they developed through Army Corps of Engineers funding. The Service will cost-share this position with funding in Round 9.
- b) Since the public's involvement will be crucial in the overall cooperative effort to preserve, restore, and enhance the Lake Tahoe region, volunteers from schools and the community will be engaged to participate in special restoration efforts.

The LTAISWG has determined that the above described projects are of highest priority for funding through Round 9.

Describe the anticipated project accomplishments (i.e. products or identifiable environmental benefits being produced or implemented under this project):

The four projects will accomplish the following environmental benefits:

- 1) Set a precedent for interagency, scientific, and stakeholder coordination in the field of aquatic invasive species control and eradication.
- 2) Conduct a comprehensive aquatic invasive species control program targeting existing source populations.
- 3) Develop a predictive management tool as a by-product of project-level monitoring to guide future invasive eradication and management in Lake Tahoe.
- 4) Complement and leverage existing AIS project funding to implement a more comprehensive and through execution.
- 5) Assist in the prevention of future AIS invasions.
- 6) Combine the best available science and investigation with proper AIS management, to effectively control the proliferation of AIS throughout the pristine waters of Lake Tahoe.
- 7) Provide for an exemplary Environmental Education Program that will actively engage citizens of all ages in preserving the Lake Tahoe environment and focus on connecting children to nature.

Describe the "readiness" of this project to move forward (urgency, capacity, capability, environmental documentation, etc.):

The assessment work guiding aquatic invasive species management in the Tahoe Keys has been funded and completed for this project. We have identified breeding and propagation hot spots for the target species. Round 8 dollars have been funded for all of these integrated projects through the revised scope of work prioritized by the AIS Working Group and submitted by the US Forest Service, US Fish and Wildlife Service and Army Corps of Engineers. Thus, eradication and control will begin in spring 2008. Round 9 funding will be instrumental in continuation of these efforts. Due to the urgent nature and strong interagency collaboration associated with this project it is anticipated that work will move forward immediately.

Similarly, the first year of removal and monitoring activities of aquatic invasive weed source populations will be conducted in Spring 2008. Removal and monitoring activities for aquatic weeds at Ski Run Marina and Emerald Bay have been conducted through a partnership grant through the Bureau of Reclamation during the 2007 and 2008 growing seasons. Round 8 dollars have been funded for this project through the revised scope of work prioritized by the AIS Working Group and submitted by the US Forest Service, US Fish and Wildlife Service and Army Corp of Engineers. Round 9 funding will be instrumental in continuation of these efforts. Due to the urgent nature and strong interagency collaboration associated with this project it is anticipated that work will move forward immediately.

A watercraft inspection program and plan will be funded in 2008 through Army Corps of Engineers, Truckee River Fund, Incline Village General Improvement District, private individuals and Round 8. Round 8 dollars have been funded for this project through the revised scope of work prioritized by the AIS Working Group and submitted by the US Forest Service, US Fish and Wildlife Service and Army Corp of Engineers. Due to the urgent nature of preventing invasive invertebrate introductions, strong interagency collaboration associated with this project, and logistical details already determined through previous funding it is anticipated that work will move forward immediately.

Lastly, a plan for an AIS Education and Outreach Program was funded in 2008 through the Army Corps of Engineers and private individuals. Round 9 dollars funding will implement the plan and continue outreach efforts. Due to the urgent nature and strong interagency collaboration associated with this project it is anticipated that work will move forward immediately.

Describe partnerships for this project. (if applicable, project should identify partner funding [committed/secured] and how it is integrated into the project)

The US Fish and Wildlife Service will work collaboratively with the Tahoe Resource Conservation District, US Forest Service, and other AIS Working Group partners to pass through 81%, the majority of Round 9 funding, through contracts or agreements to perform project work.

Aquatic weed removal and monitoring at Ski Run Marina and Emerald Bay is currently coordinated and administered by the Tahoe Resource Conservation and includes the following partners; Tahoe Regional Planning Agency, California State Lands Commission, California State Parks, Remetrix Consultants, and the Tahoe Divers Conservancy.

The initial watercraft inspection program and plan will be funded in 2008 through Army Corps of Engineers, Truckee River Fund, Incline Village General Improvement District, private individuals and Round 8 funding. The Tahoe Regional Planning Agency will write the plan and the Tahoe Resource Conservation District will oversee and implement it.

The U.S. Fish and Wildlife Service will enlist the help of the Tahoe Resource Conservation District to implement the Environmental Education Program who began implementing it through funding awarded by the Army Corps of Engineers in 2008.

Research and assessment work has been completed and involved federal agencies and other entities including: US Fish and Wildlife Service, US Forest Service, Army Corps of Engineers, the Tahoe Environmental Research Center at the University of California-Davis, Aquatic Ecology Laboratory at the University of Nevada-Reno, Ontario Ministry of Natural Resources, University of Toronto, California Department of Fish and Game, Nevada Division of Wildlife, USDA-Agricultural Research Service (Davis), and Nevada State Parks.

Describe the project monitoring that will be implemented as part of this project including:

1) The questions the monitoring program is designed to answer

- a) How effective and efficient are aquatic invasive species removal efforts in extirpation of existing invasive species in Lake Tahoe?
- b) How efficient and effective is the developed predictive management tool in identifying hot spots for AIS invasion?
- c) How effective are watercraft inspections in preventing invasive invertebrates from being introduced into Lake Tahoe?
- d) What logistical adaptive management strategies need to be employed in order to improve efficiency and effectiveness of watercraft inspections?
- e) What behavioral/opinion changes have occurred due to educational efforts?

2) The monitoring approach:

The approach to be taken will be one of adaptive management. Our prevention, removal, and restoration efforts will be monitored annually to ensure effectiveness. At the conclusion of our annual efforts surveys will be conducted to determine how effective these efforts were. We will use identical methods before and after and determine what was achieved.

Surveys to determine aquatic invasive species range distribution and quantification of localized populations as well as public perception and behavioral changes will be conducted throughout implementation. These surveys will be designed such that they are repeatable over time and capable of quantifying changes in the distribution and populations. It is anticipated that complete eradication of the current assemblage of warm water invasive species can not be obtained by mechanical means. Therefore, successful implementation will not be determined by eradication. Success will be determined by containment and suppression of the current populations and reducing the reproductive segment of the population. Success will be determined in macrophyte projects by percentages of reduction in biomass and biovolume and the ability to prevent further proliferation. Success will be determined in the watercraft inspection program by the consistency and scope of surveys conducted. Finally, success will be measured for AIS Education and Outreach efforts by the number of individuals targeted and by opinion surveys conducted to monitor changes in behavior.

3) Whether this project monitoring fits into a larger monitoring or research program (including how information from the monitoring and research will be used to improve the continued performance of the proposed project or improve future similar projects).

The Army Corp of Engineers in coordination with the LTAISWG is in the process of awarding a contract that will develop an aquatic invasive species management plan for Lake Tahoe. It is anticipated that part of the suggested management measures outlined in the plan will include an outline of key monitoring elements designed to track the effectiveness of such implementation projects. Data from all projects will be shared at a local and national scale through presentations, publications, and collaborations with groups such as the LTAISWG and the 100th Meridian.

Describe these two items which will be considered along with the above project monitoring information by the Tahoe Science Consortium related to research and monitoring resource areas and the effectiveness of environmental restoration activities:

1) Describe the specific goals and objectives of the project and describe how fulfilling those objectives will contribute to the achievement of one or more environmental thresholds.

The overall goal of the Lake Tahoe Integrated Aquatic Invasive Species Project is to control and prevent AIS proliferation in Lake Tahoe. Our primary objectives will be: to remove the majority of breeding adult warm-water fish in concert with the manual and bottom barrier removal of Eurasian milfoil and curlyleaf pondweed at primary source locations to improve near shore habitats; engage in a watercraft inspection prevention program to help reduce the risk of further AIS introductions; and, engage the public by implementing an Environmental Education Program. In doing so we will achieve fisheries habitat thresholds for the lake.

2) Describe the risk to the environment from failure of the proposed project (i.e. if the project fails what is the environmental consequence).

Failure of this project would likely be catastrophic to the current Lake Tahoe ecosystem. If the existing population invasions continue we can expect to see the spread of invasive fish and aquatic weeds across much more of the lake than the current existing condition, especially when considering global warming trends. This will have detrimental effects on not only native fish habitat and the sustainability and persistence of native fish species, but the overall clarity of Lake Tahoe, and health of the near shore environments. If invasive invertebrates are introduced into Lake Tahoe they could be damaging to Tahoe's native invertebrate communities by the large quantities of plankton they are known to consume. This could ultimately negatively affect both native and game fish supported by existing plankton populations. Along with this are the potential economic effects. Mussels clog the intakes of water systems and negatively affect recreation by attaching themselves to boats, piers and docks.

Risk to the Environment: The Impact of Invasive Species

Invasive species introductions into aquatic ecosystems are of growing concern worldwide due to their economic and ecological impacts. Lake Tahoe has received considerable attention over the past 40 years, primarily for its famed water clarity and the threats causing its decline. The construction of major boat marinas beginning in the 1970's, and attendant increases in recreational and commercial vessel use since that time have provided pathways for introductions of invasive, non-native aquatic species including warm water game fish, invertebrates, and flowering aquatic plants. The combination of altered natural shorelines (i.e. construction of marinas and piers) and loss of marshes, which once served as biofilters and sustainable habitat for native vegetation, now provide a safe haven and suitable habitat for newly introduced aquatic invasive species (AIS) such as Eurasian water milfoil, curly-leaf pond weed, and warm water game fish such as large-mouth bass. Adding to the concern, New Zealand mud snails have been identified in Putah Creek (Yolo County) and the Owens River (Inyo County). Possibly more alarming, is the furthest westward

expansion of the Quagga mussel, which in January 2007 was found in the Colorado River Basin and Lake Havasu, Arizona. The altered near shore habitats that are currently developing from recent introductions provide for a more suitable habitat for possible new introductions.

By actively engaging in AIS control, prevention, and eradication activities, Lake Tahoe will assist other regional efforts currently taking place across the nation. For instance, the Chief of the National Forest Service identified invasive species as one of the four primary threats to National Forest ecosystems. The U.S. Fish and Wildlife Service have taken an active leadership role in areas of the United States where aquatic nuisance species are prevalent by conducting control and prevention activities under the Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990. USDA Agriculture Research Service has conducted extensive invasive aquatic vegetation surveys in Lake Tahoe and have published and presented their findings so that others may be aware. Recently, Lake Tahoe's AIS Working Group was recognized as one of the active teams of the 100th Meridian Initiative; a subdivision of the U.S. Fish and Wildlife Service helping to coordinate the prevention of the westward expansion of Zebra/Quagga mussels.

Describe how the project results will be communicated and made available to the public.

The information created from this project will be disseminated to various audiences: 1) the general public through the media; 2) the LTAISWG; 3) the broader scientific community; 4) national partners who are also fighting the control and prevention battle of AIS in their watersheds; and, 5) via printed material, presentations, and web pages created by the newly-developed Environmental Education Program.

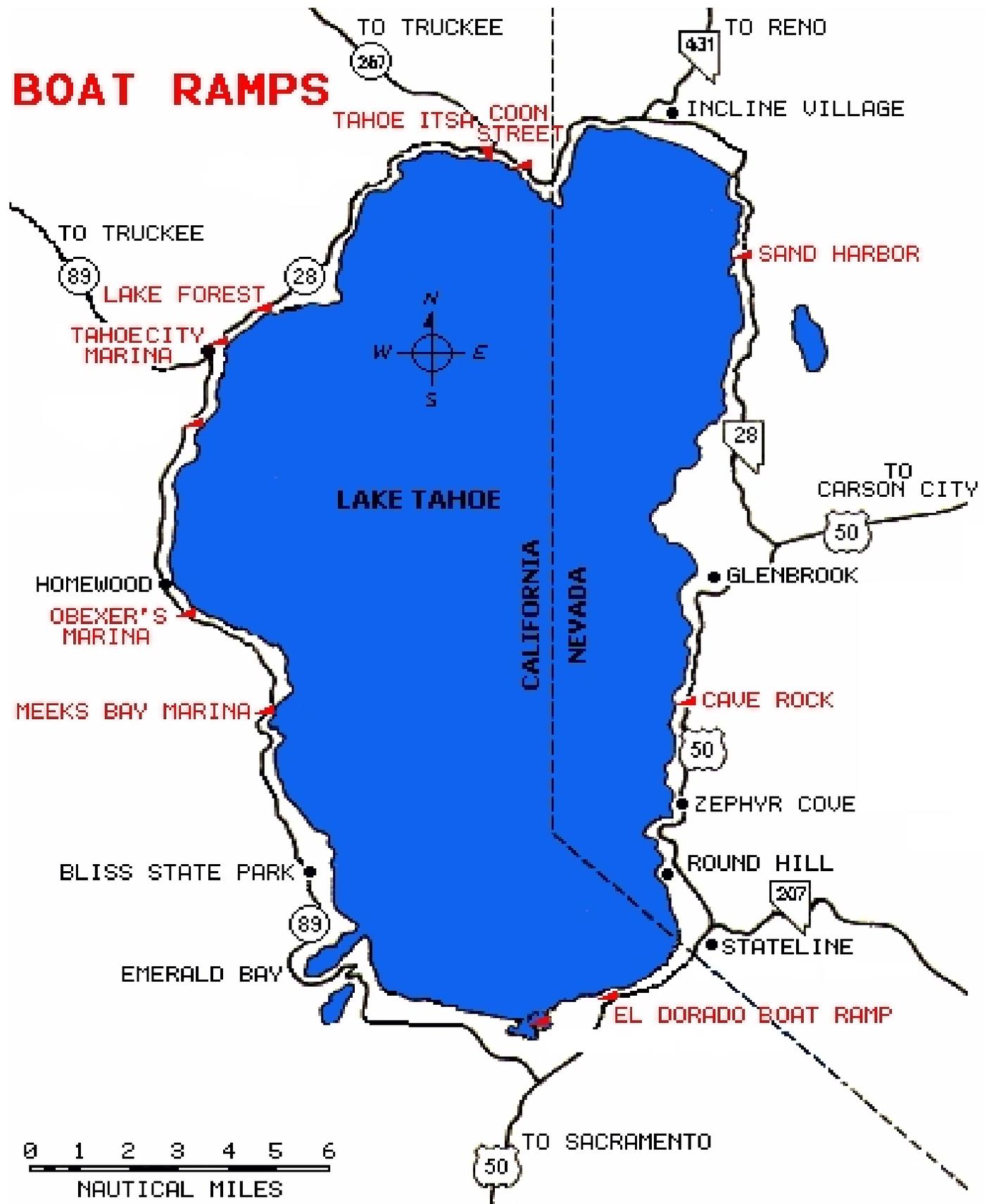
Information regarding the potential negative consequences of warm water fish, aquatic weeds, and invasive invertebrate invaders will be distributed by targeting a variety of audiences through holding a series of public seminars, executing highly visible signage and media, and by partnering with other local nonprofit and community groups within the basin. These groups include the Tahoe Resource Conservation District, the Tahoe Keys Homeowner's Association, the League to Save Lake Tahoe, the Tahoe-Baikal Institute, the Squaw Valley Institute, and Trout Unlimited. Specific details about the model and its GIS layers (habitat, thermal dynamics, and potential bass invasions sites), watercraft inspection results, and aquatic weed removal success stories will be available to the LTAISWG, general public and other resource managers encountering similar issues within their ecosystems via the internet.

Information will be available as free downloadable material which will be maintained at the Aquatic Ecology Laboratory website at the University of Nevada, Reno and through the Lake Tahoe AIS Working Group webpage on the TRCD website. In order to ensure strong scientific scrutiny and acceptance these approaches we will present this information at least the following international conferences (American Society of Limnology and Oceanography, American Fisheries Society, Aquatic Plant Management Society, and the 100th Meridian Annual Meeting) and publish the results in leading journals dealing with controlling invasive species (Canadian Journal of Fisheries and Aquatic Sciences and Limnology and Conservation Biology, Journal of Aquatic Plant Management).

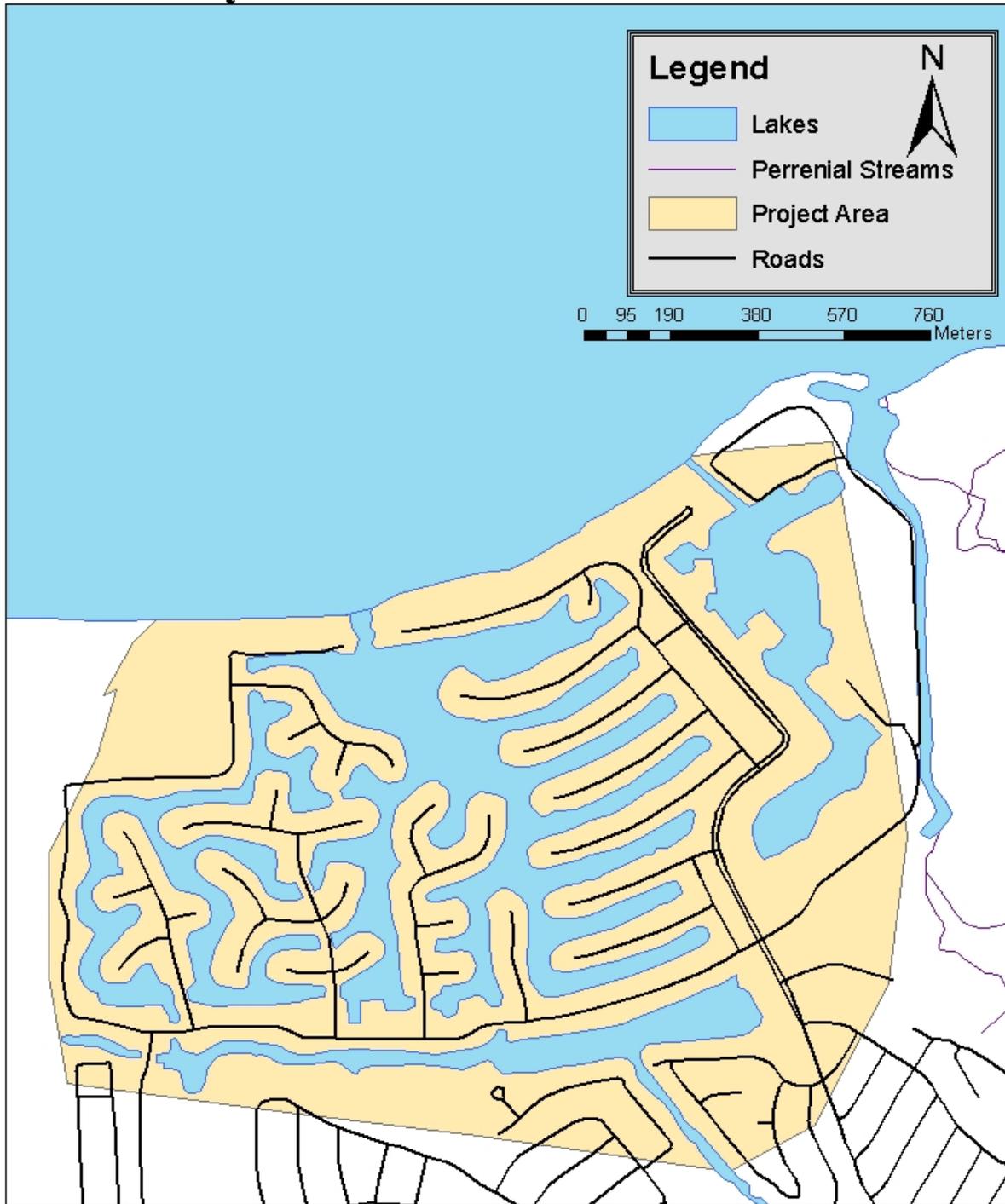
Maps depicting the project areas.



BOAT RAMPS



Tahoe Keys Invasive Fish and Weed Eradication



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Budget Summary to Show Pass Through Funding to Partners (U. S. Fish and Wildlife will pass through 81% and keep 19%)

Project Titles	Funds Kept by FWS	Funds Passed to Partners
Project 1) Integrated Tahoe Keys Aquatic Invasive Species Eradication Project - \$200,000	\$ 38,000	\$ 162,000
Project 2) Lake-wide Near Shore Habitat Improvement Project - \$200,000	\$ 38,000	\$ 162,000
Project 3) Watercraft Inspection Prevention Program - \$300,000	\$ 57,000	\$ 243,000
Project 4) - Aquatic Invasive Species Environmental Education Prevention Program \$100,000	\$ 19,000	\$ 81,000
Total for five projects (\$800,000 requested):	\$ 152,000	\$ 648,000