

Final Report



California Aquatic Invasive Species Rapid Response Fund An Economic Evaluation

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Prepared For U.S. Fish and Wildlife Service

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An Economic Evaluation

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Table of Contents

Executive Summary	1
Chapter 1 Introduction	1
1.1 Background.....	1
1.1.1 Overview.....	1
1.1.2 Rapid Response Defined.....	2
1.1.3 Isolated AIS Population	3
1.1.4 Need for Rapid Response Funding	4
1.2 Study Purpose and Objectives	6
1.3 Outline of Report	7
Chapter 2 Benefits of a Rapid Response Fund	1
2.1 Avoided Management Costs.....	1
2.2 Avoided Side Effects	1
2.3 Avoided Economic Impacts and Damages	2
2.3.1 Market Effects	2
2.3.2 Non-Market Effects	3
Chapter 3 Rapid Response Planning in Other Regions	1
3.1 Multi-state and Multinational Rapid Response Plans	1
3.2 State Rapid Response Plans.....	2
3.2.1 Maine	2
3.2.2 Washington.....	4
3.2.3 Oregon	7
3.3 Summary of Rapid Response Funding Programs	8
Chapter 4 Aquatic Invasive Species Management in California	1
4.1 California Invasive Species Advisory Committee List.....	2
4.2 California Aquatic Invasive Species Management Plan (CAISMP)	3
4.2.1 General Overview	3
4.2.2 Rapid Response Plan	4

Chapter 5	Recommended Size of a Rapid Response Fund	1
5.1	Cost of Awards for Rapid Response Activities	1
5.1.1	AIS Expenditures in Other Regions.....	1
5.1.2	AIS Expenditures in California.....	2
5.1.3	Amount Needed for Rapid Response Awards	9
5.2	Administrative Costs.....	15
Chapter 6	Funding Sources	1
6.1	Principles of Conservation Financing.....	1
6.1.1	Ability to Pay	2
6.1.2	Benefit Principle	2
6.1.3	“Polluter Pays” Principle	2
6.2	Fees and Other Possible Sources for a Rapid Response Fund.....	3
6.2.1	Fees on AIS Vectors, Resource Users, and Stakeholders.....	3
6.2.2	Taxes and Charges on the General Population	16
6.2.3	Grant Funding & Contributions.....	20
6.3	Summary of Funding Options.....	20
Chapter 7	Administrative Scenarios	1
7.1	Fund Administrator.....	1
7.2	Financial Management.....	1
7.3	Institutional Structure for Funding Decisions.....	1
7.3.1	Single Agency or Multiple Entity Structures.....	1
7.3.2	Timing of Decision-making.....	2
7.4	Funding Eligibility and Criteria.....	2
7.4.1	Entities Eligible for Funding.....	2
7.4.2	Eligible Activities	4
7.4.3	Limits on Award Size	6
7.4.4	Scope of Response Plan and Phasing	7
7.4.5	Probability of Success.....	7
7.4.6	Establishment Status	8
7.4.7	Probability of Reintroduction	9

	7.4.8 Regional Significance	9
	7.4.9 Invasion History.....	9
	7.4.10 Side Effects.....	10
	7.4.11 Independent Oversight of Eradication Efforts	10
	7.4.12 Other Criteria	10
Chapter 8	References	1

Tables

Table 1-1	Some definitions of rapid response to biological invasions.....	3
Table 2-1	Estimates of the Economic Impacts of AIS, from Lovell and Stone (2005).....	5
Table 3-1	Washington State Invasives: Lead Agency Responsibility by Species Type	6
Table 3-2	Characteristics of Existing or Proposed Programs for Funding AIS Rapid Response	9
Table 4-1	State Agencies and General Responsibilities prior to a Statewide AIS Plan.....	1
Table 4-2	Ten Most Economic Damaging AIS Threatening California	2
Table 4-3	CAISMP Objectives and Implementing Agencies.....	4
Table 4-4	17-Step Rapid Response Procedure, from the Draft California RRP	5
Table 4-5	Rapid Response Planning Tasks, from the Draft California RRP	6
Table 5-1	Estimates of Control Costs for AIS	1
Table 5-2	Funds Spent by California State Agencies on AIS Programs and Activities in 2005-07	5
Table 5-3	<i>Caulerpa taxifolia</i> Eradication Project Costs.....	7
Table 5-4	Eradication Efforts in California Marine Waters	8
Table 5-5	Funds Spent by California State Agencies on AIS Programs and Activities, by Activity Type	10
Table 5-6	Approximate Costs for 5 Large Rapid Response/Eradiation Projects in California in 2000-2009.....	11
Table 5-7	Large Rapid Response or Eradication Projects in California Marine and Fresh Waters in Progress During 2000-2009.....	13
Table 5-8	Projected Demand: Number of Rapid Response Projects in California over 10 Years	13

Table 5-9	Projected Demand: Annual Average Cost of Rapid Response Projects in California	14
Table 5-10	Projected Average Number and Cost of Rapid Response Projects in California	14
Table 5-11	Projected Average Annual Award Costs for Four Funding Scenarios	14
Table 5-12	Projected Average Annual Total Costs for Four Funding Scenarios.....	16
Table 6-1	Summary of Marine Invasive Species Program Fee Revenues	5
Table 6-2	Summary of Potential Funding Sources for AIS RRF.....	21
Table 7-1	Management of Implemented and Planned Eradication Efforts in California Marine Waters.....	3
Table 7-2	Management of Implemented and Planned Eradication Efforts in California Marine Waters, by Organization Type.....	4

Acronyms

AIS	Aquatic Invasive Species
AIMSP	Aquatic Invasive Species Management Plan
AISWG	Aquatic Invasive Species Working Group
BOE	California Board of Equalization
CAAIST	California Agencies Aquatic Invasive Species Team
CAISMP	California Aquatic Invasive Species Management Plan
CDFA	California Department of Food and Agriculture
CDFG	California Department of Fish and Game
CVP	Central Valley Project
DBW	California Department of Boating and Waterways
DMV	California Department of Motor Vehicles
ISCC	Invasive Species Council of California
MDEP	Maine Department of Environmental Protection
MDIFW	Maine Department of Inland Fisheries and Wildlife
MISP	Marine Invasive Species Program
NISC	National Invasive Species Council
OISC	Oregon Invasive Species Council
RRF	Rapid Response Fund
RRP	Rapid Response Plan
SCC	California State Coastal Conservancy

SLC	California State Lands Commission
SWP	California State Water Project
SWRCB	California State Water Resources Control Board
TEU	twenty-foot equivalent unit
VLF	vehicle license fee
WDFW	Washington Department of Fish and Wildlife
WDOA	Washington Department of Agriculture
WDOE	Washington Department of Ecology
WSANS	Washington State Aquatic Nuisance Species Committee

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Executive Summary

This study addresses the economic and institutional aspects of establishing a rapid response fund (RRF) for aquatic invasive species (AIS) in California. It addresses potential sources of funding, the level of funding required, economic benefits, institutional arrangements, and funding criteria.

AIS are an increasingly-serious problem in California as well as in other states and countries. They cause widespread economic damages to fisheries, maritime infrastructure, recreational venues and equipment, water supply systems, and other resources and infrastructure. Non-market impacts—such as impacts on biodiversity and habitats, changes in ecosystem dynamics, and impairment of our ability to manage ecosystems—are also extensive but historically underestimated because of their non-monetary nature. Efforts to eradicate and control aquatic invasive species in the U.S. have been estimated at up to \$9 billion per year.¹

Rapid response plans have been proposed or developed in several states and for some multi-state or multinational regions. CDFG's Aquatic Invasive Species Management Plan includes a draft rapid response plan, whose goal is to identify steps to minimize AIS' adverse impacts, including actions to eradicate or contain or slow their spread. Though several California agencies already address some AIS concerns or coordinate on specific projects, the plan provides a more comprehensive statewide approach.

As used in this study, rapid response is a functional rather than a temporal concept. The focus is on whether there is a realistic potential for eradication or long-term containment of an AIS rather than on how quickly or how soon after discovery a response is implemented. Eradication or containment of an AIS is much more difficult, and in many cases may be impossible, after it has become established and spread. Early eradication offers the potential for avoiding widespread impacts and/or much higher eradication or control costs in the future. Examples of impacts from AIS that could be avoided include increased operations and maintenance costs for water distribution systems and industrial cooling systems; increased maintenance costs for boats, marina facilities, navigational equipment and other infrastructure; reduced water supplies; greater water treatment costs; and reduced commercial and recreational fishing. Property values can also be affected. Non-market economic impacts of AIS can be substantial, including changes in biodiversity, habitats or food webs; reduced water quality; and reduced recreational, cultural, aesthetic, scientific or educational values.

Numerous factors affect the annual demand for rapid response funding, including the rate of invasion, the fraction of invasions for which response is perceived to be useful or desirable, and the cost of response including eradication efforts. Expenditures per AIS eradication in California have ranged from the thousands to the tens of millions. Based on the historical costs of AIS

¹ Pimentel, David. 2003. Economic and Ecological Costs Associated with Aquatic Invasive Species, pp. 3-5, in K. Wakefield and A. Faulds (eds.) *Proceedings of the Aquatic Invaders of the Delaware Estuary Symposium*, Malvern, Pennsylvania, May 20, 2003. Cited in California Department of Fish and Game. 2008. Aquatic Invasive Species Management Plan. Sacramento.

eradication efforts in California and the frequency of such attempts, we recommend an initial fund size of \$1 - 2 million. The ongoing size of the fund should be set adaptively in response to the number of applications that are judged to be suitable for funding and the costs of the projects.

Potential sources of moneys for an RRF include fees or charges on AIS vectors; fees or charges on resource users and other stakeholders; fees or charges on the general population or appropriations from the State's general fund; and grants from governmental or non-governmental sources. Fees on AIS vectors could include assessments on commercial or recreational vessels, on aquaculture operations, or on sales of imported live aquatic organisms including ornamental plants and animals, bait and seafood. Fees on resource users or other stakeholders could include assessments on recreational vessels, on recreational and commercial fishing and aquaculture, on other water-based recreational activities, and on water deliveries.

Fees set at reasonable levels could annually generate more than \$17 million from commercial shipping, more than \$11 million from cruise ship passengers, more than \$1 million from commercial fishing operations (higher fish landing tax rates), more than \$3 million from sport fishing (either from a surcharge on fishing license fees or a higher excise tax on recreational fishing gear), and more than \$10 million from water deliveries (surcharges on State Water Project and Central Valley Project deliveries). Such fees would be subject to political, legal, economic and other considerations. General fund appropriation levels are always uncertain, and the potential for supporting an RRF through general fund appropriations appears highly unlikely in the near term due to perennial, large state budget deficits in recent years. For similar reasons, there appears to be little near-term potential to raise general sales and use taxes, or vehicle registration fees, to support an RRF.

We recommend that the RRF be set up as a nonlapsing fund within the California state treasury, with full carryover from year to year of any unused funds; that replenishment accrues continuously from fees or other sources; and that investment of unused funds be managed by the state treasurer's office. Institutional structures for deciding which projects to fund range from keeping decision-making within a single agency to a large, multiple entity panel. The key benefit of a single agency structure is the potential for making quicker decisions on which rapid response proposals to fund, though it could also modestly reduce administrative costs. The benefits of a multiple entity panel include decision-making based on broader knowledge, experience and/or perspectives: broader buy-in by more entities and better support for the program; better co-ordination among entities to assist funded responses; the development of greater AIS rapid response awareness and judgment in multiple agencies; building more stable institutional knowledge and experience for fund decisions; and guarding against agency capture of the fund (i.e. the administering agency awarding most of the funds to its own proposals) or misuse of the fund (awarding funds to projects that address agency priorities other than rapid response).

We recommend that both governmental and non-governmental entities be eligible for RRF funding, and eligible activities include interim containment and eradication efforts, and other activities that support these. Key criteria to be considered in deciding on whether to fund from the RRF should include, but are not limited to the probability of success; the probability of reintroduction; the regional significance of the targeted AIS population; the history of invasion by the AIS and the experience with containment and eradication; the expected ecological side

effects of the eradication effort; and the provision for independent oversight of the eradication effort.

Chapter 1

Introduction

1.1 Background

1.1.1 Overview

An aquatic invasive species (AIS), also known as an aquatic nuisance species, is defined in the National Aquatic Nuisance Prevention and Control Act of 1990 as a nonindigenous species that threatens native species; the ecological stability of infested waters; or the commercial, agricultural, recreational, or other activities dependent upon those waters.² The rate of introduction of such species into new areas has accelerated because of increases in population, international trade and travel. In many cases, the introductions are unintentional, as the species find temporary residence on vessels or vehicles or in cargoes moving between areas. In other cases the transport, and sometimes the release, is intentional, including introductions represented by pets, crops, garden and other ornamental plants, aquaculture organisms, biocontrol agents, live bait, live food items, and efforts to establish non-native shellfish, sport fish and forage fish.

AIS are a threat to economies and ecosystems throughout the United States and other countries. It has been estimated that more than 50,000 nonnative species (including both aquatic and terrestrial species) have been introduced in the United States, and that annual control costs exceed \$120 billion.³ Damages include significant economic losses in agriculture, forestry, and other economic segments as well as important adverse environmental impacts. Costs for control of AIS are estimated at more than \$9 billion per year.⁴ Moreover, these figures typically include only damages for which monetary figures can easily be estimated, i.e., for market-based variables such as lost power generation, reduced water flows, and others. Non-market measures are most often discussed only qualitatively and include, e.g., the values of such lost ecosystem services as natural water filtering, and recreational activities.

The threats from AIS have been reflected in the establishment of government agencies at the federal and state levels. For example, the Federal Aquatic Nuisance Species Task Force was established in 1990 and is responsible for supporting activities that target the prevention of the introduction and spread of AIS. The Task Force collaborates with federal, state, tribal, and other

² United States Senate and House of Representatives. 1990. NONINDIGENOUS AQUATIC NUISANCE PREVENTION AND CONTROL ACT OF 1990 [As Amended Through P.L. 106–580, Dec. 29, 2000].

³ Pimentel, David, et.al. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics*, Volume 52, pp. 273-288.

⁴ Pimentel, David. 2003. Economic and Ecological Costs Associated with Aquatic Invasive Species, pp. 3-5, in K Wakefield and A Faulds (eds.) *Proceedings of the Aquatic Invaders of the Delaware Estuary Symposium*, Malvern, Pennsylvania, May 20, 2003. Cited in California Department of Fish and Game. 2008. Aquatic Invasive Species Management Plan. Sacramento.

entities in AIS prevention and control programs, including coordinating responses to confirmed AIS introductions.

Interest in establishing rapid response plans (RRPs) has been growing throughout the United States. Many states have developed or expressed interest in developing such plans, including California. However, with few exceptions, states have not developed separate, dedicated funding mechanisms for rapid response, herein called rapid response funds (RRFs). Instead, states' responses to AIS typically include transferring funds from other programs to eradicate or control the threatening species, which reduces the funding available for ongoing programs or activities.

In California, both freshwater and marine AIS have caused or have the potential to cause serious damage. In response, the state in 2008 released the California AIS Management Plan (CAISMP).⁵ It addresses a variety of AIS taxa, including plants, fish, mollusks, amphibians, and reptiles. The Plan notes that AIS in California have onerous impacts on such sectors and activities as agriculture, fishing, shipping, and water delivery while concurrently damaging docks, levees, and native habitats as well as the species which inhabit them. The Plan includes several high priority actions, one of which is establishing a dedicated AIS RRF. This study discusses the benefits and costs of such a fund, potential sources of monies for the fund, and various scenarios for administering the fund.

1.1.2 Rapid Response Defined

Definitions of rapid response to species invasions generally focus on actions that are taken early in an invasion, while it is “new” or “newly detected” or “still localized,” or while it is still capable of being eradicated or contained (Table 1-1). For this analysis rapid response is defined as actions taken while there is a realistic potential for eradication or long-term containment of an isolated AIS population, and that contribute to or support either eradication or initial or interim containment. By “isolated AIS population” is meant an AIS population in a part of a water system that is sufficiently isolated from other populations of the AIS that it would not be readily re-invaded if eradicated.

Some examples of AIS populations that would not be considered isolated include:

- An AIS fish population in one part of a lake or a bay if there is a population of the same species elsewhere in the lake or bay, where re-invasion could be expected because of swimming fish;
- A quagga mussel population in a lake downstream of another lake containing a quagga mussel population, where re-invasion could be expected due to larvae carried downstream; and
- A quagga mussel population in a lake upstream of another lake containing a quagga mussel population if there is significant boat traffic between them, where re-invasion could be expected due to mussels attached to boat hulls or otherwise transported by boats.

⁵ California Department of Fish and Game. 2008. California Aquatic Invasive Species Management Plan.

Table 1-1 Some definitions of rapid response to biological invasions.

"A response conducted in time to eradicate or contain a potentially damaging invasive species" (US General Accounting Office, 2001).
Implementing "rapid eradication or control responses for newly detected aquatic invasive species" (in several bills introduced in Congress in 2005-2009, but not enacted). ⁶
Implicitly defined as "eradication" or "early eradication" (NY State Department of Environmental Conservation, 2005).
"An attempt at eradication, with the understanding that if eradication is not possible, early response might still improve the effectiveness and reduce the cost of ongoing control" (Washington State Aquatic Nuisance Species Committee, 2005, Draft Early Detection and Rapid Response Plan for AIS).
"The primary goal of rapid response deployment is to initiate eradication efforts (which may take years to complete) or critical interim measures to achieve effective containment while a longer term eradication or suppression strategy is formulated" (Maine Department of Environmental Protection, 2006, Rapid Response Plan for Invasive Aquatic Plants, Fish, and Other Fauna).
"Rapid response means that soon after an aquatic species new to the [state] or a specific region of the state is discovered, 1) the state will make a determination of whether it is potentially detrimental and/or invasive and 2) if that is the case, the State will develop and implement a course of action...Possible courses of action for newly discovered AIS may include an effort to eradicate the species, control its spread, prevent future introductions, minimize or mitigate the damage it causes, or study it further before any other action is taken"(CDFG, 2007, Draft Rapid Response Plan for AIS).
"Rapid Response (RR) is a systematic effort to eradicate or contain invasive species while infestations are still localized. RR may address totally new introductions into the United States or range expanding infestations of previously established species. Timeliness is key to RR. It is critical to quickly mobilize resources to intensely control an infestation before it becomes more widely established" (National Invasive Species Council, 2008, National Invasive Species Management Plan).
"A well planned, timely and coordinated control plan...to contain or control new or spreading AIS" (Utah Division of Wildlife Resources, 2009, Utah AIS Management Plan).
"The steps taken, starting before detection of the invasion of a non-indigenous species, through a decision process that may culminate in an attempt to eradicate the species before it becomes established in the new habitat" (Locke and Hanson, 2009).

1.1.3 Isolated AIS Population

Rapid response is defined as certain actions that target isolated AIS populations. A recent invasion illustrates some of the complexities of determining whether a population qualifies as an isolated AIS population.

Some biologists have proposed attempting to eradicate an exotic plant, *Limonium ramosissimum* (Algerian Sea Lavender) from San Francisco Bay salt marshes, where it was discovered in 2006.⁷ Two subspecies of *L. ramosissimum* are present in the upper tidal zone at several San Francisco Bay marshes, one in a few sites in the northern part of the Bay and the other in many sites more to the south. Both subspecies probably initially arrived as garden plants in local watersheds (they are sometimes sold by nurseries). It is thought that seeds carried downstream from creek-side gardens established populations in some salt marshes, from which the plant spread to other

⁶ The National Aquatic Invasive Species Act (S770 and HR1591 introduced on Apr. 13, 2005; S725 and HR1080 introduced on Mar. 1, 2007); the Prevention of Aquatic Invasive Species Act (HR5030 introduced on Mar. 28, 2006); and the Great Lakes Collaboration Implementation Act (HR5100 introduced on Apr. 5, 2006; HR1350 introduced on Mar. 6, 2007; S791 introduced on Mar. 7, 2007; HR500 and S237 introduced on Jan. 14, 2009).

⁷ Archbald, G. 2011. About Algerian Sea Lavender (*Limonium ramosissimum*) an Early Detection and Eradication Priority for San Francisco Bay. A Bay Area Early Detection Network Factsheet.

marshes (*L. ramosissimum* is broadly salt-tolerant, and its seeds can successfully germinate after floating for weeks in estuarine water).

Given the apparent ability of *L. ramosissimum* to spread between marshes via floating seeds, a population in one marsh should not be considered an isolated population for rapid response purposes. Rather, all the marsh sites of at least each subspecies should be considered together as a population. If the two subspecies cannot hybridize, then each one could be considered a separate AIS population; otherwise populations of both subspecies may need to be considered together as a single targeted population.

In addition, given the potential for additional seeds of *L. ramosissimum* to reach the Bay from creek-side gardens (it has apparently happened at least twice in recent years—once for each subspecies—and possibly more often), the *L. ramosissimum* growing near creeks in the watershed should probably be considered part of the same population as the *L. ramosissimum* in the Bay marshes for rapid response purposes. The overall project, then, would be expected to include efforts to locate and eliminate both the Bay populations and the upstream *L. ramosissimum* that could serve as seed sources for rapid re-invasion of the Bay, and perhaps also should include efforts to prevent further sale and plantings of *L. ramosissimum* in the watershed. This is a very different matter than simply pulling plants from the marshes and would involve public outreach and possibly amendments of regulations or local ordinances. It substantially changes the appropriate scale of a rapid response project for this invasion.

1.1.4 Need for Rapid Response Funding

AIS are a serious, growing problem. Such species may be introduced to an area or ecosystem long before becoming established or being discovered. Once an AIS is established, it is very difficult or impossible to eradicate it or prevent its spread to other areas. Moreover, unlike the one-time discharge of a chemical pollutant, exotic species as “biological pollutants” can become more concentrated and potent over time and may persist for centuries.⁸ While effective prevention would avoid most of the costs of AIS, prevention frequently requires significant regulation or modification of commercial or industrial activities or of human behavior, and this is often difficult to achieve.

The literature is replete with references commending the value of responding rapidly to non-native species, both aquatic and terrestrial. The common themes in these publications are that non-native species are an increasingly serious problem, that early eradication or control is preferable and less costly than such activities after the species have become established or spread, and that rapid response activities should be financed by funds outside the typical parameters of resource agency budgets.

The number of non-native species that enter and are later discovered in the United States has increased for a variety of reasons, many of them tied directly or indirectly to economic factors. It is expected that economic growth, international trade, and population growth will increase the

⁸ Cohen, Andrew A., and Moyle, Peter B. June 14, 2004. Summary of data and analyses indicating that exotic species have impaired the beneficial uses of certain California waters. Report submitted to the State Water Resources Control Board.

global flows of goods and the scale of commercial and recreational activities that have been associated with the introduction and spread of non-native species.

The value of responding to non-native species sooner rather than later is based on biological and economic factors. Eradication or containment of an invading population is more easily accomplished when that population is small and has a limited distribution rather than after it has had time to grow and spread. Indeed, after growth and spread pass a certain threshold, eradication or containment may become impossible. The primary benefits of rapid response are:

- Avoiding larger management costs later—by eradicating an AIS at the early stages of its growth we avoid potentially much greater costs for containing, eradicating or controlling it or mitigating its effects in the future, when the population may be more abundant and widespread and a considerably larger effort is need to eradicate or contain it;
- Avoiding the environmental impacts (side effects) of those larger management efforts; and
- Avoiding potentially very wide-spread and long-term impacts from the invasion.

These types of benefits are considered in more detail in Chapter 2.

California’s draft RRP notes that: “Once non-native invasive species become widespread, efforts to control them are typically more expensive and less successful than rapid response measures. The damage caused by an AIS that becomes widespread, and the actions that are taken to control it, may be more harmful to the environment than a successful rapid response.”⁹ The California Department of Food and Agriculture’s (CDFA) *Hydrilla* Eradication program is based “on an ‘early detection and rapid response’ strategy... and the CDFA considers this to be one of the keys to its success.”¹⁰

Rapid response activities are often undertaken by state agencies with funds either taken out of budgets that were developed without allocations for such activities, or in a few cases, provided on an emergency basis by special budget appropriations. Due to the absence of a source of regular, consistent funding, some response actions have been delayed or not been undertaken. A dedicated RRF would ensure timely response to new invasions in relation to their threats to the state’s ecosystems and economy.¹¹

The following case studies, from both aquatic and terrestrial situations, illustrate the potential value of implementing rapid response and of having dedicated funding for it.

⁹ California Department of Fish and Game, 2007, op. cit.

¹⁰ Akers, P. The California Department of Food and Agriculture *Hydrilla* Eradication Program, Annual Progress Report 2009.

¹¹ See California Invasive Species Advisory Committee. September 23, 2010. Stopping the Spread: A Strategic Framework for Protecting California from Invasive Species, Draft. Internet website http://www.iscc.ca.gov/docs/CISAC_StrategicFramework.pdf, accessed February 21, 2011.

- **Giant Salvinia.** In 1999, an infestation of giant salvinia was discovered on a river bordering Arizona and California, which affected state, tribal, private, and federally managed land.¹² Interior agencies, such as the Fish and Wildlife Service, Bureau of Reclamation, and Bureau of Land Management; as well as Arizona and California state agencies, local water districts, and other affected parties quickly formed a task force to coordinate action. However, this effort evaporated in the face of funding obstacles and disagreements over who should be the lead agency and appropriate control strategies. It is estimated that had immediate action been taken, eradication of the infestation would have been possible.¹³
- **Asian Long-horned Beetle.** The Asian long-horned beetle was first reported in New York in August 1996 but the removal of the first several hundred infested trees was not completed until June 1997, nearly a year later. Response was delayed because the federal and state officials initially involved in the effort lacked the authority to make funding commitments, and because of state and local concerns regarding the sufficiency of federal funding available for tree removal and restoration.¹⁴
- **Sudden Oak Death.** Sudden Oak Death is a tree disease, fatal to some oak species, caused by the pathogen *Phytophthora ramorum*. It has had devastating effects on forests in California and Oregon. The first Sudden Oak Death infested nursery stock was identified in 2001 in Santa Cruz County, however, the U.S. nursery industry was not widely impacted by the disease until 2003.¹⁵ Forest Service scientists were unable to fund accelerated research and were delayed by the time-consuming process used to obtain funding to develop control methods and basic knowledge about the pathogen. Scientists noted that although \$3.5 million was needed to do the research, it took seven months, from late June 2000 until late January 2001, for the Forest Service to obtain about \$1.1 million (one-third) of the requested amount.¹⁶ One study estimated losses to sudden oak death in the many tens of millions of dollars, with direct damages being the greatest in the horticultural industry. The disease also affects timber trees and the amenity value of trees around homes.¹⁷

1.2 Study Purpose and Objectives

The purpose of this study is to determine the feasibility of establishing an RRF for AIS in California. The objectives are to analyze the costs and benefits, funding scenarios, and

¹² Lower Colorado River Giant Salvinia Task Force. 2002. Lower Colorado River Giant Salvinia Task Force Action Plan. Internet website <http://www.anstaskforce.gov/Species%20plans/Giant%20Salvinia.pdf>, accessed February 21, 2011.

¹³ United States General Accounting Office. 2001. Report to Congressional Requesters, Invasive Species: Obstacles Hinder Federal Rapid Response to Growing Threat. Website <http://www.gao.gov/new.items/d01724.pdf>, accessed January 14, 2011

¹⁴ Ibid.

¹⁵ California Oak Mortality Task Force. Internet website <http://www.suddenoakdeath.org/>, accessed February 15, 2011.

¹⁶ United States General Accounting Office, 2001, op. cit.

¹⁷ University of Nevada, Reno, Nevada Agricultural Experiment Station. Nevada Dividends Impact Report, Economic Analysis of Sudden Oak Death. Website http://www.cabnr.unr.edu/NAES/Impact_Details.aspx?ImpactID=81, accessed February 15, 2011.

administrative scenarios relative to the establishment of such a fund. The specific issues addressed include the following:

- Costs and benefits of an RRF;
- Level of funding required;
- Potential sources of revenue for an RRF;
- Administrative scenarios; and
- Eligibility and criteria for funding.

1.3 Outline of Report

Following this Introduction, Chapter 2 discusses the benefits of a rapid response fund. Chapter 3 expands on rapid response planning in other states, focusing on Maine, Washington, and Oregon. Chapter 4 describes AIS management in California. Chapter 5 addresses the appropriate size for a California RRF. Chapter 6 discusses the advantages and disadvantages of various potential funding sources. Chapter 7 discusses administrative scenarios, including potential alternative structures involving single or multiple agencies, and criteria for funding.

Benefits of a Rapid Response Fund

An RRF would facilitate more timely and potentially more effective responses to AIS discoveries across the state. With funding readily available, new AIS discoveries could quickly be characterized and action plans developed resulting in a higher probability of either successful eradication or effective containment within a limited range. In the absence of readily available funding, there is an increased probability that AIS become established or spread, which would result in higher eradication or containment costs and greater side effects from those efforts, if they even remain feasible; or more likely would result in long-term management expenditures and ongoing ecological and economic impacts. In cases where funding is limited or unavailable, potential management options become restricted and the magnitude of potential economic impacts is exacerbated. The economic benefits of an RRF are founded on the large and long-term costs and impacts that may be avoided by responding to AIS invasions expeditiously.

As discussed in §1.1.4, the primary benefits of an AIS RRF are centered on avoiding larger management costs later; avoiding the environmental impacts (side effects) of those larger management efforts; and avoiding potentially wide-spread and long-term impacts from the invasion.

2.1 Avoided Management Costs

Two scenarios illustrate how rapid response (facilitated by an RRF) would provide economic benefits by reducing total management costs for an invasion. First, a quick response to a new AIS invasion could potentially eradicate the AIS population before it proliferated and spread within the initial water body. This would reduce the extent and complexity of the eradication, thereby requiring less staffing, equipment or biocide. For example, if a non-native aquatic weed is identified in a localized reach of a water body and funding is readily available, eradication efforts could focus exclusively on that reach, which would require less biocide and staff relative to eradicating once the species became established across the entire water body. Further, it may be possible to use a lower-cost eradication technique when an AIS' range is limited, e.g., electroshocking to eliminate a non-native fish versus rotenone treatment. Second, without a rapid response, there is a risk that the AIS will spread to new locations in the interim, requiring multiple eradication efforts and higher cumulative costs. Conceptually, the quantification of benefits derived from avoided management costs is based on market prices for items such as labor, equipment, and supplies. Bioeconomic models could be used to estimate these types of benefits, relating projected population growth curves for an AIS to its expected economic costs and impacts.

2.2 Avoided Side Effects

Many AIS management actions, including eradication and control efforts, and possibly including containment or mitigation actions, can harm ecosystems and native organisms. The potential impacts of biocide use, and the risks of releasing non-native biocontrol agents, are well-

documented and generally recognized; the potential for impacts from large-scale mechanized removal, draining water bodies, burning off vegetation, or covering large areas with tarps is also obvious; however, even modest actions such as surveying for and removing organisms by hand or the placement of barriers can have significant impacts if they involve entry into sensitive habitats or the potential for removing or harming rare species. Ecological impacts that occur as side effects of AIS management activities can be expressed as economic costs; to the extent that providing funding for rapid response actions reduces the spatial or temporal scale of later management actions, or makes especially damaging or risky actions (such as the introduction of non-native biocontrol agents) unnecessary or less likely, the reduction in accompanying ecological side effects is an economic benefit.

2.3 Avoided Economic Impacts and Damages

Although the value of avoiding the expense and side effects of later and larger AIS management efforts can be significant, the major economic benefit from a dedicated RRF would likely result from avoiding the economic impacts of AIS that can only be eradicated if attacked early. This section describes types of economic impacts that could potentially be avoided by rapid response. These are organized into market effects, which are measured directly through market prices, and non-market effects, which can be separated into changes in use and nonuse (i.e. existence) values.

2.3.1 Market Effects

Valuing AIS impacts on marketed goods and services is more straightforward and generally less controversial than valuing non-market goods and services because market prices are widely accepted as indicators of value. The following are representative impacts associated with AIS for which market prices can be used to estimate changes in economic value.

- **Increased operations and maintenance costs.** AIS have the potential to adversely affect the operations of a wide range of infrastructure, such as the water intake and delivery components of water supply systems, of cooling systems for thermal power generation and industrial uses, and of hydroelectric generators; navigational infrastructure; and marina facilities. These types of impacts are often attributed to species such as quagga and zebra mussels, mitten crabs and certain aquatic weeds that can clog screening equipment and distribution pipes or coat submerged surfaces, resulting in added operation and maintenance costs for AIS removal and cleaning of infrastructure. In some cases, infrastructure may be damaged, requiring substantial repairs or even replacement at even higher costs, e.g., turbine damage at dam facilities. Substantial infrastructure costs may be incurred including alterations of system components to make them less susceptible to fouling; installation of chemical feeds to prevent or reduce fouling; installation of inspection ports, monitoring devices or maintenance access; and installation of redundant intakes or delivery systems to reduce the risk of operational shutdowns or to enable the periodic removal of system elements from service for inspection and maintenance. Increased costs for waters suppliers would likely lead to increases in water rates.
- **Increased water treatment costs.** Besides interfering with system operations, AIS in drinking water sources or systems can cause taste and odor problems or pose public health risks. Addressing these could increase water treatment costs, and/or require treatment to control or eradicate the species.

- **Water supply restrictions.** In cases where infrastructure impacts cannot be mitigated in the short term, there is also the potential for reductions in water delivery, resulting in declines in agricultural and industrial production that is dependent on available water supplies. A reduction in agricultural water supplies could lead to land fallowing. Restricted water flows could reduce hydroelectric power production. For municipal and industrial supplies, water purveyors would likely try to secure replacement water supplies at higher costs, which would probably be passed on to residential and commercial ratepayers; this may not always be feasible, however, or possible to implement quickly, and forced reductions in water use could ensue.

The presence of AIS in California could lead to “prophylactic” restrictions on raw water transport in an effort to halt the spread of the AIS throughout the state. This would be especially problematic as a response to AIS in the Sacramento-San Joaquin Delta, the source of water exported through the federal Central Valley Project (CVP) and State Water Project (SWP) water systems. Such restrictions could reduce water supplies for agricultural, municipal and industrial users throughout the central and southern part of the state, resulting in substantial and widespread economic impacts. An ancillary effect would be a reduction in hydroelectric power generation at generating facilities that are part of the CVP and SWP systems.

- **Reductions in commercial fishing landings.** AIS can adversely affect commercial fish and shellfish species, including cultured species, due to predation, competition, or the introduction of diseases or parasites. A decline in the quantity and quality of commercial species would reduce the value of commercial fish landings. In addition, AIS can affect the viability of commercial aquaculture operations, resulting in a decline in aquaculture production values.
- **Damage to recreational watercraft.** The presence of some AIS in areas with boating activity can result in damage to recreational watercraft. For example, quagga and zebra mussels can infiltrate engine cooling systems and potentially damage boat engines (due to overheating), affect steering and other components, as well as increase hull drag and fuel consumption. Aquatic weeds, such as *Hydrilla*, can become entangled and damage boat propellers. Such damages are direct economic impacts of AIS.
- **Reduced property values.** AIS can also depress localized property values due to degradation in recreation quality and visual impacts.¹⁸ This would primarily affect waterfront properties. The hedonic property price methodology is generally used to estimate changes in property values.

2.3.2 Non-Market Effects

Evaluations of the economic impacts of AIS are incomplete if they do not account for non-market impacts, which can significantly outweigh direct market impacts. Below are some representative non-market impacts of AIS.

¹⁸ Horsch, E.J. and D.J. Lewis. 2009. The effects of aquatic invasive species on property values: evidence from a quasi experiment. *Land Economics* 85: 391-409.

- **Damage to ecosystems and sensitive species.** AIS can harm native and endangered species through predation, competition, introduction of parasites or diseases, habitat changes, water quality impacts, etc.¹⁹ AIS can also alter ecosystem processes and functions, including energy, nutrient and contaminant flows, sedimentation and erosion rates, evapotranspiration rates, etc. The economic value of protecting ecological systems results in part from the services (use value) that these ecosystems provide, however it is difficult to quantify the links between AIS and impacts on ecological services, and to estimate the economic value of those services. Further, there are important non-use values (aesthetic, cultural, spiritual, educational, scientific) associated with native species and habitats whose valuation may be even more challenging.
- **Loss of native biodiversity.** AIS alter biodiversity at several levels. While the initial impact of an invasion is to increase alpha biodiversity (diversity within a site)²⁰ by the addition of one species (counting both native and non-native species), the longer term impact may be the loss of native species richness, in some notable cases by tens or hundreds of species.²¹ Dominance of an ecosystem by one or a few AIS can also reduce diversity as measured by diversity indices that take relative abundance into account (e.g. Shannon-Weiner Diversity, Simpson's Diversity, etc.). Beta diversity (diversity between sites) is reduced as the same invading species occur at more and more locations around the world. At the global level, gamma diversity (overall diversity) is reduced over time as AIS contribute to species extinctions.²²
- **Loss of ecosystem understanding.** By altering ecosystem structure and processes, AIS invasions render obsolete much of the accumulated knowledge of how these ecosystems function. To the extent that such knowledge has informed our management of these ecosystems, our ability to manage them effectively is impaired.
- **Reduced recreation opportunities or quality.** Recreation opportunities and quality can be directly and indirectly affected by AIS. AIS can make waters unnavigable for boating, limit suitable areas for fishing, and adversely affect sport fishery populations. In some cases, management directives in response to an AIS invasions may prevent the use of water systems for recreation, e.g., site closures. These impacts diminish the economic value associated with recreation, measured commonly by consumer surplus for recreation activities. Non-market valuation techniques are needed to estimate recreation-based economic values, such as travel-cost and contingent valuation methodologies.
- **Public safety and health risks.** AIS have also been known to cause boating accidents (e.g., due to weeds in propellers) and drowning due to entanglement while swimming and

¹⁹ Lassuy, D.R. 1995. Introduced species as a factor in extinction and endangerment of native fish species. American Fisheries Society Symposium 15: 391-396. Williams, J.E., et al. 1989. Fishes of North America endangered, threatened, or of special concern: 1989. Fisheries 14: 2-20.

²⁰ Whittaker, R.H. 1972. Evolution and measurement of species diversity. Taxon 21: 213-251.

²¹ Goldschmidt, T., F. Witte and J. Wanink. 1993. Cascading effects of the introduced Nile Perch on the detritivorous/ phytoplanktivorous species in the sublittoral areas of Lake Victoria. Conservation Biology 7(3): 686-700.

²² Miller, R.R., Williams, J.D., and J.E. Williams. 1989. Extinctions of North American fishes during the past century. Fisheries 14(6):22-38.

recreating. Various AIS have been implicated in public health impacts ranging from nuisance level conditions (e.g. swimmer’s itch due to introduced avian parasites or introduced vectors, including AIS in San Francisco Bay) to serious illness and death (e.g. red-tide dinoflagellates that produce Paralytic Shellfish Poisoning, and possibly epidemic cholera). Although difficult to quantify, the economic cost associated with bodily injury and death can be substantial.

- **Cultural values.** In some cases, environments affected by AIS represent important cultural properties that provide cultural, spiritual, religious, inspirational, and sense of place values, which are inherently difficult to quantify

Table 2-1 summarizes estimates of the economic impacts of AIS taken from a recent review.²³ The estimates range widely, and are often not readily comparable since they are presented variously as total costs for different periods (from an hour to a half-century), or as costs per acre or per boater-year. The wide range is a product of both the disparity of economic impacts for different AIS and different locations, as well the disparity in methods of estimation.

Table 2-1 Estimates of the Economic Impacts of AIS, from Lovell and Stone (2005)

Organism(s)	Location or Sector	Impact	Reference	Notes
Aquatic weeds	11 Florida Counties	\$7.3 million/yr	Rockwell (2003)	Residential flood control
Aquatic weeds	11 Florida Counties	\$6,500/acre	Rockwell (2003)	Average benefit with improved drainage for citrus production
Aquatic weeds	11 Florida Counties	\$300,000	Rockwell (2003)	Average benefit with improved drainage for vegetable production
Aquatic weeds	Florida, Alabama, Illinois, British Columbia	\$738,000/yr	Rockwell (2003)	Total willingness to pay for recreational benefits of aquatic weed control
Asian Clam	U.S. Nuclear Power Industry	\$1 billion /yr	Office of Technology Assessment (1993)	Economic losses
Fish	U.S.A.	\$1 billion/yr	Pimentel et al (2001)	Economic losses to sport fishing due to invasive fish
Ruffe	Lake Erie	\$600 million in 1985-95	Hushak (1997)	Losses to sport fishery
Ruffe	Great Lakes	\$513 million over 50 yr	Leigh (1988)	Net public savings, primarily to recreational fisheries
Sea Lamprey	St Mary's River	\$3.5 million by 2015	Lupi et al (2003)	Benefits to anglers of sea lamprey control
Sea Lamprey	Great Lakes	\$ 3 billion/yr	Sturtevant and Cangelosi (2000)	Benefits to anglers of sea lamprey control

²³ Lovell, S. J. and S. Stone. 2005. The Economic Impacts of Aquatic Invasive Species: A Review of the Literature. Working Paper # 05-02, U.S. Environmental Protection Agency, National Center for Environmental Economics, Washington D.C. A slightly modified version of this report was published as Lovell, S.J., S.F. Stone and L. Fernandez. 2006. The economic impacts of Aquatic Invasive Species: a review of the literature. Agricultural and Resource Economics Review 35/1: 195-208. Additional references may be found in Thomas, C.M. 2010. A Cost-Benefit Analysis of Preventative Management for Zebra and Quagga Mussels in the Colorado-Big Thompson System, unpublished M.S. Thesis. Department of Agricultural and Resource Economics, Colorado State University. Website http://www.aquaticnuisance.org/wordpress/wp-content/uploads/2011/01/thomas_benefitcostthesis.pdf, accessed February 7, 2011.

Organism(s)	Location or Sector	Impact	Reference	Notes
Zebra Mussels	Great Lakes	\$100 million/yr	Armour et al. (1993)	Costs to 46 power plants for a one or two day downtime and 1% reduction in plant heat rate
Zebra Mussels	Great Lakes	\$1.4 million/yr	Armour et al. (1993)	Costs to upgrade chlorination injection for water utilities
Zebra Mussels	Great Lakes	\$3,100 million over 10 yr	Cataldo (2001)	Cost of damages to intake pipes, water filtration equipment, and power plants
Zebra Mussels	U.S Power Industry	\$800 million/yr	Office of Technology Assessment (1993)	Costs for power plant redesign
Zebra Mussels	U.S Power Industry	\$60 million /yr	Office of Technology Assessment (1993)	Estimated cost of annual maintenance
Zebra Mussels	U.S Power Industry	\$5,000/hr	Office of Technology Assessment (1993)	Estimated shut down costs for a 200 megawatt system
Zebra Mussels	not specified	\$350,000/yr	USGS (1999)	Average control costs per plant for hydroelectric, fossil fuel, and nuclear power facilities
Zebra Mussels	Lake Erie	\$472/boater-yr	Vilaplana and Hushak (1994)	Expenses to each recreational boater for protective paints, additional maintenance, and insurance costs

Rapid Response Planning in Other Regions

As noted previously, many states have developed RRP, including California; or have planned to develop such plans. Few states, however, have developed Rapid Response Funds (RRFs), stand-alone repositories of monies to be utilized exclusively for funding rapid response to invasive species. Instead, states typically respond to unanticipated invasions by diverting funds from other ongoing programs or activities.

Nonetheless, the need to respond rapidly to invasive species has been increasingly recognized as the adverse impacts of the species have become evident. Plans have been developed for single- and multi-state, and multinational regions.

3.1 Multi-state and Multinational Rapid Response Plans

Examples of multi-state plans include those for the Great Lakes, Upper Colorado Region, and the Lake Tahoe Region. The onerous AIS impacts around the Great Lakes caused by the introduction and establishment of such species as the sea lamprey, zebra and quagga mussels, ruffe, and round goby stimulated the development of a model RRP for aquatic invasions.²⁴ The discovery of quagga mussels in Lake Mead in 2007 led to the development of an RRP for quagga and zebra mussels in the Upper Colorado River region.²⁵ The Lake Tahoe Region Aquatic Invasive Species Management Plan was developed following the establishment of at least 20 non-native species in the watershed, including fishes, plants, invertebrates, and an amphibian.²⁶

The Lake Champlain Basin is a multinational region that includes parts of the states of New York and Vermont and the Province of Quebec. A RRP for the basin has been proposed to facilitate cooperation among Federal, State, and Provincial agencies and private organizations.²⁷ The goal of the Plan is to help ensure the availability of resources and protocols to contain and potentially eradicate newly discovered AIS by means of an inter-jurisdictional Task Force that would implement and oversee rapid response actions.

²⁴ Great Lakes Commission Staff of the Resource Management Program. December 2006. Model Rapid Response Plan for Great Lakes Aquatic Invasions, Draft. Prepared for the U.S. Environmental Protection Agency, Great Lakes National Program Office.

²⁵ U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region. January 11, 2010. Upper Colorado Region Prevention and Rapid Response Plan for Dreissenid Mussels. Salt Lake City, Utah.

²⁶ U.S. Army Corps of Engineers. 2009. Lake Tahoe Region Aquatic Invasive Species Management Plan, California-Nevada.

²⁷ Lake Champlain Basin Program, Aquatic Nuisance Species Subcommittee, Rapid Response Workshop. May 2009. Lake Champlain Rapid Response Action Plan for Aquatic Invasive Species.

3.2 State Rapid Response Plans

Several individual states have developed RRP, including Ohio, Idaho, Maine, Maryland, Washington, and Oregon. While similar in purposes and goals, the plans differ somewhat in structure and administration. Those discussed below are for Maine, Washington, and Oregon, each of which has established funding mechanisms for rapid response.

3.2.1 Maine

The Plan

The Maine Rapid Response plan for AIS, finalized in January 2006, serves as an administrative blueprint for interagency agreement among the Department of Environmental Protection (MDEP), the Department of Inland Fisheries and Wildlife (MDIFW), and the Department of Conservation. The State's rapid response goals include mobilizing and deploying resources as quickly as possible to address newly detected AIS. The primary goal is to begin treatment of an infestation within the first season of detection (preferably in less than 30 days); or to act on measures to achieve effective containment while a longer term eradication or suppression strategy is formulated.²⁸

Lead Agencies and Authorities

Maine's RRP designates lead responsibility for fish and aquatic fauna to MDIFW, and for aquatic plants to MDEP. Both agencies are to work with the Department of Conservation when surface use restrictions or other response initiatives affect state facilities and are needed to facilitate control or eradication.²⁹

The RRP outlines the procedures that MDEP and MDIFW are to follow in responding to a newly detected aquatic plant invasion. These procedures include compiling and evaluating preliminary information to determine the threat posed by the invasion; the potential for eradication; whether immediate surface use restrictions are critical; and whether a rapid response mode is likely to be successful. If staff designees agree on an approach, the lead agency will draft an order for the two department Commissioners to sign. The Commissioners reserve the right to consult directly on any order, but are less inclined to do so if delegated staff agrees; and will expedite the decision-making process to facilitate rapid action and to move into the Treatment Implementation stage. The lead agency Commissioner is authorized to determine the best population control methods.³⁰

Maine's statutes authorize the MDEP to attempt eradication of AIS from a water body if department staff determines that it is feasible. The MDEP Commissioner is authorized to use control methods (physical, chemical or biological) to eradicate invasive aquatic plant populations if it is determined that eradication activities must be undertaken immediately. However, if the

²⁸ Maine Department of Environmental Protection. Rapid Response Plan for Invasive Aquatic Plants, Fish, and Other Fauna, Part 1: Plant Protocol. Website http://www.state.me.us/dep/blwq/topic/invasives/rrp_part1final.pdf, accessed December 13, 2010.

²⁹ Ibid.

³⁰ Ibid.

infested water body is a public drinking water supply, public notification by the Commissioners of both MDEP and MDIFW is required prior to any response action that proposes the use of a chemical control agent. Chemical control agents may not be used in a water body that is a public water supply without the prior written consent of each public water supplier using that water body.³¹

Advisory Councils

The Interagency Task Force on Invasive Aquatic Plants and Nuisance Species was established to advise the Land and Water Resources Council on matters pertaining to research, control, and eradication of AIS. The Task Force consists of twelve public members appointed by the Governor and five ex officio members (the MDEP Commissioner or designee, who serves as chair; and representatives from MDIFW, the Department of Human Services, the Department of Agriculture, Food and Rural Resources, and the Department of Conservation). Ten of the 12 public members represent different interest groups: the state's lake associations; a statewide recreational watercraft owners association; a statewide organization of marina owners; a lakes education program; public drinking water utilities; commercial tree and garden nurseries; home gardeners; municipal government; a statewide sporting association; and a statewide outdoor recreational group. The last two members are an individual with demonstrated expertise in lake ecology, and an individual who has demonstrated experience or interest in the area of threats to fish and wildlife posed by invasive aquatic plants and nuisance species.³²

The public members serve four-year terms, except for the initial appointments which are for two or three years. Members serve until their successors are appointed.³³

The Task Force advises and makes recommendations on the following:³⁴

- The importation and transportation of AIS;
- Monitoring and education programs;
- Comprehensive AIS management plans;
- A statewide inventory of AIS;
- Methods to improve the cooperation of state, provincial, federal and nongovernmental agencies on AIS prevention and control;
- Recommendations on the feasibility of implementing lake protection assessment districts that allow residents and owners of land within 250 feet of inland waters to assess themselves to raise funds for the prevention and control of AIS; and

³¹ State of Maine. 2002. Action Plan for Managing Invasive Aquatic Species, Appendix C. Website <http://www.maine.gov/dep/blwq/topic/invasives/invplan02.pdf> accessed February 16, 2011.

³² Maine Department of Environmental Protection, Bureau of Land and Water Quality, Interagency Task Force on Invasive Aquatic Plants and Nuisance Species. Website http://www.state.me.us/dep/blwq/topic/invasives/interagency_task_force/index.htm, accessed February 16, 2011

³³ Ibid.

³⁴ Ibid.

- Recommendations as necessary to control the introduction of AIS in Maine.

Funding

A Lake and River Protection Sticker program requiring the purchase and display of a sticker on registered watercraft was implemented in 2002. The sticker fee is \$10 for watercraft registered in-state and \$20 for other watercraft. Failure to display the sticker is a civil violation carrying a \$100-\$250 fine. Sticker fees are paid to the Maine Treasurer, who credits 60 percent of the revenues to the Invasive Aquatic Plant and Nuisance Species Fund for MDEP to conduct AIS inspections, prevention, containment, eradication and management activities, and to reimburse agencies as needed for costs associated with conducting or enforcing the provisions. MDEP may also use funds to contract with municipalities or other entities to conduct inspection, prevention, or eradication programs to protect the inland waters of the State from AIS and nuisance species.³⁵

The remaining 40 percent of the revenues collected from the program are credited to the Lake and River Protection Fund for MDIFW to enforce laws pertaining to AIS. These include inspection of watercraft for invasive aquatic plant materials, educational and informational efforts targeted at AIS prevention, eradication and management activities, and the production and distribution of the Lake and River Protection Stickers. The Maine Legislature appropriates the amount equal to the administrative costs incurred by MDIFW in collecting revenue from the sticker program.³⁶ The Invasive Aquatic Plant and Nuisance Species Fund and the Lake and River Protection Fund were initially funded from the Maine Rainy Day Fund under the provision that MDEP and MDIFW reimburse the Rainy Day Fund in full by June 30, 2002.³⁷

3.2.2 Washington

The Plan

Washington defines a rapid response as “an attempt at eradication, with the understanding that if eradication is not possible, early response might still improve the effectiveness and reduce the cost of ongoing control.”³⁸ The Washington RRP specifies that eradication, not continual control, is the objective and that the purpose is to provide general guidance for rapid response to all types of aquatic invasions.³⁹

Washington’s RRP calls for procuring emergency funding and authorizing one or two state agencies to control the funding, staff, permits, and other resources needed for immediate response, unless the invader falls within an existing control program. The RRP contains a number of additional objectives and related tasks including: maintaining a pool of experts to verify and identify invasive and deleterious species; and maintaining a pool of experts and risk

³⁵ State of Maine, 2002, op. cit..

³⁶ State of Maine, 2002, op. cit.

³⁷ State of Maine, 2002, op. cit..

³⁸ Washington State Aquatic Nuisance Species Committee. 2005. Draft Early Detection and Rapid Response Plan for Aquatic Invasive Species in Washington State.

³⁹ Ibid.

managers to quickly decide whether a newly discovered potentially harmful species deserves rapid response and if eradication is practical. The plan also calls for the creation of two lists: a list of invaders already currently known to occur in Washington, and another list of species not yet known to be in the state. Each list is to identify a few species of the greatest priority or concern.⁴⁰

Lead Agencies and Authorities

Several agencies are responsible for addressing AIS within the state. The Washington Department of Fish and Wildlife (WDFW) and the Washington State Aquatic Nuisance Species Committee (WSANS) are to develop, maintain, and update a list of species and taxonomic groups likely to cause the most damage in Washington and to post this information on-line. They are also required to develop model response plans for specific invasive species, and to develop a training strategy that identifies needs and conducts periodic training for government and private-sector rapid response cooperators.

WDFW is also responsible for developing a Memorandum of Understanding with agencies on the process for determining lead agencies for rapid response actions.⁴¹ WDFW currently manages priority threats at various levels depending upon legislative direction and available resources. WDFW's primary AIS management programs are for zebra and quagga mussels, non-native tunicates, and ballast water. Other species and pathways are addressed under WDFW's general AIS Prevention and Enforcement Program.

The Washington Department of Ecology (WDOE) provides financial assistance and grants to state and local governments, and technical support through the Aquatic Weeds Program to deal with freshwater invasive plants statewide.⁴² WDOE is also required to develop model response plans for specific AIS plant species.

The Washington State Department of Agriculture (WDOA), like WDFW, is required to develop model response plans for specific weed species. WDOA is also required to develop, maintain, and update a list of species and taxonomic groups likely to cause the most damage in Washington and to post that information on-line. WDOA works with other state and local agencies on eradication programs and researches and updates the state's Wetland and Aquatic Weed Quarantine List.

Lead agency responsibilities are shown in Table 3-1. In circumstances where the lead responsibility is unclear or disputed, the Governor's Office has the authority to make the ultimate decision.⁴³

⁴⁰ Ibid.

⁴¹ Ibid.

⁴² Washington Department of Fish and Wildlife, Washington State Aquatic Nuisance Species Committee. January, 2011 Report to the 2010 Legislature. Website <http://wdfw.wa.gov/publications/pub.php?id=01165>, accessed February 15, 2011.

⁴³ Washington State Aquatic Nuisance Species Committee, 2005, op. cit.

Table 3-1 Washington State Invasives: Lead Agency Responsibility by Species Type

Lead Agency	Species Type
Department of Agriculture	Freshwater emergent plants, marine animals
Department of Ecology	Freshwater submerged plants, freshwater algae, marine algae
Department of Fish and Wildlife	Freshwater animals, marine plants
Department of Health	Diseases, pathogens and viruses

Source: Aquatic Nuisance Species Committee and Washington Department of Ecology

Advisory Councils

Washington’s Draft Early Detection and Rapid Response Plan for AIS was prepared by WSANS in October 2005. WSANS, which consists of representatives from state, federal, local, tribal, and non-governmental organizations, was created to overcome the previous disjointed approach to AIS management.⁴⁴ WSANS identifies and recommends management practices to minimize the introduction and spread of non-native aquatic species.

In 2006, state legislation was passed that authorized the Washington Invasive Species Council to provide policy level direction, planning, and coordination for fighting damaging non-native species and preventing new introductions throughout the state. The Council consists of 18 members from state, federal, local, tribal, private, and non-governmental organizations, with support from the staff of the agencies represented on the Council.⁴⁵ The Council periodically updates the statewide strategic plan for addressing non-native species, submits an annual report of its activities, and is authorized to establish technical and advisory committees. The bill that authorized the creation of the Council also authorized the creation of an Invasive Species Council Account in custody of the state treasurer. Expenditures from the account can only be used to carry out the purposes of the council and require approval from the Director of the Recreation and Conservation Funding Board (formerly known as the Interagency Committee for Outdoor Recreation).⁴⁶ The Council’s top priorities include recommendations on:⁴⁷

- Compiling and conducting a baseline assessment;
- Developing a web-based information clearinghouse;
- Supporting targeted outreach campaigns;
- Increasing and enhancing communication across all entities; and
- Improving agencies’ access to emergency funding and develop an interagency early detection and rapid response network.

⁴⁴ Washington State Aquatic Nuisance Species Committee, 2005, op. cit.

⁴⁵ State of Washington, Secretary of State, Engrossed Substitute Senate Bill 5385, Chapter 152, Laws of 2006, http://www.invasivespecies.wa.gov/documents/Final_Bill.pdf accessed February 16, 2011.

⁴⁶ State of Washington, State Legislature, Chapter 79A.25 RCW. Website <http://apps.leg.wa.gov/rcw/default.aspx?cite=79A.25&full=true> accessed February 16, 2011.

⁴⁷ Washington State Recreation and Conservation Office, Washington Invasive Species Council, About the Council. Website http://www.invasivespecies.wa.gov/about_council.shtml access February 16, 2011.

Funding

The WDFW, with assistance from WSANS, is responsible for securing money for an interagency fund to support rapid response efforts. In 2005, the Legislature established funding for an algae control program and asked the WDOE to develop the program. However, the approximate \$250,000 per year allotted for this program was not enough to fund comprehensive lake-wide and watershed-wide algae reduction projects. Instead the WDOE has focused on providing grants to local agencies to manage algae problems.⁴⁸

A bill under consideration by the State Legislature would authorize a \$3 surcharge on the annual boat registration fee to fund AIS programs as follows: \$1.50 for WDFW to carry out invasive species prevention work including boat inspections, educating law enforcement staff about AIS laws, evaluating specific risks, and implementing an early detection and rapid response plan; \$1.00 for WDOE to distribute grants and provide technical assistance to manage excessive freshwater algae; and \$0.50 for WDFW and the Washington State Patrol for enforcement, including boat inspections.⁴⁹

3.2.3 Oregon

The Plan

The goal of the Oregon Aquatic Nuisance Species Management Plan⁵⁰ is to minimize the harmful impacts of AIS through prevention and management. The plan details several goals: the establishment of a management structure that coordinates AIS activities; a prevention program; a monitoring program that allows for early detection and rapid response; a control program aimed at established species; education; and research. Supporting actions include establishing a dedicated fund for AIS management activities and creating emergency response plans. The plan places a high priority on establishing an Invasive Species Council and a coordinator position.

Lead Agencies and Authorities

The Oregon Invasive Species Council (OISC) was created and began operating in January, 2002. The OISC statute identifies four main functions for the Council: to create and publicize a system for reporting sightings of invasive species; to undertake educational activities to increase awareness of invasive species issues; to develop a statewide plan for dealing with invasive species; and to administer an account for funding eradication and education projects. The Council consists of twelve members who meet three times a year, or more when special meetings are called. Four ex officio members represent the agencies with leading roles in invasive species management: Oregon Department of Agriculture, Portland State University, Oregon Department of Fish & Wildlife, and the Sea Grant College of Oregon State University. The ex officio

⁴⁸ State of Washington, Department of Ecology, Freshwater Algae Control Program. Website <http://www.ecy.wa.gov/programs/wq/plants/algae/index.html> accessed February 17, 2011.

⁴⁹ State of Washington, Senate Committee on Natural Resources and Marine Waters, SB 5036. Website <http://apps.leg.wa.gov/documents/billdocs/2011-12/Pdf/Bill%20Reports/Senate/5036%20SBR%20NRMW%2011.pdf> accessed February 17, 2011.

⁵⁰ Oregon Aquatic Nuisance Species Management Plan. Website http://www.anstaskforce.gov/State%20Plans/OR_ANS_Plan.pdf accessed February 17, 2011.

members appoint eight at-large members for two-year terms. The members may represent federal, state or local governments; universities; or industry or other groups with an interest in invasive species.

OISC keeps a list of the 100 worst invaders that threaten Oregon. Species on the list include non-native species that are not present in the state or are present in limited contained ranges within the state. The list also includes species prohibited by regulation.⁵¹

Funding

The estimated cost of implementing the AIS Management Plan is \$3 million per year.⁵² In 2009, the Oregon Legislature authorized the creation of an Invasive Species Control Account with the OISC as the administrator. Monies from the account are to be used for emergency eradication and containment of invasive species, including both aquatic and terrestrial species. Funded activities could include surveys, inspections, enforcement actions, rapid response planning, administration, treatment and disposal, cleaning and disinfection, and repayment to owners of destroyed property resulting from eradication or control programs. Funds can be released only after the OISC has declared an Invasive Species Emergency and made certain findings regarding the soundness, effectiveness, cost-effectiveness and necessity of the actions to be funded. Funds from the account cannot be used to manage non-native species that are established widely in the state; general outreach, education or research on non-native species; or any cost that is not necessary to respond to an Invasive Species Emergency. The maximum authorized expenditure is \$5 million over two years (2009-2011). Funds are to be generated from the sale of lottery bonds and are continuously appropriated.⁵³

Funds can be released from the Account through awarded grants or through the declaration of an Invasive Species Emergency.⁵⁴ OISC bylaws specify that decision-making is consensus driven, but when a consensus is not possible, majority rules apply. In the event of a tie, the OISC Chair casts the deciding vote.⁵⁵

3.3 Summary of Rapid Response Funding Programs

The funding programs described in §3.2 are summarized in Table 3.2. Maine's two funds come from fees levied on boats, and are intended to support both rapid response actions (as they are defined in this report) and other actions addressing AIS. Washington's proposed funding would also come from boat fees and support both rapid response and non-rapid response actions

⁵¹ State of Oregon, Oregon Invasive Species Council, 100 Most Dangerous Invaders to Keep Out. Website http://www.oregon.gov/OISC/most_dangerous.shtml accessed February 17, 2011.

⁵² Oregon Aquatic Nuisance Species Management Plan, op. cit.

⁵³ State of Oregon, Committee on Agriculture, Natural Resources and Rural Communities, House Amendments to House Bill 2020. Website <http://www.leg.state.or.us/09reg/measpdf/hb2000.dir/hb2020.1ha.pdf> accessed February 17, 2011.

⁵⁴ State of Oregon, Oregon Invasive Species Council, Oregon Invasive Species Control Account. Website http://www.oregon.gov/OISC/609_010_0100.shtml accessed February 17, 2011.

⁵⁵ State of Oregon, Oregon Invasive Species Council, Bylaws. Website <http://oregon.gov/OISC/docs/pdf/bylaws.pdf> accessed February 17, 2011.

addressing AIS; the funds in this case would go directly to a state agency to implement these actions. Oregon's fund is to be supported by the net proceeds from lottery bonds, and addresses only rapid response actions (and thus constitutes a dedicated Rapid Response Fund), but these are to target both AIS and terrestrial species.

Table 3-2 Characteristics of Existing or Proposed Programs for Funding AIS Rapid Response

State:	Maine	Washington	Oregon
RRP Date	2006	2005 (Draft)	2001
Date Funding was Established:	2002	Proposed in current legislation	2009
Fund Name:	Invasive Aquatic Plant and Nuisance Species Fund, and Lake and River Protection Fund	No fund; funds provided directly to Washington Department of Fish and Wildlife to conduct work	Invasive Species Control Account
Fund Administrator	Maine Department of Environmental Protection, and Maine Department of Inland Fisheries and Waterways		Oregon Invasive Species Council
Source of Funds	\$10 fee on boats registered in-state and \$20 fee on other boats	\$1.50 surcharge on boat registration fee	Net proceeds of lottery bonds, with a maximum expenditure of \$5 million over 2 years
AIS Rapid Response Activities* Funded	Containment or eradication	Implement a rapid response plan	Emergency eradication or containment
Other Activities Funded	Boat inspections, prevention, management, education, law enforcement for AIS	Boat inspections, educate law enforcement staff about AIS laws, risk evaluation, implement an AIS early detection plan	Emergency eradication and containment of terrestrial invasive species

* Refers to rapid response activities as defined in this report in §1.1.2.

Chapter 4

Aquatic Invasive Species Management in California

The total number of AIS in California is not known, and the lists of California AIS prepared by different studies are generally incomplete and/or inconsistent. Some of these may include either marine species or freshwater species, or both; some may include established species, or species that have been reported but are not established in California, or species that have invaded elsewhere but have not yet reached California. Some differ in their definitions of “aquatic” or “invasive”; or differ in their judgments about which species are non-native or are established. One list, developed by the California Invasive Species Advisory Committee, is described below in §4.1.

Seven state agencies have been involved in large-scale management programs dealing with AIS (Table 4-1). Some programs focus on a specific introduction vector such as commercial shipping or aquaculture, some on certain species such as agricultural pests, and some on protected waters or on water uses such as boating or wildlife habitat.

Table 4-1 State Agencies and General Responsibilities prior to a Statewide AIS Plan

State Agency	General Responsibility
California Department of Boating and Waterways	Recreational boating.
California Department of Fish and Game	Fish, aquatic organisms, plants, and marine algae introduced through all vectors including aquaculture, ballast water, commercial fishing, and live fish and animal transportation/importation.
California Department of Food and Agriculture	Regulated aquatic weeds, and pests that threaten agriculture or nurseries.
California Department of Water Resources	Flooding, water supply/delivery systems, and the protection of aquatic food webs.
California State Lands Commission	Non-native estuarine, marine, and freshwater species introduced through ballast water, commercial shipping, and vessel fouling.
State Coastal Conservancy	Coastal preservation and restoration, and combating non-native species in wetlands.
State Water Resources Control Board	Regulating discharges and runoff and generally protecting against non-native species

Source: California Invasive Species Management Plan (2008)

4.1 California Invasive Species Advisory Committee List

The Invasive Species Council of California (ISCC) was established in February 2009. It is chaired by the Secretary of the California Department of Food and Agriculture (CDFA) and vice-chaired by the Secretary of the California Natural Resources Agency. Other Council members include the State Environmental Protection, Business, Transportation and Housing, Health and Human Services, and Emergency Management Agencies. The ISCC is an ad hoc body and does not have legislative authority.⁵⁶

The ISCC created the California Invasive Species Advisory Committee in 2009. The purpose of the committee is to advise the ISCC and develop recommendations based upon input from and cooperation with other stakeholders and existing organizations addressing invasive species issues. The Committee consists of twenty-four appointed members who serve as representatives of a broad range of constituencies.⁵⁷

The Committee developed a list of damaging non-native organisms already in the state and of non-native species that have a reasonable likelihood of entering California for which an exclusion, detection, eradication, control, or management action by the state might be taken (see Table 4-2 for ten AIS on the list). The list was developed from over 80 existing lists of non-native species from California and elsewhere, including regulatory lists and those maintained by universities and nongovernmental organizations. Collectively, these lists contained over 1,700 species of all types (vertebrate, invertebrate, plant, and disease).⁵⁸ Relative to economic impacts, the higher the number, the greater the potential economic impact of the species. As shown, the highest score for impacts is 27, for the Golden mussel. Relative to ability to respond, the higher the number, the greater the ability to respond to the species. The score of 5 for the Golden mussel indicates poor ability to respond, while the score of 16 for Hydrilla indicates a relatively good ability to respond.

Table 4-2 Ten Most Economic Damaging AIS Threatening California

Common Name	Species Name	Type	Economic Impact (0 to 40)	Ability to Respond (0 to 25)	Confidence	Extent
Golden mussel	<i>Limnoperna fortunei</i>	freshwater mollusk	27	5	High	Not present
Zebra mussels	<i>Dreissena polymorpha</i>	freshwater mollusk	23	15	High	Limited
Quagga mussels	<i>Dreissena bugensis</i>	freshwater mollusk	23	15	High	Limited
Giant salvinia	<i>Salvinia molesta</i>	herb	23	15	High	Limited
Hydrilla	<i>Hydrilla verticillata</i>	herb	21	16	High	Limited

⁵⁶ Environmental Law Institute, Status and Trends in State Invasive Species Policy: 2002-2009, Appendix. Website http://www.eli.org/program_areas/Invasives/index.cfm accessed February 14, 2011.

⁵⁷ California Invasive Species Advisory Committee. Website <http://www.iscc.ca.gov/cisac.html> , accessed online February 14, 2011.

⁵⁸ California Invasive Species Advisory Committee, California Invasive Species List, April 20, 2010. Website <http://www.iscc.ca.gov/docs/CaliforniaInvasiveSpeciesList.pdf> , accessed online January 13, 2011.

Common Name	Species Name	Type	Economic Impact (0 to 40)	Ability to Respond (0 to 25)	Confidence	Extent
Miramar weed	<i>Hygrophila polysperma</i>	herb	19	7	Medium	Not present
New Zealand mudsnail	<i>Potamopyrgus antipodarum</i>	freshwater mollusk	18	13	High	Limited
Wakame	<i>Undaria pinnatifida</i>	alga	18	3	High	Widespread
Water hyacinth	<i>Eichhornia crassipes</i>	herb	18	12	High	Widespread
Northern Pike	<i>Esox lucius</i>	fish	17	14	High	Not present

Source: California Invasive Species Advisory Committee (2010)

4.2 California Aquatic Invasive Species Management Plan (CAISMP)

4.2.1 General Overview

The California Aquatic Invasive Species Management Plan (CAISMP) was prepared by CDFG and released in 2008. The plan meets the federal requirements to develop statewide Nonindigenous Aquatic Nuisance Species Management Plans and is therefore authorized to receive matching federal funds to achieve the objectives and actions outlined in the plan. The plan explains the management framework and control options for AIS, provides a brief overview of AIS programs operating in CA, summarizes the responsibilities of California state agencies most involved in AIS work, and lists gaps and challenges in state AIS management.

The overall goal of the CAISMP is to identify steps to be taken to minimize the impacts of AIS, with detailed actions to eradicate, contain, or at least slow the spread of AIS, as appropriate. The plan proposes management actions for addressing AIS that threaten the state and identifies eight objectives to address those threats. The objectives include coordination and collaboration; prevention; early detection and monitoring; rapid response and eradication; long-term control and management; education and outreach; research; and laws and regulation. The plan identifies 163 supporting actions which support the main objectives, of which more than 80 are considered high priority. The five highest priority items include: creation of a coordinating entity for state agencies and one for a broader range of AIS interest; creation of a mechanism for state AIS managers to share information; securing funding; conducting a statewide assessment of the risk from major AIS vectors; and funding and launching early detection and rapid response actions.

Several state agencies already address AIS concerns (see Table 4.1) or coordinate on individual projects. However, a more comprehensive statewide approach is considered essential. The CAISMP calls for the formalization of the California Agencies Aquatic Invasive Species Team (CAAIST), and the creation of an Aquatic Invasive Species Working Group (AISWG). The CAAIST is made up of AIS managers from eight state agencies (DBW, CDFG, CDFA, California Department of Water Resources, SLC, SWRCB, California Department of Conservation and SCC) who report to their respective executive level managers for implementation. The CAAIST is led by CDFG’s State Invasive Species Coordinator. CAAIST responsibilities include drafting a working list of high priority AIS; coordinating AIS activities among agencies; identifying funding sources; conducting outreach; prioritizing efforts; briefing

policy makers; conducting economic impact studies; and formally evaluating the CAISMP on a regular basis.

The AISWG, which has not yet been formed, would be made up of representatives from various agencies, research institutions and stakeholder groups and would require staff support and regular funding. AISWG responsibilities would include reviewing working lists of high priority AIS and waters; assessing the effectiveness of programs, identifying gaps, and making recommendations; forming partnerships with neighboring states and Mexico; developing outreach programs and distributing information; quantifying and assessing research, management, and education efforts; developing an early detection approach; and implementing the RRP.

Both the AISWG and CAAIST are to be assisted by technical advisory panels. If the AISWG is unable to perform its duties, the CAAIST is to assume its role. These two groups along with seven state agencies are to have lead implementation responsibilities, listed in Table 4-3. There are other state agencies, stakeholders, federal agencies, and research institutions that will act as cooperating organizations.

Table 4-3 CAISMP Objectives and Implementing Agencies

Major Objective	Implementing Agencies
Coordination and collaboration	AISWG, CAAIST and upper management of state agencies and departments
Prevention	AISWG, DBW, CDFG, CDFA, Dept of Parks & Recreation, SLC and SWRCB
Early Detection and Monitoring	AISWG, CAAIST, CDFG and SLC
Rapid Response and Eradication	AISWG, CAAIST and CDFG
Long-term Control & Management	AISWG, CAAIST, CDFG, CDFA and SLC
Education & Outreach	AISWG, CAAIST, DBW, CDFG, CDFA, NGOs, Sea Grant, SCC, SLC and University of California Cooperative Extension
Research	AISWG, CAAIST and SLC
Laws and Regulations	CAAIST, CDFG and CDFA

Source: California Aquatic Invasive Species Management Plan, 2008

4.2.2 Rapid Response Plan

The CAISMP calls for the development, implementation, and funding of a Rapid Response Plan (RRP) and recognizes that an effective rapid response effort may require formal interagency cooperation. The goal is for agencies and other interests to work together as effectively and efficiently as possible through prior agreements about roles and responsibilities, chains of command and communications, criteria for initiating rapid response actions, public safety, funding, regulatory permit processes, public information, data collection, implementation and follow-up evaluation.

CDFG developed a draft AIS Rapid Response Plan in 2007⁵⁹, which was included as an appendix to the 2008 CAISMP. The plan describes existing legal authorities that may facilitate rapid response actions, a generalized 17-step rapid response procedure (Table 4.4), and 11 basic tasks for rapid response planning (Table 4.5).

Table 4-4 17-Step Rapid Response Procedure, from the Draft California RRP

1) Identify species and notify authorities	10) Conduct a rapid assessment
2) Activate command-level participants	11) Plan eradication or control measures
3) Implement the Incident Command System planning cycle	12) Implement the eradication or control plan
4) Develop the organization	13) Prevent reinfestation
5) Create a safety plan	14) Prepare demobilization plan
6) Conduct outreach	15) Monitor the outcome of the rapid response
7) Develop a training plan	16) Undertake remedial actions and long-term follow up
8) Address regulatory compliance	17) Implement the demobilization plan
9) Take containment actions	

⁵⁹ California Department of Fish and Game. 2007. Draft Rapid Response Plan for Aquatic Invasive Species in California.

Table 4-5 Rapid Response Planning Tasks, from the Draft California RRP

- 1) Collaborate to complete a plan
 - a. Collaborate with public agencies and other organizations that are currently involved in rapid response efforts.
- 2) Complete cooperative agreements
 - a. Develop list of entities which should be included in Memoranda of Understanding, Implementation Agreements, or similar instruments to cooperate on rapid response to AIS.
- 3) Secure funding
 - a. Coordinate efforts to pursue funding options.
- 4) Finalize the RRP
 - a. Develop the process and criteria for the State to use in determining the course of action to take for any new AIS introductions.
 - b. Identify likely species and/or early detection scenarios for AIS.
 - c. Develop information needed to help cooperating agencies designate and train, in advance, potential responders to AIS introductions.
 - d. Develop a procedure to designate and prepare potential alternate staff. This could avoid delays in managerial and staff time during a response.
 - e. Develop a statewide Rapid Response Personnel Directory.
 - f. Develop and maintain a directory among cooperating agencies for equipment, operations centers, supply sources and associated contacts.
 - g. Develop lists of taxonomic experts and protocols for requesting and using their services.
 - h. Develop a protocol for responding to a private entity or local government agency that wishes to conduct a rapid response under its own direction, but requests assistance or permits from one or more agencies signatory to the statewide Rapid Response Plan.
 - i. Develop a list of who, outside of those directly involved, should be notified when rapid response procedures are being planned and implemented.
 - j. Consider whether information should be collected in a particular manner in order to be compatible with existing AIS databases.
- 5) Staff from relevant agencies should streamline the permit process for rapid response
- 6) Revise the RRP
 - a. Identify and prioritize certain species, groups of species or certain locations for the development of specific rapid response plans.
- 7) Develop species, or location, specific RRP
 - a. Identify and prioritize certain species, groups of species or certain locations for the development of specific rapid response plans.
- 8) Train employees, participants, and team members and conduct pertinent drills
 - a. Develop a training program and train employees.
 - b. Ensure that training includes AIS rapid response drills using a variety of scenarios and locations around the state.
- 9) Conduct education and outreach
 - a. Develop a plan of potential methods and protocols for outreach to local communities, interest groups, and the media during rapid response events.
 - b. Apprise supervisors of employees in the Rapid Response Personnel Directory that rapid response work can supersede other projects on very short notice.
- 10) Conduct research necessary for improved response
 - a. Cooperating agencies should promote research that can specifically improve or promote rapid response efforts.
 - b. Research the costs of rapid response, possible funding mechanisms and, if feasible, study the environmental and economic benefits and costs of conducting rapid response efforts versus not conducting rapid response.
- 11) Develop interim rapid response protocols
 - a. What steps can be taken to prepare to implement a rapid response effort while a formal plan is going through the review and approval processes.

Recommended Size of a Rapid Response Fund

A Rapid Response Fund must be sufficiently large to cover both the funds awarded for rapid response activities as well as the costs of administering the fund. Discussion below focuses on past expenditures for rapid response activities in California and on estimated staffing needs for those activities in the future.

5.1 Cost of Awards for Rapid Response Activities

Historic expenditures on AIS can provide some guidance on the appropriate size of an RRF. Presented below is some information on AIS control costs elsewhere (§5.1.1) and in California (§5.1.2), and the implications for the level of funding that should be provided through an RRF (§5.1.3).

5.1.1 AIS Expenditures in Other Regions

Table 5-1 summarizes some estimates of the control costs for certain species and categories of AIS.⁶⁰ These show large costs for certain AIS (estimates of \$7 million per year to \$14.5 million per year for *Hydrilla* in Florida, though much less to eradicate it early elsewhere (\$700,000 in Indiana); \$20 million per year for zebra mussels in eight Great Lakes states). While some of the costs listed in Table 5-1 would qualify as rapid response, most appear to be for long-term control.

Table 5-1 Estimates of Control Costs for AIS

Organism(s)	Location or Sector	Control Costs	Reference	Notes
Aquatic plants	U.S.A.	\$100 million/yr	Office of Technology Assessment (1993)	
Aquatic plants	Florida	\$14 million/yr	Rockwell (1984)	
European Loosestrife	U.S.A.	\$45 million/yr	Pimentel et al. (2000)	Control costs and forage losses
<i>Hydrilla</i>	Florida	\$14.5 million/yr	Office of Technology Assessment (1993)	
<i>Hydrilla</i>	Florida	\$174 million in 1980-2005	Washington Dept. of Ecology	
<i>Hydrilla</i>	Indiana	\$700,000	Great Lakes Commission	Rapid response and eradication

⁶⁰ Mainly from Lovell and Stone, 2005, op. cit.

Organism(s)	Location or Sector	Control Costs	Reference	Notes
Asian Clam	U.S. Nuclear Power Industry	\$4.5 million in 1980	Office of Technology Assessment (1993)	
Zebra Mussels	One major power utility	\$100/megawatt	Jenkins (2001)	Mussel monitoring
Zebra Mussels	Great Lakes	\$120 million in 1989-94	Park and Husak (1999)	Retrofitting, physical removal, biocides
Zebra Mussels	Great Lakes	\$375,000/user/yr	Ruetter (1997)	Cost per large water user
Sea Lamprey	New York	\$275,000 in 1999	Government Accountability Office	Control and monitoring
Sea Lamprey	Michigan	\$3 million in 1999	Government Accountability Office	Control and monitoring
Sea Lamprey	Lake Huron	\$5 million per application	Lupi et al (1999)	Lampricide treatment
Sea Lamprey	St Mary's River	\$4 million per application	Lupi et al (2003)	Lampricide treatment
Sea Lamprey	Lake Huron	\$300,000/yr	Lupi et al (1999) Jenkins (2001)	Sterile male releases
Northern Snakehead	Maryland	\$110,000	ENSR International 2005	Eradication from several small ponds
Ruffe	Great Lakes	\$12 million over 11 years	Leigh (1988)	

5.1.2 AIS Expenditures in California

Information below is on expenditures for AIS management (including both rapid response and other activities) by state agencies (§5.1.2.1), and information specifically on marine eradication efforts conducted in the state by a variety of governmental and non-governmental parties.

5.1.2.1 AIS Expenditures by California State Agencies

This section provides information on AIS management activities and expenditures by some key California agencies, the state's AIS expenditures over a 2-year period, and the history and costs of some major AIS rapid response and eradication efforts in the state.

Department of Boating and Waterways

The Department of Boating and Waterways (DBW) has an Aquatic Weeds Program that is primarily involved in control programs. In 1982, state legislation designated DBW as the lead agency for controlling water hyacinth (*Eichhornia crassipes*) in the Sacramento-San Joaquin Delta, its tributaries, and the Suisun Marsh. The *Egeria densa* program was added in 1997; however, treatment did not begin until 2001 due to litigation that prevented all DBW weed treatment during the 2000 season. Due to the high level of infestation, water hyacinth and *Egeria densa* are not expected to ever be eradicated from the Delta area, and the program's

objective is to control the weed populations at a level that doesn't interfere with boating. DBW currently spends approximately \$6 million yearly on these efforts.⁶¹

Department of Food and Agriculture

CDFA has an Aquatic Weeds program with an annual budget of approximately \$2.1 to \$2.3 million.⁶² In the past 15 years, the Aquatic Weeds program has dealt primarily with two species, *Hydrilla verticillata* and the South African spongeplant (*Limnobium laevigatum*). Most of the eradication work is done by the Pest Detection and Emergency Projects Branch.

State Coastal Conservancy

The State Coastal Conservancy (SCC) is a unique state agency with flexible powers to serve as an intermediary among government, citizens, and the private sector. The SCC's mission is to purchase, protect, restore, and enhance coastal resources, and to provide access to the shore. The SCC is primarily funded by state general obligation bonds approved by state voters.⁶³

Since 2000, SCC has funded AIS eradication efforts for several species of cordgrass (*Spartina* spp.) as well as the oyster *Crassostrea gigas*, the seaweed *Caulerpa taxifolia*, and the freshwater reed *Arundo donax*. The total cost estimates for these eradication efforts, including matching funds from other agencies or organizations, is nearly \$41 million. SCC provides eradication funds for projects on an "as needed" basis.⁶⁴

Department of Fish and Game

CDFG monitors AIS when feasible but does not have funds specifically for eradication. However, CDFG's Habitat Conservation Planning Branch has an Invasive Species Program which participates in efforts to prevent the introduction of non-native invasive species in California, detect and respond to introductions when they occur, and prevent the spread of non-native invasive species that have become established.⁶⁵ CDFG contributed \$585,000 in Section 27 funds to the *Caulerpa taxifolia* eradication.⁶⁶ As reported below, CDFG's Office of Spill Prevention and Response conducts AIS surveys for the Marine Invasive Species Program operated by SLC.

⁶¹ State of California, Department of Boating and Waterways, Aquatic Pest Control. Website <http://www.dbw.ca.gov/Environmental/Aquatic.aspx>, accessed March 1, 2011.

⁶² Akers, Patrick, California Department of Food and Agriculture. February 2, 2011. Personal communication with Cardno ENTRIX staff.

⁶³ State Coastal Conservancy, About the Conservancy. Website <http://scc.ca.gov/about/>, accessed March 1, 2011.

⁶⁴ Corbaley, Su. State Coastal Conservancy. February 28, 2011. Personal communication with Cardno ENTRIX staff.

⁶⁵ California Department of Fish and Game. Habitat Conservation. Website <http://www.dfg.ca.gov/habcon/>, accessed March 1, 2011.

⁶⁶ Woodfield, R. and K. Merkel. 2006. Final Report on the Eradication of the Invasive Seaweed *Caulerpa taxifolia* from Agua Hedionda Lagoon and Huntington Harbour, California, Merkel and Associates, Inc. May 2006. Website http://www.sccat.net/Final_Eradication_Report_California_2006.pdf, accessed February 15, 2011.

State Water Resources Control Board

The State Water Resources Control Board (SWRCB) has limited capacity to respond to AIS. Aside from constraints due to furloughs and budget reductions, most of the SWRCB's funds are "special funds" dedicated to specific issues/projects. SWRCB receives less than \$100,000 a year for consultative activities related to preventing the introduction of AIS through ballast discharge and hull fouling.⁶⁷ The San Diego Region SWRCB office spent approximately \$2.1 million on the *Caulerpa taxifolia* eradication project⁶⁸, but securing this funding was a lengthy effort.

State Lands Commission

The State Lands Commission (SLC) operates the Marine Invasive Species Program (MISP), which is focused on preventing the introduction of AIS by cargo vessels, and is not involved in eradication efforts. A major part of the program is implementing California's ballast water discharge standards. Four state agencies have responsibilities under the MISP: the Board of Equalization collects the fees; SLC implements the program; CDFG's Office of Spill Prevention and Response conducts biological surveys for AIS in coastal waters; and SWRCB has a consultative role.⁶⁹ These activities are funded through a Marine Invasive Species Control Fund, supported by fees levied on arriving cargo vessels. The fees are adjusted periodically based on overall agency budgets and the number of vessels operating in California waters. The funding supports staff, data collection, research, inspection, regulation and legislative development. The fund has a reserve of approximately \$1 million which carries over year to year, and has a current balance of approximately \$1.1 million.⁷⁰

Two projects unrelated to the MISP that were undertaken by SLC include efforts to remove Eurasian watermilfoil from Lake Tahoe and the removal of tamarisk from Owens Lake and its river delta. Removal efforts are still underway and the combined costs to date are approximately \$120,000.⁷¹

AIS Expenditures by California State Agencies in 2005-2007

The CAISMP compiled data on AIS-related expenditures by state agencies during fiscal years 2005-06 and 2006-07, averaging \$26.8 million per year (Table 5-2). The CAISMP noted that some state agency expenditures were likely missed; in addition, there were presumably AIS expenditures in those years by water agencies, park districts and other local government, and probably by businesses or nonprofit organizations. Thus, these data represent a lower bound on total AIS expenditures in the state, though only part of these expenditures are for rapid response activities.

⁶⁷ Ward, Kim. February 15, 2011. State Water Resources Board. Personal communication with Cardno ENTRIX staff.

⁶⁸ Woodfield and Merkel, 2006, op. cit.

⁶⁹ Falkner, Maurya, State Lands Commission, Marine Invasive Species Program. February 23, 2011. Personal communication with Cardno ENTRIX staff.

⁷⁰ Falkner, personal communication.

⁷¹ Falkner, personal communication.

Table 5-2 Funds Spent by California State Agencies on AIS Programs and Activities in 2005-07

Name of Program or Activity	Type	Agency	FY 05/06	FY 06/07
Aquatic and Riparian Invasive Species Control on CDFG Lands (One Time Funding)	C	CDFG		\$720,000
Aquatic and Riparian Invasive Species Control on CDFG Lands (Regular Funding)	C	CDFG	\$160,000	\$160,000
Wetlands and Riparian Invasive Plant Control	C	Wildlife Conservation Board		\$4,610,000
Santa Clara River Invasive Species Control (Santa Clara River Trustee Council Grants)	C	CDFG		\$507,700
Santa Clara River Invasive Species Research (Santa Clara River Trustee Council Grants)	B	CDFG		\$100,000
Santa Clara River Invasive Species Monitoring	B	CDFG		\$200,285
Santa Clara River Invasive Species - Outreach and Education	B	CDFG		\$49,734
Shellfish Health Laboratory	B	CDFG	\$130,000	\$130,000
Marine Invasive Species Program – Invasive Species Monitoring	B	CDFG/Office of Spill Prevention & Response	\$1,080,000	\$1,080,000
Marine Invasive Species Program – Commercial Vessel Vectors	B	SLC	\$1,531,000	\$2,013,000
Quagga Mussel Response – Unified Command participation, planning and logistics, surveys, border inspections, public outreach	A	CDFG, CDFA		\$1,048,119
Quagga Mussel Response – Unified Command participation, eradication planning, dive inspections, surface survey training	A	DWR		\$39,944
Quagga Mussel Response – Outreach to boaters	A	DBW		\$400,000
Northern Pike Containment System at Lake Davis	A	CALFED	\$2,000,000	
Lake Davis Pike Eradication Project	A	CALFED		\$17,500,000
<i>Hydrilla</i> Eradication Program	A	CDFA	\$2,100,000	\$2,100,000
Invasive Spartina Monitoring	A	CALFED		\$1,234,396
Aquatic Weed Control (Water Hyacinth and <i>Egeria densa</i>)	B	DBW	\$7,000,000	\$7,000,000
Coordination & Collaboration; Education & Outreach; Program Development; and Other AIS Activities	B	Sea Grant	\$90,000	\$90,000
Commercial Vessels and Maritime Activities	B	Sea Grant	\$137,250	\$137,250
AIS Monitoring & Inspections	B	Sea Grant	\$114,500	\$114,500
Total of Reported Activities		--	\$14,342,750	\$39,234,928
Average Annual Expenditures		--	\$26,788,839	

Source: California Aquatic Invasive Species Management Plan (2008). "Type" sorts expenditures by whether or not they are for rapid response activities: A – rapid response; B – not rapid response; C – might in part be rapid response

Quagga and Zebra Mussel Response

Following the discovery of quagga mussels in the lower Colorado River system in January 2007, \$1.5 million was spent by CDFG, CDFA, DBW and DWR for rapid response activities during

the first half of 2007; another \$11.5 million was allocated through CDFG through fiscal year 2009-10, for a total of at least \$13 million.⁷² It is not clear what portion of this would constitute rapid response as defined in this report, since at some point the focus moved away from assessing the potential for eradication or long-term containment, and more toward developing long-term monitoring and control. Some of these funds were also spent on responding to the discovery of zebra mussels in a reservoir in San Benito County in January 2008; in that case the focus was always on developing and implementing an effort to eradicate the population, so all of those costs (much less than \$1 million, including federal and local agency expenses as well as the State's expenses) would qualify as rapid response. Also, some federal and local agencies, including the Metropolitan Water District of Southern California, spent additional sums that might in part qualify as rapid response to quagga mussels.

Caulerpa taxifolia Eradication

Caulerpa taxifolia is a highly invasive marine alga known for causing substantial ecological and economic damage in the Mediterranean, where it is reported to have harmed tourism, pleasure boating and recreational diving, and had a costly impact on commercial fishing both by altering the distribution of fish and by fouling nets.⁷³ In March 1999, the Mediterranean clone of *C. taxifolia* was listed as a Federal Noxious Weed, in recognition of the threat it posed to reefs and seagrass meadows in Southern California and other warm coastal waters of the U.S.⁷⁴ The eelgrass beds and other coastal resources that could be directly impacted by *C. taxifolia* are part of a food web that is critical to the survival of numerous native marine species including the commercially and recreationally important spiny lobster, California halibut, and sand basses.⁷⁵

In June 2000, *C. taxifolia* was discovered in Agua Hedionda Lagoon in Southern California, and at the end of June an informal "rapid response" team⁷⁶ composed of federal, state, and local agencies, businesses, scientists and others was formed and efforts were begun to survey the extent of the invasion and develop an eradication plan.⁷⁷ In July it was learned that *C. taxifolia* was also present in Huntington Harbour. The invasions were eradicated through the use of tarps, chlorine and hand removal, supported by extensive surveys and monitoring, between 2000 and

⁷² California Legislative Analyst's Office. Supplemental Report of the 2007 Budget Act, 2007-08 Fiscal Year. Norton, Dominique, Invasive Species Program, California Department of Fish and Game, personal communication to Andrew Cohen, March 31, 2011.

⁷³ Woodfield, R. 2001. Noxious Seaweed Found in Southern California Coastal Waters. Website: National Marine Fisheries Service, Southwest Regional Office. Website <http://swr.nmfs.noaa.gov/hcd/CAULERPA.htm>, accessed online January 14, 2011.

⁷⁴ Cohen, A.N. et al. 1998. Letter petition to Bruce Babbitt, Secretary of the Interior, requesting that the Mediterranean clone of *Caulerpa taxifolia* be listed as a prohibited species under the Federal Noxious Weed Act (October 19, 1998).

⁷⁵ Woodfield, 2001, op. cit.

⁷⁶ The Southern California Caulerpa Action Team, or SCCAT.

⁷⁷ U.S. Environmental Protection Agency. Overview of EPA Authorities for Natural Resource Managers Developing Aquatic Invasive Species Rapid Response and Management Plans. Website http://water.epa.gov/type/oceb/habitat/invasives_management_index.cfm, accessed January 13, 2011.

2006.⁷⁸ Total costs were \$7.7 million (Table 5.3).⁷⁹ Costs for surveys and treatment were between \$2.0 million and \$4.3 million at Agua Hedionda Lagoon (reported as a range due to the aggregation of certain costs in the project’s final report) and were \$700,000 at Huntington Harbour. It is unclear to what extent the surveys outside of these two water bodies or the education and outreach (with combined costs of at least \$2.2 million) would be considered rapid response activities under the definition in this report.

Table 5-3 *Caulerpa taxifolia* Eradication Project Costs

Task	Amount
Grant Acquisition	\$103,000
Treatment Research	\$265,000
Surveys and Treatment at Agua Hedionda Lagoon	\$1,971,193
Surveys and Treatment at Agua Hedionda Lagoon; Coastal Surveys	\$448,899
Surveys at Agua Hedionda Lagoon; Outreach and Education	\$1,895,000
Surveys and Treatment at Huntington Harbour	\$700,000
Surveys at Southern California Waterbodies	\$2,211,000
Scientific Review of Eradication Program	\$55,000
Outreach and Education	\$55,000
Total	\$7,704,092

Source: Woodfield and Merkel, 2006, Appendix F.

Northern Pike Eradication in Lake Davis

Northern pike (*Esox lucius*), is an aggressive predatory fish which can significantly affect aquatic ecosystems and impact native fish populations. Illegally introduced pike were discovered in Lake Davis in 1994, and within a few years the local trout fishery and associated local economy were severely impacted by the pike’s presence. California State University at Chico modeled the local economic impacts of the pike in Lake Davis and their eradication and found that not undertaking an eradication project would have a greater negative impact on the local economy than conducting a treatment. The study also concluded that even a failed eradication attempt would have long-term economic benefits outweighing short-term losses.⁸⁰

Table 5-2 lists \$19.5 million contributed by CalFED to this eradication effort in 2005-07. Though there must have been some prior planning costs, this appears to be nearly the full cost of this eradication (not counting previous eradications in the watershed in the early 1990s

⁷⁸ Anderson, L.W.J. 2005. California’s reaction to *Caulerpa Taxifolia*: a model for invasive species rapid response. *Biological Invasions* 7: 1003-1016.

⁷⁹ Woodfield and Merkel, 2006, op. cit.

⁸⁰ California Department of Fish and Game. 2007. Lake Davis Pike Eradication Project: Short-Term Impacts on the Local Economy and Real Estate Values, Report to the California Legislature. Website <http://www.dfg.ca.gov/lakedavis/econ-report/LakeDavisEconomicReport.pdf>, accessed January 17, 2011

(Frenchman Lake and the Middle Fork of the Feather River), an eradication effort in Lake Davis in 1997, and control and containment efforts in Lake Davis up to 2005).

Hydrilla Eradication

Hydrilla verticillata is a Eurasian submersed aquatic weed that has invaded several U.S. states and often crowds out other species. It was discovered in California in 1976, and CDFA began eradication efforts in 1979. Since then, CDFA has targeted 29 separate infestations in 18 counties; infestations at 19 sites have been eradicated,⁸¹ and work continues at 10 sites. Recent budgets for the *Hydrilla* program have averaged \$2.2 million per year.⁸²

Spartina Eradication (Invasive *Spartina* Project)

The Invasive *Spartina* Project is a regional, coordinated program of the SLC that began in 2000. Its objective is to eradicate four species of non-native cordgrass and one native-nonnative hybrid cordgrass from central California estuaries, with nearly all of the infestations and the work being in San Francisco Bay. These species have been present for decades. The goal for the hybrid is not complete eradication of plants containing any non-native genome but rather removal of all plants exhibiting non-native morphology. The overall amount that has spent or budgeted since the start of the program is approximately \$20 million, and if the eradication proceeds as expected total expenditures will be on the order of \$30 million over a 20 year period.⁸³

5.1.2.2 Marine Eradications in California

Table 5.4 provides information on a fairly complete list of eradication efforts in California’s marine waters, listed as separate efforts for each bay or estuary (and thus targeting isolated AIS populations, as defined in this report). Included is an estimate of each project’s size, as follows:

- Small projects—rapid response efforts whose total cash need (exclusive of in-kind contributions or assistance) is ≤\$100,000.
- Medium-sized projects—rapid response efforts whose total cash need is \$100,000-\$1 million.
- Large projects—rapid response efforts whose total cash need is >\$1 million.

Table 5-4 Eradication Efforts in California Marine Waters

Organism	Species Name	Location	Date	Methods	Project Size
seaweed	<i>Caulerpa taxifolia</i>	Aqua Hedionda Lagoon	2000-05	covering, biocide	Large
seaweed	<i>Caulerpa taxifolia</i>	Huntington Lagoon	2000-05	covering, biocide	Medium or Large?
seaweed	<i>Ascophyllum nodosum</i>	San Francisco Bay	2002	hand removal	Small
seaweed	<i>Ascophyllum nodosum</i>	San Francisco Bay	2008	hand removal	Small

⁸¹ Akers, P. The California Department of Food and Agriculture *Hydrilla* Eradication Program, Annual Progress Report 2009. CDFA considers *Hydrilla* to be eradicated from a site only if it is not found for at least six years.

⁸² Akers, pers. comm.

⁸³ Peggy Olofson, Director, Invasive *Spartina* Project, personal communication to Andrew Cohen, March 31, 2011.

Organism	Species Name	Location	Date	Methods	Project Size
seaweed	Undaria pinnatifida	Santa Catalina Island	2001-present?	hand removal	Small
seaweed	Undaria pinnatifida	Monterey Harbor	2002-10	hand removal	Small
seaweed	Undaria pinnatifida	San Francisco Bay	2009-present?	hand removal	Small?
plant	Zostera japonica	Humboldt Bay	2003-present	hand excavation, covering	Medium
plant	Zostera japonica	Eel River Estuary	start in 2011	hand excavation, covering	Small or Medium
plant	Spartina alterniflora	Humboldt Bay	1985-89	mowing, covering	Small
plant	Spartina alterniflora	Drakes Estero	2002-05	covering	Small
plant	Spartina alterniflora	Bolinas Lagoon	2002?-05	hand removal, covering	Small
plant	Spartina alterniflora	San Francisco Bay	2005-present	biocide, mowing	Large
plant	Spartina anglica	San Francisco Bay	2005-present?	biocide, hand removal	Small
plant	Spartina densiflora	Humboldt Bay	2004-present	mowing, burning	Large
plant	Spartina densiflora	Tomales Bay	1999	hand removal	Small
plant	Spartina densiflora	Tomales Bay	2002-?	hand removal	Small?
plant	Spartina densiflora	San Francisco Bay	2005-present	biocide, hand removal	Medium or Large?
plant	Spartina patens	San Francisco Bay	2005-present?	biocide, hand removal	Small?
plant	Salsola soda	Bodega Harbor	1994	hand removal	Very Small
plant	Salsola soda	Limantour Estero	1998	hand removal	Very Small
plant	Limonium ramosissimum	San Francisco Bay	recent/planned	hand removal	Medium?
tree	Avicennia marina	San Diego Bay	1979-80	hand removal	Small
tree	Avicennia marina	San Diego Bay	mid-1980s-2000	hand removal	Small
tree	Avicennia marina	San Diego Bay	2006-present?	hand removal	Small
worm	Terebrasabella heterouncinata	Cayucos	1997?	hand removal of hosts	Small
snail	Batillaria attramentaria	San Francisco Bay	2005-present?	hand removal	Medium
snail	Littorina littorea	San Francisco Bay	2004	hand removal	Small
snail	Littorina littorea	San Francisco Bay	2009-present	hand removal	Small
snail	Littorina littorea	Anaheim Bay	2004	hand removal	Small
oyster	Crassostrea gigas	San Francisco Bay	2006-present	hand removal	Medium
crab	Carcinus maenas	Tomales Bay	2009?-present	trapping	Small?

5.1.3 Amount Needed for Rapid Response Awards

This section includes an estimate of the funds needed for the rapid response efforts that would be funded by an RRF. The approach is to project the future demand for rapid response funding based on the costs of past rapid responses, developing a high projection and a low projection, then to apply different scenarios describing what part of that demand the RRF would fund. The

result is a range of estimated fund sizes based on different demand projections and different expectations about the RRF’s funding targets.

5.1.3.1 Analysis of Cost Data

The cost data provided in §5.1.2.1 are for AIS management expenditures by California state agencies. Only a part of these are for rapid response actions as defined in this report. A column in Table 5-2 sorts the listed activities into three types:

- Type A - Activities that are identified as rapid response or eradication or as a supporting element of an eradication effort, and therefore meet the definition of rapid response given in §1.1.2; these consisted of four large rapid response or eradication projects, costing an average of \$13.2 million per year over those two years.
- Type B - Activities that do not appear to meet the definition of rapid response (e.g. prevention activities; and monitoring, outreach or research that is not in support of an eradication effort); these cost an average of \$10.5 million per year.
- Type C - Activities that might include some rapid response actions in part (e.g. actions identified as control, which might include some eradication efforts or responses to a new invasions); these cost an average of \$3.1 million per year.

Expenditures on these three types of activities are summarized in Table 5-5.

Table 5-5 Funds Spent by California State Agencies on AIS Programs and Activities, by Activity Type

Activity	FY 05/06	FY 06/07	Average Annual
Type A: Rapid Response/Eradication			
Quagga Mussel Response	\$0	\$1,488,063	\$744,032
Lake Davis Pike Eradication Program & Containment System	\$2,000,000	\$17,500,000	\$9,750,000
Hydrilla Eradication Program	\$2,100,000	\$2,100,000	\$2,100,000
Invasive Spartina Monitoring	\$0	\$1,234,396	\$617,198
Type A: Subtotal	\$4,100,000	\$22,322,459	\$13,211,230
Type B: Not Rapid Response/Eradication	\$10,082,750	\$10,914,769	\$10,498,760
Type C: Might be Rapid Response/Eradication in part	\$160,000	\$5,997,700	\$3,078,850
Total	\$14,342,750	\$39,234,928	\$26,788,839

Of the rapid response expenditures in this table and described in §5.1.2, the major part was for a few large projects or programs addressing quagga and zebra mussels, *Caulerpa*, northern pike in Lake Davis, *Hydrilla* and *Spartina* in central California. Averaged over 10 years (2000-2009), expenditures on these work out to about \$7-8 million per year (Table 5-6); this includes expenditures on some medium-sized or small rapid response projects (zebra mussels in San Benito County and *Hydrilla* and *Spartina* eradications in some sites), and probably some costs that don’t qualify as rapid response (e.g. some part of the expenditures on quagga mussels). Ongoing large projects to control water hyacinth (initiated in 1982) and *Egeria densa* (initiated in 1997) in the Sacramento-San Joaquin Delta (expenditures of \$6 million per year by DBW) do

not qualify as rapid response since there is no expectation that these species will ever be eradicated from the Delta. On the other hand, there were probably a few other large (>\$1 million) AIS rapid response projects in the state during these years, such as the *Spartina densiflora* eradication effort in Humboldt Bay (which is not part of the Invasive Spartina Project). Overall, \$8 million per year would seem to be a reasonable estimate for the average annual cost of large AIS rapid response projects during this period.

Table 5-6 Approximate Costs for 5 Large Rapid Response/Eradication Projects in California in 2000-2009

Project	Total Cost over 2000-2009	Average Annual Cost during 2000-2009	Notes and Reference
Quagga and Zebra Mussel Response	\$13.5 million	\$1.35 million	CAIAMP; Norton pers. comm.
Caulerpa Eradication	\$7.7 million	\$0.77 million	Woodfield and Merkel 2006
Northern Pike Eradication	\$19.5 million	\$1.95 million	Based on 2005-07 cost (CAISMP)
Hydrilla Eradication Program	–	\$2.2 million	\$2.2 million in recent years (Akers pers. comm.), assumed to be the same over the decade
Invasive Spartina Project	\$14 million	\$1.4 million	Rough estimate (Olofson pers. comm.)
Total	–	\$7.7 million	

There are less data on medium-sized or small rapid response projects. Section 5.1.2 mentions three ongoing eradication efforts in California that would likely fall into the category of medium-sized projects: efforts to eradicate Eurasian water-milfoil from Lake Tahoe and to eradicate tamarisk from Owens Lake and the Owens River delta, with combined spending to date on these two projects of \$120,000; and an effort to eradicate the oyster *Crassostrea gigas* from San Francisco Bay, with total funding to date of \$338,895.⁸⁴ Several *Hydrilla* and *Spartina* eradications are medium-sized or small projects, and the rapid response to the San Benito County Zebra Mussel infestation was a medium-sized project. CDFG's efforts to control South American spongeplant and efforts around the state to control *Arundo* include some attempts to eradicate isolated populations that would qualify as rapid response. Some additional small or medium-sized rapid response or eradication efforts might be included in the control costs listed in Table 5-2 (e.g., \$500,000 for AIS control in the Santa Clara River, \$1 million for AIS control on CDFG lands, and \$6 million for wetland and riparian plant control). As noted earlier, the data in Table 5-2 are incomplete, and under-reporting is likely to be greatest for small and medium-sized projects. In addition, rapid response projects funded and carried out by local governments, nonprofits or businesses are most likely to be for small or medium-sized projects. Thus it seems that a substantial number of small or medium-sized rapid response projects could have been implemented over the past decade, even though they are not reflected in the data on expenditures by state agencies presented in §5.1.2.1.

The distribution of small, medium-sized and large rapid response projects data on marine eradications is presented in Table 5-4. It focuses on eradications because they represent the major part of rapid response actions. We focused on *marine* eradications because the number of

⁸⁴ Cohen, A.N. and A. Gilbreath. 2010. Exotic Oyster Survey, Removal and Research in San Francisco Bay: Second Progress Report. Center for Research on Aquatic Bioinvasions, Richmond, CA, and San Francisco Estuary Institute, Oakland, CA.

eradication appears to be much smaller in marine than in fresh waters,⁸⁵ and there are likely to be fewer government agencies involved in eradication efforts,⁸⁶ making it easier to assemble a relatively complete list. Of the 32 projects listed in Table 5-3, 3-5 are large projects, 4-7 are medium-sized projects, and 22-23 are small projects. In assembling this list, smaller projects were more likely to be missed than larger ones. This suggests that there may be a substantial number of small and medium-sized rapid response projects, addressing small AIS populations of limited extent, that could be funded through an RRF, and there may even be a significant number of very small projects—involving the hand removal and disposal of an AIS from a small, isolated site—that could be completed for a few thousand dollars. In addition, the existence of an RRF and the increased availability of funds for rapid response would result in an increase in rapid response efforts, particularly for smaller projects that in the past would not have been pursued because there was no mechanism for obtaining timely funding.⁸⁷

5.1.3.2 Demand Projections

This section provides an approach to estimate the future demand for AIS rapid response in these three project size categories. First, the marine eradication numbers are increased by 50 percent to account for omitted projects, rapid response projects that are not eradication projects, and growth in demand produced by the existence of an RRF. These numbers are then extrapolated to all AIS (marine and freshwater) using two projections (a low and a high projection) based on the relative number of large rapid response or eradication projects in marine and fresh water in California, and on other information. The projected demand in dollars is estimated using average costs for project size categories.

The number of large rapid response or eradication projects in California marine and fresh waters over ten years appears to be about the same (Table 5-7). Thus, for the low projection it is assumed that the number of freshwater projects in each size category equals the number in marine waters. However, the larger number of separate fresh water bodies and of agencies with jurisdictions that include fresh water bodies suggests that the number of small and medium-sized projects is likely to be considerably larger in fresh waters than in marine waters. Thus for the high projection it is assumed that the number of large freshwater projects equals the number in marine waters, but that the number of medium-sized and small projects is three times the numbers in marine waters. These projections are shown in Table 5-8.

⁸⁵ Eradication efforts in marine waters are a relatively new phenomenon and less widely developed than in freshwater ecosystems, and there are fewer isolated water bodies in California's marine waters (e.g. about 30-40 separate bays and estuaries, depending on how you count them) than in California's fresh waters (possibly thousands of separate water bodies, depending on how you count them).

⁸⁶ For example, only a fraction of California local agencies have jurisdictions with coastal shorelines, while virtually all of them probably include or adjoin some freshwater bodies.

⁸⁷ Supporting such efforts is part of the reason for establishing an RRF.

Table 5-7 Large Rapid Response or Eradication Projects in California Marine and Fresh Waters in Progress During 2000-2009

Project Type and Size	Project (Year Started)
Marine waters: Clearly Large Projects	Agua Hedionda <i>Caulerpa</i> Eradication (2000); San Francisco Bay <i>Spartina alterniflora</i> Eradication (2000); Humboldt Bay <i>Spartina densiflora</i> Eradication (2004)
Marine waters: Possibly Large Projects	Huntington Harbour <i>Caulerpa</i> Eradication (2000); San Francisco Bay <i>Spartina densiflora</i> Eradication (2000)
Fresh waters: Clearly Large Projects	Quagga Mussel Rapid Response (2007); Lake Davis Pike Eradication (2005); Clear Lake <i>Hydrilla</i> Eradication (1994 or 2007)*
Fresh waters: Possibly Large Projects	Imperial Irrigation District <i>Hydrilla</i> Eradication (1981); Chowchilla River/Eastman Lake <i>Hydrilla</i> Eradication (1989); Oregon House Area <i>Hydrilla</i> Eradication (1997)

* The first Clear Lake *Hydrilla* eradication ran from 1994 to 2003; *Hydrilla* was not observed in surveys in 2004 to 2006 and was considered to be eradicated. However, *Hydrilla* reappeared in the lake in 2007, apparently as regrowth from surviving tubers rather than a new introduction, and a new round of eradication was started (Akers 2009).

Table 5-8 Projected Demand: Number of Rapid Response Projects in California over 10 Years

Project Size	Eradication Project Data - Marine	Rapid Response Projection - Marine (add 50%)	Rapid Response Projections - Freshwater		Rapid Response Projections - Total	
			Low	High	Low	High
Large	4	6	6	6	12	12
Medium	5.5	8	8	24	16	32
Small	22.5	34	34	102	68	136
Total	32	48	48	132	96	180

The annual cost of the projected demand is estimated by multiplying the projected number of rapid response projects by estimated average per-project costs of \$50,000 for small projects, \$500,000 for medium-sized projects and \$5,000,000 for large projects (Table 5-9). The estimated total cost to meet projected demand (\$7.3-\$8.6 million per year) is close to the earlier estimate for large AIS rapid response projects during 2000-2009 (\$8 million per year), based on the costs of large rapid response and eradication programs that received state funding (§5.1.3.1). Most of the estimated total cost to meet projected demand is for large projects (≈70-85%). This suggests that the figure used in these calculations for the average cost of a large project (\$5 million) may be somewhat low.⁸⁸

⁸⁸ It is noted here that the cost data cited in this report, on which these calculations are roughly based, have not been inflated to current dollars. Because these are intended to be only rough estimates, presenting the cost data in current dollars would not likely change the picture significantly.

Table 5-9 Projected Demand: Annual Average Cost of Rapid Response Projects in California

Project Size	Projected Number of Projects per Year		Average Cost per Project	Projected Total Cost per Year	
	Low	High		Low	High
Large	1.2	1.2	\$ 5,000,000	\$ 6,000,000	\$ 6,000,000
Medium	1.6	3.2	\$ 500,000	\$ 800,000	\$ 1,600,000
Small	6.8	13.6	\$ 50,000	\$ 340,000	\$ 680,000
Total	9.6	18		\$ 7,140,000	\$ 8,280,000

5.1.3.3 Funding Scenarios

Four funding scenarios are considered, one in which all projects for which there is demand are funded, and three in which projects are funded up to limits of \$1 million, \$500,000, or \$250,000 per project. To calculate the funding needed for each scenario, the medium-sized project categories are separated into four subcategories (Table 5-10). The projected costs for the four scenarios are shown in Table 5-11.

Table 5-10 Projected Average Number and Cost of Rapid Response Projects in California

Project Size	Projected Number of Projects per Year		Average Cost per Project	
	Low	High		
Large	> \$1,000,000	1.2	1.2	\$ 5,000,000
Medium	\$750,000-\$1,000,000	0.4	0.8	\$ 875,000
	\$500,000-\$750,000	0.4	0.8	\$ 625,000
	\$250,000-\$500,000	0.4	0.8	\$ 375,000
	\$100,000-\$250,000	0.4	0.8	\$125,000
Small	< \$100,000	6.8	13.6	\$ 50,000
Total		9.6	18	

Table 5-11 Projected Average Annual Award Costs for Four Funding Scenarios

Funding Scenario	Projected Total Award Cost per Year	
	Low	High
Fund all demand	\$ 7,140,000	\$ 8,280,000
Fund all demand up to a limit of \$1,000,000 per project	\$ 2,340,000	\$ 3,480,000
Fund all demand up to a limit of \$500,000 per project	\$ 1,540,000	\$ 2,480,000
Fund all demand up to a limit of \$250,000 per project	\$ 990,000	\$ 1,680,000

Other funding scenarios are possible, but it is believed that these provide a reasonable picture (as well as can be done with the currently available data) of the degree of coverage of demand that can be achieved with different levels of total annual RRF funding. The three scenarios with per project limits of \$250,000 to \$1 million represent a funding plan in which a set of the least costly projects is fully funded by the RRF, a set of more costly projects receives substantial but not

complete funding from the RRF, and the set of most costly projects receives only start-up funding from the RRF. It is believed that this is the most realistic approach, with the largest projects still having to obtain most of their funding from planned allocations in agency budgets, bond funding or general fund appropriations, sometimes in combination with federal or other non-state sources of funding; and the smallest projects, which otherwise might either not proceed or be unduly delayed, being fully funded by the RRF.

It is recommended that the RRF be funded at a level that would allow total annual awards in the range of \$1-2 million. This funding level is generally consistent with other plans for dedicated rapid response funding.⁸⁹

5.2 Administrative Costs

The administrative costs for an RRF will vary with the number of projects reviewed and funded, the overall size of the fund, and the institutional structure used to decide which projects to fund, with the number of projects probably being the most important factor. As discussed in the next chapter, alternatives for the decision-making structure range from a small number of individuals within a single agency to a large, multiple-entity panel, with the latter necessarily entailing some increased administrative costs. In either case, based on discussions with state agency staff, the estimated staffing need to administer a California RRF would be on the order of 0.5-1.0 FTE, with total administrative costs on the order of \$100,000-\$200,000 per year. To calculate average total annual costs (award costs + administrative costs), the lower and higher estimates of administrative costs are applied to the lower and higher projections of demand (Table 5-12). The estimated administrative costs range from 9-11% of the total cost for the smaller fund sizes to 1-2% for the larger fund sizes; this probably underestimates administrative costs for the larger fund sizes. There will be additional administrative staffing needs and costs during the first year of an RRF in order to set up the institutional and administrative structure, prepare basic documentation and materials, and make various decisions. This might require that an additional 0.5-1.0 FTE (\$100,000-\$200,000) be allocated to administrative costs in the first year.

⁸⁹ For example, several bills introduced in Congress during 2005-2009 would authorize \$25 million per year for an emergency AIS rapid response fund that would contribute at least 50% to state and 75% to regional AIS rapid response efforts (HR1591 and S770 in 2005; HR5030 and HR5100 in 2006; HR1080, HR1350, S725 and S791 in 2007; HR500 and S237 in 2009). Thus these bills envisioned total national funding for AIS rapid response of up to \$50 million per year, which is consistent with \$1-2 million for a large, frequently invaded state like California. Oregon created an RRF for both AIS and terrestrial species, with authorized expenditures of \$2.5 million per year (see §3.2.3).

Table 5-12 Projected Average Annual Total Costs for Four Funding Scenarios

Funding Scenario	Projected Total Award Cost per Year		Projected Administrative Cost per Year		Projected Total Cost per Year	
	Low	High	Low	High	Low	High
Fund all demand	\$ 7,140,000	\$ 8,280,000	\$ 100,000	\$ 200,000	\$ 7,240,000	\$ 8,480,000
Fund all demand up to \$1,000,000/project	\$ 2,340,000	\$ 3,480,000	\$ 100,000	\$ 200,000	\$ 2,440,000	\$ 3,680,000
Fund all demand up to \$500,000/project	\$ 1,540,000	\$ 2,480,000	\$ 100,000	\$ 200,000	\$ 1,640,000	\$ 2,680,000
Fund all demand up to \$250,000/project	\$ 990,000	\$ 1,680,000	\$ 100,000	\$ 200,000	\$ 1,090,000	\$ 1,880,000

Chapter 6

Funding Sources

Often the funds used for rapid response by state or local agencies are allocated away from ongoing programs or activities, which is a zero-sum game. Agencies involved in rapid response throughout the United States have stated that such efforts should be supported by a separate, dedicated source of funding.

Chapter 5 presents demand projections and rapid response fund sizes needed to address the projected demand under different funding scenarios. These fund sizes range from a recommended minimum of \$1-2 million annually to fully fund smaller projects and provide partial or start-up funding for larger projects, up to \$7.5-9 million annually to meet the entire projected demand for AIS rapid response projects. This chapter first provides background on key economic principles related to conservation financing (§6.1), and then identifies funding options that could potentially support an RRF at these levels. Discussion below provides for each option a general overview of the funding source, evaluation of its revenue-generating potential, review of some advantages and disadvantages, and identification of important factors warranting further consideration.

This chapter does not make recommendations regarding which funding options should or should not be pursued. Instead, it presents a menu of funding options for further research and discussion among state agencies and lawmakers, including consideration of the regulatory and political viability of different options.

6.1 Principles of Conservation Financing

Like other governmental programs, the burden of costs associated with the conservation of natural resources should be based on such well-accepted concepts as distributional equity and an absence of externalities.⁹⁰ In general, these concepts are embraced in several key principles:⁹¹ the ability to pay; the benefit principle; and the “polluter pays” principle. These provide a rationale for the selection of funding mechanisms and of who bears the costs of implementing these activities. However, they do not necessarily consider the barriers and constraints (such as political constraints) associated with specific funding options. All factors should be considered when selecting appropriate revenue sources.

⁹⁰ Distributional equity refers to an allocation of costs among parties in proportion to their respective benefits from the activity being funded. Absence of externalities refers to an allocation of total costs only to the parties responsible for those costs.

⁹¹ These principles were adapted from: Hoerner, J.A. and R. Shrivastava. 2009. *Options for Financing Coastal and Ocean Conservation in California*, prepared for the California Ocean Protection Council by Redefining Progress - The Nature of Economics. Website http://www.opc.ca.gov/webmaster/ftp/project_pages/Fund_Studies/RP_FinancingCoastalConservation_Study.pdf, accessed January 11, 2011.

6.1.1 Ability to Pay

Ability to pay refers to the capacity of the individual (or group) charged to pay a fee, charge, or tax without undue harm. This principle is based on the premise that the financing of public goods should be progressive (or proportional) in nature. The ability to pay principle conforms to both the horizontal and vertical equity principles. The horizontal equity principle states that those with a similar ability to pay should incur similar costs for the protection of public goods. The vertical equity principle states that those with a greater ability to pay should incur higher costs than those with a lesser ability to pay. An example of this is the progressive U.S. tax system, in which people in comparable income brackets are taxed at the same marginal tax rate. Ability to pay is most often measured in terms of annual income or wealth.

In the context of public financing for AIS management in California, the ability to pay principle may be applicable under the premise that the benefits of AIS eradication are pure public goods that are distributed evenly among all residents within the state. In some respects, this is true, e.g. the ecological values associated with preserving native ecosystems and biodiversity. However, in some instances, AIS eradication provides benefits to distinct user groups (e.g., resource users) and/or remedies problems caused by a few identifiable entities or activities (e.g., AIS vectors).⁹² In these situations, the allocation of public financing costs may be governed by the benefit and polluter-pays principles, respectively.

6.1.2 Benefit Principle

The benefit principle is founded on the concept that charges should be levied on individuals or groups in accordance with the level (or value) of the benefit realized by the service provided. Thus, when public financing of a particular activity or service provides benefits to specific entities, it is reasonable to charge these entities rather than the general population. This approach is considered to be consistent with the fairness concept because it allocates the cost of providing government services in a manner that provides incentive for payment and reduces coerced payment from entities with no vested interest in the service. Because this principle is intuitively reasonable, it provides legitimacy to potential financing options. It also makes it easier to recruit support from the charged group because that group would realize net benefits from implementation of the activity or service. The benefit principle is especially relevant when the benefit can be easily traced to identifiable individuals, groups or industries, e.g., charges on commercial fisherman for services that would improve the health of fisheries and increase fish landings.

6.1.3 “Polluter Pays” Principle

For this analysis, “polluter” represents AIS vectors, which are defined as the means or agents that transport species from one place to the next. The principle states that the direct and indirect costs and damages of AIS invasions should be charged to the vectors that caused the problem. From an equity standpoint, the polluter pays principle is intuitive in that those responsible for the costs should pay for the costs, rather than those with no role in the activity that causes the impact.

⁹² In some cases, the same parties may be both vectors and users of affected resources.

Related considerations involve the magnitude of the charge and how it is used. The charge could theoretically cover all costs associated with AIS invasions, which may include both market costs and non-market costs that are difficult to quantify in the context of environmental services. Alternatively, charges could be set at levels that produce an outcome where benefits exceed costs, but some reduced level of AIS impacts is tolerated. In the equity framework, the use of the revenue is important in that funds could be used to prevent future pollution, remediate past pollution, and/or compensate those adversely affected. Each such consideration has a role in the public debate on environmental and fiscal policy.

6.2 Fees and Other Possible Sources for a Rapid Response Fund

This section discusses the potential sources for an AIS RRF in three categories:

- Fees or charges assessed on AIS vectors, resource users, and stakeholders⁹³
- Fees or charges assessed on the general population
- Grant funding

Discussion includes the revenue base associated with each option based on assumptions that represent the potential upper and lower bound on funds. Advantages and disadvantages of various options are also discussed. A summary of funding sources and potential revenues is provided at the end of this section.

Efforts to develop a funding source for the RRF may need to consider the requirements contained in California Proposition 26, passed in 2010. Proposition 26 increases the legislative vote requirement to two-thirds for state levies and charges and for certain taxes currently subject to majority vote, with limited exceptions; and changes the constitution to require voter approval of local levies and charges by either a two-thirds or majority vote, with limited exceptions. These provisions include fees that address adverse impacts on society or the environment caused by the fee-payer's business.

6.2.1 Fees on AIS Vectors, Resource Users, and Stakeholders

The CAISMP identifies vectors that are known or believed to introduce AIS into the state. The polluter pays principle suggests that those activities or entities responsible for the environmental damage should also bear the cost burden, thus translates into fees and charges on distinct AIS vectors. This section considers each main AIS vector independently and discusses potential funding mechanisms specific to each. The AIS vectors considered here include.⁹⁴

⁹³ There is substantial overlap between AIS vectors and beneficiaries of AIS prevention; therefore, they are presented jointly.

⁹⁴ There are other AIS vectors that have been identified beyond those listed in this section. The ornamental plant and animal trade, and the live bait and live seafood trades, are potentially important vectors that are currently being studied by the California Ocean Science Trust under a grant from the Ocean Protection Council. Other AIS vectors include aquatic construction, research activities and habitat restoration projects; however, since there appears to be minimal potential for revenue generation from these sources, they were excluded from the analysis.

- Commercial shipping;
- Cruise ships;
- Commercial fishing;
- Aquaculture operations;
- Recreational fishing;
- Recreation watercraft;
- Aquarium trade;
- General recreation activity;
- Water deliveries; and
- Direct transport and other illegal activity.

6.2.1.1 Commercial Shipping

Commercial shipping activity at California ports represents one of the primary AIS vectors in the state for marine species in coastal waters, accounting for nearly 80 percent of introductions in North America.⁹⁵ These species could become established in coastal ports and estuaries, and prospective eradication efforts could benefit from rapid response funding. There are two primary mechanisms by which commercial shipping poses risks for the spread of AIS – release of ballast water and hull fouling. The filling and discharge of ballast water in commercial vessels facilitates the spread of AIS because water (and aquatic species) from one location are discharged into waters at another location as vessels move from port to port. Hull fouling represents the process by which organisms attach themselves to the hull of a ship during a voyage and transport themselves long distances resulting in the spread of AIS. Funding options related to commercial shipping include allocations or additional fees levied under the existing California Marine Invasive Species Program and/or new fees on the commercial shipping industry based on size or weight of containers.

California Marine Invasive Species Program Fee Allocation. The California Marine Invasive Species Act was enacted in 2003 and established the California Marine Invasive Species Program administered by the California SLC. Under this program, a ballast water management fee was put into effect to regulate the discharge of ballast water from commercial vessels at California ports. The ballast water fee, levied on the number of qualifying voyages, is collected by the California Board of Equalization (BOE) and deposited into the Marine Invasive Species Control Fund created pursuant to Section 71215 of the California Public Resources Code. Revenues from this fund are deposited into the Marine Invasive Species Control Fund to support research and monitoring activities. There are often unused funds that are carried over from year to year. The current fee is \$850 per qualifying voyage,⁹⁶ which has been in effect since November 2009. The maximum fee that can be levied per the enacting legislation is \$1,000 per

⁹⁵ California State Lands Commission. 2011. *2011 Biennial Report on the California Marine Invasive Species Program*.

⁹⁶ A “qualifying voyage” for purposes of reporting and fee submittal refers to all vessels greater than 300 gross registered tons operating in California waters

voyage.⁹⁷ A summary of the Marine Invasive Species Program and associated fee revenues is presented in Table 6-1.

Table 6-1 Summary of Marine Invasive Species Program Fee Revenues

Year	Voyages Billed	Voyages Reported	Total Voyages	Fees Billed	Fees Reported	Total Fees	Payments Received for Period
2005	6,161	1,157	7,318	\$2,873,800	\$535,200	\$3,409,000	\$3,374,372
2006	6,247	1,161	7,408	\$2,498,800	\$464,400	\$2,963,200	\$2,956,348
2007	5,997	1,199	7,196	\$2,398,800	\$479,600	\$2,878,400	\$2,863,459
2008	5,578	1,133	6,711	\$2,753,750	\$557,825	\$3,311,575	\$3,273,822
2009	5,023	866	5,889	\$3,324,325	\$574,100	\$3,898,425	\$3,856,119
Average (5-Year)	5,801	1,103	6,904	\$2,769,895	\$522,225	\$3,292,120	\$3,264,824

Source: California State Lands Commission, 2011

Table 7-1 shows that total charges levied under the MISP were approximately \$3.9 million on 5,889 voyages in 2009. Because 2009 data reflect the recent economic downturn in California and include only partial application of the revised fee structure (which started in November 2009), it is more representative to calculate potential fee revenues based on shipping activity over the most recent five-year period between 2005 and 2009 and the new fee of \$850 per voyage. On average, there have been about 6,900 qualifying voyages per year since 2005, which would generate approximately \$5.9 million in fee revenues annually moving forward.

There are two possible mechanisms to integrate MISP funding into the proposed RRF. First, the MISP Fund could possibly be restructured to allocate a pre-defined percentage of fee revenues to the RRF based on the parallel objectives of both programs and the potential use of the RRF on eradication efforts for marine species. However, it is acknowledged that these revenues are integral to other components of the MISP; therefore, only a small percentage of total program funding could reasonably be allocated to the RRF. For planning purposes, it is assumed that between 10 and 20 percent of ballast water fee revenues could potentially be allocated to the RRF, resulting in about **\$587,000 to \$1.2 million** in annual funding.

In addition, the MISP fee could be increased up to its maximum permitted level, which is \$1,000 per qualifying voyage, with the incremental revenues (\$150 per voyage) being allocated to the RRF. This could be implemented in conjunction with or separate from funding allocation from the MISP Fund (based on existing fees) described above. Based on the average number of voyages, an additional **\$1.0 million** could be allocated to the RRF.

Current legislation requires that revenues collected from the Marine Invasive Species Control Fee are to be used to implement the MISP. It is not clear whether funding allocations to a

⁹⁷ California Public Resources Code Section 71215. Website <http://www.leginfo.ca.gov/cgi-bin/waisgate?WAISdocID=90517711061+0+0+0&WAIAction=retrieve>, accessed January 11, 2011.

statewide RRF would meet this provision. As a result, legislative changes to the Public Resources Code may be required to allocate a portion of these revenues for invasive species management actions that are outside the scope of the MISF, such as rapid response activities that address both freshwater and marine species. It is likely that the shipping industry would oppose any fee increase, and possibly any change in the use of fees.

Commercial Shipping Capacity or Tonnage Fees. Additional fees and charges may also be levied on the commercial shipping industry based on measures of capacity, such as length of containers or tonnage. The concept of levying fees based on length of shipping containers has already been considered by the California legislature. In 2007, SB 974 (Port Investment Bill) was introduced, which would have implemented a \$30 fee per twenty-foot equivalent unit (TEU) shipping container processed at the ports of Los Angeles, Long Beach, and Oakland, with the funds being used for projects improving air quality and port infrastructure.⁹⁸ According to an analysis of the bill, it was estimated that the container fee would raise approximately \$500 million annually, and up to \$1.5 billion annually by 2020 based on projected growth in container volume. The bill was opposed by the shipping industry, but it passed both houses of the legislature before being vetoed by the governor in September 2008. A similar, but more limited, bill could be developed for the purposes of AIS management and eradication. Assuming a more modest \$1 to \$5 fee per TEU and no growth in container volume, potential contributions to the RRF are estimated to range between **\$17.0 million and \$85.0 million** annually. Additional fees could be generated if the fee was expanded to all California ports.

Alternatively, a charge could be levied based on the gross tonnage of commodities shipped through the California port system. There are seven ports in California that are included in the port rankings by cargo volume in 2009 (in descending order of short tons): Long Beach (72,500,221 tons), Los Angeles (58,406,060 tons), Richmond (25,362,626 tons), Oakland (17,405,784 tons), Port Hueneme (1,371,790 tons), Redwood City (907,220 tons), and San Francisco (888,216 tons).⁹⁹ In total, approximately 176.8 million tons of commodities were shipped through these seven ports in 2009. The extent of potential revenues for transfer to the RRF is based directly on the proposed unit charge per ton shipped. It is difficult to ascertain the appropriate fee level without more research on commodity values and public outreach to the shipping industry and other stakeholders. For planning purposes, fee levels from \$0.10/ton to \$1.00/ton were evaluated, which result in revenue estimates ranging from an estimated **\$17.7 million to \$176.8 million**. This type of fee would require legislative approval, which may be difficult depending on the political and economic climate at the time a bill is proposed.

6.2.1.2 Cruise Ships

Similar to the commercial shipping industry, the risks of AIS introduction are also prevalent with commercial passenger cruise ships, including release of ballast water and hull fouling. There is also the added risk of direct transport of species by passengers visiting foreign ports of call.

⁹⁸ Senate Appropriations Committee. 2007. SB 974 Senate Bill – Bill Analysis. Website http://info.sen.ca.gov/pub/07-08/bill/sen/sb_0951-1000/sb_974_cfa_20070514_115807_sen_comm.html, accessed January 11, 2011.

⁹⁹ American Association of Port Authorities. Port Industry Statistics. Website <http://www.aapa-ports.org/Industry/content.cfm?ItemNumber=900&navItemNumber=551>, accessed January 11, 2011.

Cruise Ship Passenger Excise Tax. Commercial cruise ships are subject to the \$850 per voyage charge levied under the California Marine Invasive Species Program, which targets the cruise line industry. However, there may be opportunities to generate revenue directly from cruise ship passengers via a direct surcharge (or excise tax) on passengers. Such a fee could be levied on a per-passenger basis or alternatively on a percentage of cruise prices.

There is precedent for this type of charge in other regions, specifically a commercial passenger vessel excise tax that is in effect in the State of Alaska. When implemented originally in 2006, the tax in Alaska was \$46 per person traveling on a vessel providing overnight accommodations in state marine waters, in addition to a \$4 per person ocean ranger fee, for a total cost of \$50 per passenger.¹⁰⁰ Recently, Senate Bill 312 was passed by the Alaska legislature that reduced the excise fee to \$34.50 per passenger.¹⁰¹ The tax is paid by the cruise ship operator, which collects the fee from passengers as part of the cost of the cruise ticket. This excise tax is referred to as a “head” tax and has the characteristics of a regressive flat tax.

A similar excise tax can be levied on cruise passengers embarking from ports in California with the funds allocated to the RRF. The magnitude of the excise tax in Alaska can be used as a proxy to estimate revenues generated by a similar measure in California. For this study, a maximum charge of up to \$50 per passenger is considered. In total, there were 1.1 million cruise ship passengers that embarked from California in 2009.¹⁰² This number is down slightly from approximately 1.3 million in 2007 and 1.2 million in 2008. Based on a tax ranging between \$10 and \$50 per passenger, total estimated revenues would be between **\$11.1 million and \$55.6 million** annually.

Alternatively, the charge could be levied as a percentage of cruise ship ticket prices. Assuming the average cost of a cruise is approximately \$1,000, this tax rate could range between 1.0 percent and 5.0 percent of cruise prices to yield equivalent revenues presented above. The benefit to this approach is that it would make the fee progressive in that higher income passengers that tend to purchase higher-priced fares would generally incur a proportionally higher share of the costs.

Voluntary Donations by Cruise Ship Passengers. There may also be opportunity to implement a system of voluntary donations by cruise ship passengers. Such a program may facilitate the development of a “greener” (or more environmentally-friendly) cruise experience and operator, which could lend itself to additional marketing opportunities. A voluntary contribution program has been successful in Baja California for adventure travelers serviced by Lindblad Expeditions, with donations geared toward conservation purposes.¹⁰³ Over a three-year period (2003/04 to

¹⁰⁰ Alaska Department of Revenue. Commercial Vessel Passenger Excise Tax. Website www.legis.state.ak.us/basis/get_documents.asp?session=26&docid=181, accessed January 11, 2011.

¹⁰¹ Alaska State Legislature. Bill History/Action for 26th Legislature, Bill SB312, Vessel Passenger Tax. Website http://www.legis.state.ak.us/basis/get_bill.asp?session=26&bill=SB%20312, accessed January 11, 2011.

¹⁰² Cruise Lines International Association. 2010 CLIA Cruise Market Overview, Statistical Cruise Industry Data Through 2009. Website <http://www2.cruising.org/Press/overview2010/>, accessed January 11, 2011.

¹⁰³ Environmental Finance Center, University of Maryland. Partnership for the Delaware Estuary Financing Feasibility Study. Website <http://www.efc.umd.edu/pdf/PDE.pdf>, accessed January 11, 2011.

2005/06), the average donation was approximately \$62 per passenger with a participation rate of 24 percent. For this analysis, more conservative assumptions were considered – a participation rate of 10 percent and a range of donation values from \$10 to \$60 per passenger. Based on these assumptions, the potential revenue generated by a voluntary donation program on cruise ship passengers is an estimated **\$1.1 million to \$6.7 million annually**. However, because this would be a voluntary program, there is significant uncertainty with this funding source, and it may be better utilized as a supplemental source of revenues.

6.2.1.3 Commercial Fishing

Commercial fishing poses a threat as an AIS vector primarily through hull fouling of vessels located in harbors, docks and berths during the off season. AIS can also be transported via commercial fishing gear, such as fishing lines, tackle, buoys, traps, and nets. There is a lack of regulatory authority on commercial fishing vessels as the State of California has no authority on vessels under 300 gross register tons in size.¹⁰⁴ Potential opportunities to generate revenues for the RRF include increases in fish landing taxes; commercial fish business license fees; and commercial fishing license, registration, stamp and permit fees. These are the three primary sources that fund the regulation and oversight of the commercial fishing industry in California.

Fish Landing Taxes. The CDFG implements a commercial fish landings tax system pursuant to California Fish and Game Code Sections 8040-8070.¹⁰⁵ Landings taxes are imposed on licensed fish receivers who receive fish from commercial fishermen or on the commercial fishermen themselves if the buyers are not licensed. The landing tax rate schedule is based on the number of pounds of individual fish species harvested, rather than on the value of the landings. The tax rates are adjusted for inflation annually pursuant to the Fish and Game Code Section 713.¹⁰⁶ The Fish and Game Code also outlines the purposes for which the funds will be used.

Commercial fish landing taxes have generated significant revenue for fisheries management. In 2005, CDFG collected approximately \$1.13 million in revenue from landings taxes from all commercial fisheries.¹⁰⁷ During this same period, the total ex-vessel value of fish landings was \$108.3 million.¹⁰⁸ Based on these figures, the effective tax rate (as a percentage of fish landing value) is roughly 1.04 percent. On average, the total value of commercial fish landings has been \$124.5 million annually between 2005 and 2009, generating an estimated \$1.3 million annually (assuming the same effective tax rate presented above).

An increase in fish landing tax rates could generate additional revenue that could be transferred into the RRF. An increase in tax rates can be implemented using the existing system (i.e., tax per

¹⁰⁴ California Department of Fish and Game. 2008. California Aquatic Species Management Plan.

¹⁰⁵ California Legislative Council. Official California Legislative Information. Website <http://www.leginfo.ca.gov/cgi-bin/waisgate?WAISdocID=06932514196+0+0+0&WAIAction=retrieve>, accessed January 11, 2011.

¹⁰⁶ Ibid.

¹⁰⁷ Hoerner and Shrivastava, 2009, op. cit.

¹⁰⁸ California Department of Fish and Game, Poundage and Value of Landings of Commercial Fish by Area, 2005, from the CFIS system, Tables 15 and 15a.

pound of fish landing), or the system can be revised to base the tax rates on the commercial value of the fishery. For planning purposes, potential tax rates of between 2 percent and 5 percent of the total value of fish landings were evaluated. Under this option, approximately **\$1.2 million to \$4.9 million** in incremental tax revenues (above the baseline levels) could be allocated for the purpose of AIS rapid response activities. However, any changes to the landings tax rates or structure will require legislative action because the tax rates are specified in the Fish and Game Code, and the Fish and Game Commission has no authority to change these rates.

Commercial Fish Business License Fees. Section 8030 of the Fish and Game Code requires any person who engages in any business for profit involving fish to obtain a commercial fish business license.¹⁰⁹ The various types of licenses include: Fish Importer's License, Fish Processor's License, Sport-Caught Fish Exchange Permit, Fish Receiver's License, Marine Aquaria Receivers License, Fish Business License (Multifunction), Fish Wholesaler License, Fisherman's Retail License, and Live Fresh Water Bait License. A complete description of these licenses required is presented in the *2011 Commercial Fish Business License Information Guide* published by DFG.¹¹⁰ Revenues generated by commercial fish business licenses have averaged approximately \$798,000 annually over the five-year period from 2005 to 2009. For this study, potential license fee increases ranging from 5 percent to 25 percent were evaluated. Using these parameters, approximately **\$40,000 to \$200,000** in additional licensing revenues could be allocated to the RRF. Implementation of this funding mechanism would require legislative approval.

There are two specific vectors noted in the CAISMP that are directly or indirectly subject to commercial fish business license fees – the live bait industry and seafood industry. Fees on the live bait industry are implemented directly as part of Live Fresh Water Bait licenses, and are especially relevant to AIS due to the potential for species transport in bait packing material. Indirectly, the seafood industry is subject to increased costs from most commercial fishing license fees. Instead of a broad increase in fees for all license types, it may be preferable to focus potential fee increases on specific types of licenses such as these.

Commercial Fish License, Registration, Stamp and Permit Fees. CDFG issues licenses and registrations for all commercial fishermen, fishing vessels, and passenger fishing boats in California. In addition, CDFG requires several species-specific or gear-specific permits for certain commercial fishing activities, as well as by-catch permits for some fish caught incidentally. Sections 7850-7858 of the Fish and Game Code outline the commercial fishing regulations applicable in California.¹¹¹ An overview of applicable regulations and current fee schedules is also published annually by CDFG in the *Digest of California Commercial Fishing*

¹⁰⁹ California Legislative Council, op. cit

¹¹⁰ California Department of Fish and Game. 2011 Commercial Fish Business License, Information Guide. Website <http://www.dfg.ca.gov/licensing/pdf/files/Guide2011.pdf>, accessed January 14, 2011.

¹¹¹ California Legislative Council. Official California Legislative Information. Website <http://www.leginfo.ca.gov/cgi-bin/displaycode?section=fgc&group=07001-08000&file=7850-7858>, accessed January 14, 2011.

*Laws and Licensing Requirements.*¹¹² All fees collected by CDFG, including those for licenses, registrations permits, and stamps, have been indexed to inflation each year since 2005, pursuant to Section 713 of the Fish and Game Code.

Conceptually, commercial fishing fees should be set at levels that appropriately charge users for the benefits derived from the right to harvest particular species, as well as management costs and potential environmental damages, such as transport of AIS. As such, an increase in commercial fishing fees may be well justified as a funding source for the RRF. Revenues collected from the sale of commercial fishing licenses, permits, registrations and stamps have averaged \$3.5 million annually from 2005-2009. Assuming an across-the-board increase in fees of 5 percent to 25 percent, an additional **\$173,000 to \$863,000** in commercial fishing revenues could be made available to the RRF.

With so many sources of commercial fishing fees in place, it is difficult to determine the relative ease of implementing proposed fee increases. The Fish and Game Commission has authority to adjust fees for 40 of the 65 different types of commercial licenses, permits, and stamps (not including transfer fees).¹¹³ Other fees have been created by statute and would require legislative action to be modified. It has been estimated that approximately 90 percent of fee revenues associated with commercial fishing are statutorily controlled,¹¹⁴ thereby requiring legislative approval. Additionally, any type of fee adjustment would need to consider other factors such as the nexus between license type and AIS risk.

6.2.1.4 Aquaculture Operations

Aquaculture has been a growing industry in California and is expected to continue growth into the future as more limits are imposed on wild fish harvests.¹¹⁵ Aquaculture operations have been identified as vectors of AIS introductions in the state due primarily to shellfish seed import, abalone culture, shellfish waste, finfish culture, and genetic dilution.¹¹⁶ Accordingly, it may be equitable to levy additional charges on the aquaculture industry to fund rapid response activities for AIS. The primary mechanism would be through an increase in aquaculture licensing fees administered by CDFG.

Aquaculture License Fees. Total revenues from aquaculture licensing fees have averaged \$101,000 annually between 2005 and 2009, with fees steadily increasing over this period. Current fees include registration of new aquaculture operations (\$716 per year); renewal of registration for existing operations (\$362.25 per year); a surcharge on operations with at least \$25,000 in gross sales annually (\$539.25 per year); and late fee for registrations received after April 1 (\$65.66 per year). Potential for revenue generation from an increase in aquaculture licensing fees is modest because of the limited revenue base. Based on existing revenues, an

¹¹² California Department of Fish and Game. 2011 Commercial Fish Business License, Information Guide. Website <http://www.dfg.ca.gov/licensing/pdf/dfs/Guide2011.pdf>, accessed January 14, 2011.

¹¹³ Hoerner and Shrivastava, 2009 op. cit.

¹¹⁴ Hoerner and Shrivastava, 2009, op. cit.

¹¹⁵ California Department of Fish and Game. 2008. California Aquatic Invasive Species Management Plan.

¹¹⁶ Ibid.

increase in fees from 5 percent to 25 percent could generate about **\$5,000 to \$25,000** annually to be allocated to the RRF. While this amount is relatively small, continued growth in this industry could increase the revenue base from aquaculture in the future; however, it could not serve as a stand-alone funding source for the RRF.

6.2.1.5 Recreational Fishing

Sport fishing is a major recreational activity in California and serves as a significant driver of economic activity, particularly in local economies with high-value recreational fisheries. However, recreational fishing can also serve as a vector for AIS. First, the use and accidental release of invertebrates and other live bait while fishing can result in AIS introductions. Another concern is the introduction of organisms that are unintentionally brought in with the packing material used to transport bait. Further, recreational fishing gear can carry AIS from one waterbody to another. Two potential funding sources related to recreational fishing include a surcharge on fishing license fees and an excise tax on recreational fishing equipment.

Recreation Fishing License Fees. Although the total number of recreational fishing licenses sold in California has decreased in recent years (approximately 1.18 million resident fishing licenses in 2009¹¹⁷), revenues from license sales have been increasing. In 2009, revenues from recreation fishing licenses and stamps totaled about \$65.3 million, up from \$54.5 million in 2005.¹¹⁸ Over this period, recreation fishing licensing revenues have averaged \$60.8 million annually. Increased revenues are attributed to the rise in licensing fees collected by CDFG, which have been indexed to inflation each year since 2005.

A surcharge could potentially be added to recreation fishing license fees to fund the RRF. A surcharge of 5 to 25 percent is considered here. A five percent licensing surcharge would yield about **\$3.0 million** per year, and at 25 percent, nearly **\$15.2 million** would be generated annually. Using the current resident fishing license as an example, the license fee would increase from \$43.46 per year to \$45.63-\$54.33 per year, resulting in a surcharge of \$2.17 to \$10.87 per license. If these incremental revenues are used for the purpose of AIS eradication and thereby result in improvements to recreational fisheries in the state, recreational anglers could benefit directly from this funding option; this conforms to the “benefit” principle presented above. Further, estimates of consumer surplus value for recreational fishing suggest that anglers may be willing to pay more for the opportunity to fish, particularly with enhancements to the quality of fisheries in the state. Public outreach efforts could be pursued to ascertain the willingness of anglers to pay this fee, while acknowledging the potential environmental and fishery benefits.

Recreation Fishing Excise Tax. In addition to fees on the opportunity to participate in recreational fishing activity (i.e., license fees), revenues can be generated by an excise tax on recreational fishing equipment and gear. There already is a federal excise tax of 10 percent on sales of sport fishing equipment by the manufacturer, including, but not limited to, rod and poles, reels, tackle, and other fishing supplies and accessories. A three percent excise tax is also levied

¹¹⁷ California Department of Fish and Game. DFG Sport Fishing License Sales Statistics. Website http://www.dfg.ca.gov/licensing/pdf/files/sf_items_10yr.pdf, accessed January 11, 2011.

¹¹⁸ Ibid.

on tackle boxes and electronic outboard boat motors.¹¹⁹ Revenues from this tax are deposited into the federal Aquatic Resources Trust Fund (commonly known as the Wallop-Breaux Fund), and are used in part to fund the Sport Fish Restoration Program, which provides funds to state agencies for land acquisition, development, research, operations and maintenance, and sport fish population management.¹²⁰ It is unlikely that additional revenues could be directed to individual states because funding allocations are based on the number of the number of licensed anglers in the state and the state's total land and water area.

However, there may be an opportunity to establish a comparable excise tax at the state level to fund the RRF. Total expenditures on sport fishing equipment in California were nearly \$327 million in 2006.¹²¹ Assuming a state-level excise tax on the sale of recreational fishing equipment was implemented at a rate between 1 and 10 percent, approximately **\$3.3 million to \$32.7 million** in new revenues could be generated and allocated to address AIS in the state.

6.2.1.6 Recreational Watercraft

Similar to commercial vessels, recreational watercraft, including boats, jet-skis and wave-runners, are significant vectors for AIS. The primary mechanisms for AIS transport are hull fouling and discharge of bilge pump water. In addition, AIS can be transported on trailers used to move watercraft from location to location. Seaplanes have also been identified as a potential vector, but the extent of seaplane activity in California is relatively limited and therefore excluded from the analysis. Potential sources of revenue from recreational watercraft users include registration fees, excise taxes, launch ramp fees, and boater education fees.

Boat & Trailer Registration Fees. Recreational watercraft and trailers must be registered within the State of California. Registration fees on watercraft are levied on a biennial basis and vary depending whether it is a new registration or renewal; the biennial renewal rate is \$20. Trailer registrations are based on a service fee of \$10 every 5 years. Registration fees are collected by the California Department of Motor Vehicles (DMV), which allocates a portion of revenues to the DBW, while retaining some revenues internally. Direct estimates of registration fees collected by DMV are not readily available; therefore, for this study, estimates have been made based on the number of boats registered in the state and registration fee levels. Between 2005 and 2009, an average of 900,500 pleasure boats was registered annually in California.¹²² If it is conservatively assumed that all registrations are renewals at an effective annual rate of \$10 per year,¹²³ existing revenue from boat registrations is about \$9 million per year. Taking into account

¹¹⁹ Internal Revenue Service. 2007. Publication 510: Excise Taxes for 2007. Website www.irs.gov/pub/irspdf/p510.pdf, accessed January 11, 2011.

¹²⁰ Congressional Research Service, Library of Congress. April 6, 2005. The Aquatic Resources Trust Fund. Website <http://www.policyarchive.org/handle/10207/bitstreams/4061.pdf>, accessed January 8, 2011.

¹²¹ U.S. Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Website http://wsfrprograms.fws.gov/Subpages/NationalSurvey/nat_survey2006_final.pdf, accessed January 8, 2011.

¹²² California Department of Boating and Waterways. Vessel Registration Reports. Website <http://www.dbw.ca.gov/Reports/VesselReg.aspx>, accessed January 9, 2011.

¹²³ Biennial registration rate of \$20 divided by 2 = \$10/year

other types of boats subject to registration requirements, out-of-state fees and new applications (subject to higher fees), this figure is likely higher. Trailer registrations are estimated to generate an additional \$1.8 million, assuming each boat has a trailer.

An increase in boat and trailer registration fees may be another option for generating revenues for the RRF. An increase in fees from 5 to 25 percent would result in boat registration renewal costs increasing from \$20 to between \$21 and \$25 biennially, and would yield approximately \$450,000 to \$2.3 million in additional revenues per year. Similarly, boat trailer registration costs would increase from \$10 to between \$10.50 and \$12.50 every 5 years, resulting in about \$90,000 to \$450,000 annually in incremental revenues. Collectively, boat and trailer registration fees could generate between **\$540,000 and \$2.7 million** for a dedicated RRF. Higher surcharges, such as those levied in other states (see below), would yield even higher revenues.

Due to the strong relationship between boating activity and transport of AIS, this funding option would likely garner support. In addition, there is precedent for boating fees to be used for AIS management in other states. For example, Minnesota implements a \$5 surcharge on all watercraft registered to fund their invasive species program. Other states assess similar types of fees, including Colorado, Oregon, Washington, and Idaho.

Excise Tax on Recreational Watercraft. Similar to the excise tax on recreation equipment, a state excise tax on recreation watercraft sales could also generate revenues to address AIS in the state. In 2009, it is estimated that total annual expenditures for new powerboats, motors, trailers and accessories was \$417 million in California.¹²⁴ Assuming a tax rate of 1 to 10 percent, a new excise tax of recreational watercraft could generate revenues of **\$4.2 million to \$41.7 million** annually.

Alternatively, the watercraft excise tax could be levied on the fair market value of non-commercial boats in California. Because the revenue base would be on all watercraft (not just new sales), the revenue potential is high. Such an excise tax is in effect in the State of Washington, where the assessment rate is 0.005 of the fair market value, with a minimum fee of \$5.00; this tax is in lieu of the property tax. However, in California, all aircraft, vessels, boats, and personal watercraft are assessable as personal property and are subject to local property tax; therefore, the viability of assessing watercraft owners with an additional tax or transferring local tax revenue to the state is low.

Launch Ramp Fee Surcharge. Many boat launch facilities throughout California are subject to a launch fee. Conceptually, a surcharge could be added to the standard launch fees to generate revenues for the RRF. However, boat launch facilities across the state are managed by an array of public agencies, as well as private entities. As such, it would be difficult to implement and collect a uniform surcharge on all facilities. It may be possible that a surcharge could be limited to state agencies that manage boat launch areas, such as California State Parks. Data are not readily available to estimate current boat launch revenues across the state, and therefore, the

¹²⁴ National Marine Manufacturers Association. 2009 Statistical Abstract. Website <http://www.discoverboating.com/info/pressrelease.aspx?id=17836>, accessed January 7, 2011.

potential revenue stream for the RRF is unknown. In addition, many boat launches are not staffed and are free.

Boater Education Fee. In California, a license is not required to operate a boat, nor is a boating safety course, although a free California Boating Safety Course is offered by DBW. (Some states do require boaters to be licensed or to have taken a boating safety course.) An option to generate revenues for DBW, as well as the RRF, is to charge a nominal fee to take the boater safety course, which could be expanded to include information of AIS prevention and management. The revenue-generating potential of this option is difficult to estimate because such a requirement is not currently in place and the extent and scope of this type of program and associated revenues are unknown.

6.2.1.7 General Recreation Activity

It is also acknowledged that a wide range of water-based recreational activities, other than fishing and boating, could facilitate the introduction and spread of AIS, including, but not limited to swimming, windsurfing, parasailing, scuba diving, and waterfowl hunting. The primary mechanism in the transport of AIS associated with these activities is via movement of recreation gear. Potential options for generating revenues from general types of recreational activities include the following:

- Parking fees at recreation areas;
- Voluntary contributions from recreationists;
- Fees on retail businesses located near developed recreation areas;
- Recreation activity surcharges (for activities subject to existing charges); and
- Excise taxes on recreational equipment (other than fishing and boating, described above).

Due to the expansive list of recreation activities and funding possibilities, as well as the limited correlation of these general recreation uses with AIS introductions, estimates of potential revenue generation using these funding mechanisms have not been developed. The theoretical limit on the extent of these types of fees and charges is the economic (or consumer surplus) value of that recreational activity. Such economic values have been estimated for many different types of recreation activity.¹²⁵

6.2.1.8 Water Deliveries

Substantial quantities of water are transported across the state to meet the needs of agricultural and M&I users. Two primary water conveyance systems are used to transport water in California –SWP and CVP – with a capacity of approximately 4 million acre-feet (AF) and 7 million AF per year, respectively.¹²⁶ These two systems facilitate movement of water from the Sacramento-San Joaquin River Delta in northern California to agricultural and municipal and industrial

¹²⁵ Loomis, John. 2005. Updated outdoor recreation use values on national forests and other public lands. General Technical Report PNW-GTR-658. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 26 p.

¹²⁶ California Department of Fish and Game. 2008. California Aquatic Invasive Species Management Plan.

interests in the San Joaquin Valley and M&I customers in Southern California, as well as other parts of the state. There are inherent risks for the spread of AIS with these water conveyance systems both within the state and out-of-state. In fact, there have been documented instances where AIS have been transported in these systems, e.g., the yellowfin goby. There are factors that limit the spread of AIS in these systems, including drinking water treatment processes for M&I deliveries and ground application of water for agricultural deliveries. However, the connectivity across the extensive network of canals, ditches, and other conveyance infrastructure make the SWP and CVP facilities important potential AIS vectors in the state.

In addition, the spread of AIS in these systems can result in substantial economic impacts to water customers. Many water contractors and agencies currently monitor for invasive species in their local conveyance systems, resulting in higher operating costs. In addition, certain AIS, like quagga mussels, have the potential to clog up water diversions and impair hydropower generation, resulting in lost production value and associated economic activity. In the case of a widespread invasion of particularly harmful AIS, there is also potential for temporary limits on water deliveries that could cause substantial economic impacts across the state.

SWP & CVP Water Deliver Surcharge. A surcharge on SWP and CVP water deliveries could be used to generate revenues for the RRF. The surcharge could be levied as a flat-rate fee on each unit of water deliveries or as a percentage charge on the cost of water paid by water contractors. For example, a \$1 surcharge on every AF of water delivered to SWP and CVP contractors would yield approximately \$8.7 million annually based on the average quantity for water deliveries by SWP (3.8 million AF, between 2007-2010) and CVP (4.9 million AF, between 2006-2010).¹²⁷ However, a flat-rate charge may cause inequities to the two sets of customers of these systems because they are subject to substantially different water charges. Water contractors served by the SWP pay on average approximately \$256 per AF, while CVP contractors pay about \$12.55 per AF based on historical water charges and payments. Therefore, it may be more equitable to levy the surcharge as a percentage of unit water costs. Assuming a 1 to 10 percent surcharge, SWP water costs could increase between \$2.56 and \$25.61 per AF and would result in approximately \$9.7 million to \$97.5 million in added revenues. For CVP contractors, water costs would increase by about \$0.13 to \$1.25 per AF, resulting in revenues of between \$616,000 and \$6.2 million. The combined revenue potential for water delivery surcharges ranges from **\$10.4 million to \$103.6 million.**

6.2.1.9 Direct Transporters and Other Illegal Activity

There is also the potential for accidental or deliberate release of AIS into aquatic environments by humans. The direct transport of AIS into the state is illegal, as is non-compliance with regulations aimed at preventing the introduction and spread of AIS in California, such as mandatory boat inspections.

Fines & Penalties related to AIS. The use of fines as a penalty for legal infractions serves as deterrent to illegal activity, such as AIS transport. Conceptually, there should be a correlation

¹²⁷ California Department of Water Resources. 2008. Bulletin 132-07: Management of the California State Water Project (Table B-5B); and U. S. Department of Interior, Bureau of Reclamation, Central Valley Operations Office, Report of Operations Monthly Delivery Tables (Table 21).

between the level of the fine and the degree of the infraction, such that offenders directly pay for their actions. Violations of applicable AIS regulations are subject to fines and penalties as outlined in the Fish and Game Code Sections 12000-12026 and California Rules of Court Rule 4.102.¹²⁸ Fines and penalties are collected by the California State Controller's Office, which disburses 50 percent of fine revenues to the state and 50 percent to the counties in which the infractions were committed. As presented in the 2011-12 California State Budget, approximately \$2.13 million in fines and additional penalties and assessments is accounted for in the various funds administered by CDFG.¹²⁹

Data on the amount of revenue generated by fines and additional penalties and assessments attributed directly to AIS-related infractions are not readily available. However, it can be argued that the fine and penalty structure for AIS-related infraction is too low, particularly in light of the potential ecological and economic damages that AIS may cause. As a result, there may be opportunities to increase the penalty levels for AIS-related violations in Fish and Game Code Sections 12000-12026 to generate additional revenue for the RRF (assuming the number of violations remains constant). However, it could be argued that higher fines would serve as a greater deterrent to illegal activity resulting in a reduction in the number of violations, and thus revenues. If this were the case, revenues would decline, but the overall objective of AIS prevention would be reinforced. Overall, it is difficult to estimate the revenue potential of this funding option.

6.2.2 Taxes and Charges on the General Population

Successful management and eradication of AIS in California would help protect and conserve natural resources and related economic activity throughout the state. The protection of the ecological and economic values of the state can be considered a public benefit, and many of the ecological features that are threatened by AIS are considered public goods (i.e., public trust resources) that provide value to society as a whole. Therefore, it may be appropriate to levy taxes and charges on the general population to generate revenues for an AIS RRF.

Because the RRF would be a state fund, it would need to be funded by taxes and charges that provide revenue at the state level. For example, property tax assessments would not be a viable funding option because property tax revenues are allocated to local cities and counties. Therefore, the discussion presented in this section considers the following options:

- General fund;
- Sales and use tax;
- Vehicle registration and license fees;
- Motor vehicle fuel tax; and

¹²⁸ Judicial Council of California, Administrative Office of the Courts. January 2009. Uniform Bail and Penalty Schedules. Website http://www.courtinfo.ca.gov/reference/documents/2009_jcbail.pdf, accessed January 9, 2011.

¹²⁹ California Governor. California State Budget, 2011-2012, 3600 Department of Fish and Game. Website <http://www.ebudget.ca.gov/StateAgencyBudgets/3000/3600/department.html>, accessed January 9, 2011.

- Bond financing

General Fund Appropriations. If a separate AIS RRF were established, the state legislature could elect to allocate money directly from the state general fund into the RRF as a direct appropriation. Alternatively, CDFG (or another state agency) could include RRF funding requirements in its annual budget, which in part is funded by general fund revenues. In essence, this funding option would be analogous to emergency funding periodically sought for AIS invasions, such as the funding for the quagga mussel response at Lake Mead. y having the RRF established, however, the funds could be in place at the time a new species is discovered resulting in time and cost savings. Such a strategy is endorsed as part of California Agricultural Vision, which states that “The State Board should work with the state’s Invasive Species Council, the California Invasive Species Advisory committee and the National Invasive Species Council to assure that, in formulating its final Strategic Framework for Protecting California from Invasive Species, it develops a comprehensive strategy supported by an adequate and stable source of funding. At a minimum, the strategy should evaluate the possibility of dedicating a percentage of the state’s general fund to invasive species.”¹³⁰ The drawback to this source is that funding levels would be potentially subject to substantially large variations from year to year. Also, because of the ongoing state budget deficit, obtaining funds directly from the general fund may prove difficult. However, this option can be written into the legislation establishing the RRF, which would provide the flexibility to use general funds in the future.

General fund revenues have been used for AIS in other states. The invasive species fund established by the Idaho Invasive Species Act of 2008 is an example of this type of funding. In that case, the fund was established in the state treasury and “receives such appropriations as deemed necessary by the governor and the legislature to accomplish the goals” of the Act.¹³¹ Other examples of direct funding include the Idaho Legislature providing funding for Eurasian watermilfoil control and the Utah Legislature appropriating \$2.5 million general funds, of which \$1.4 million is ongoing, to allow the Utah Division of Wildlife Resources to conduct an AIS program.

Sales and Use Taxes. Sales and use taxes at the retail level represent a significant source of revenue at the state and local level. The total statewide base sales and use tax rate is 8.25 percent; of this, 6.0 percent goes to the state general fund, a combined 1.25 percent goes to various funds administered at the state level,¹³² and 1.0 percent goes to local counties.¹³³ In 2006-2007, the

¹³⁰ American Farmland Trust. December 2010. California Agricultural Vision: Strategies for Sustainability. Report to the California Department of Food and Agriculture and the State Board of Food and Agriculture. Website http://www.cdfa.ca.gov/agvision/docs/Ag_Vision_Final_Report_Dec_2010.pdf, accessed March 1, 2011.

¹³¹ The invasive species fund established by the Idaho Invasive Species Act of 2008 is an example of this type of funding. In that case, the fund was established in the state treasury and “receives such appropriations as deemed necessary by the governor and the legislature to accomplish the goals” of the Act. Website <http://www.legislature.idaho.gov/idstat/Title22/T22CH19SECT22-1911.htm>, accessed March 1, 2011.

¹³² Includes: 0.25% for State’s Fiscal Recovery Fund (to pay off Economic Recovery Bonds (2004)); 0.50% for Local Public Safety Fund to support local criminal justice activities; and 0.50% for Local Revenue Fund to support local health and social services programs.

¹³³ Includes: 0.25% for county transportation funds and 0.75% for city and county operations.

state realized approximately \$53.3 billion in sales and use tax revenues,¹³⁴ which accrued primarily to the general fund. The potential use of general fund appropriations for the RRF is outlined above. However, an incremental increase to the sales and use tax rate could be implemented specifically to generate revenues for the RRF. For the purposes of an AIS RRF, the incremental tax increase would need to be relatively small to correlate to target funding levels. For this analysis, potential sales tax increases of 0.0025 percent to 0.025 percent were evaluated. Based on these rates, approximately **\$17.0 million to \$169.6 million** could be generated on an annual basis to fund the RRF.

Vehicle Registration and License Fees. An increase in vehicle registration and license fees represents another approach to charge AIS costs to the broader public. Vehicle registration and license fees are collected annually by DMV from residents that own motor vehicles in the state. Although distinct, the two fees are collected jointly as part of registration fees due annually. The current vehicle registration fee is \$34 per year.¹³⁵ The vehicle license fee (VLF) was established by the Legislature in 1935 in lieu of a property tax on vehicles. The VLF assessment is based upon the market value of the vehicle as determined by the DMV, and has been assessed at a rate of 1 percent annually since 1999. Prior to 1999, the assessment rate was 0.65 percent. The portion of the rate in excess of 0.65 percent is deposited into the state general fund; the incremental increase to generate revenues accruing to the general fund is set to expire in 2011.¹³⁶

Registration and VLF fees represent an important source of revenue for state government. Between 2003 and 2007, annual registration fee revenues have averaged \$2.5 billion and VLF revenues have averaged \$2.1 billion.¹³⁷ One or both of these fees could be increased to fund the RRF. The incremental fee increase could take the form of percentage or flat fee surcharge to the existing fee structure. If registration fees were increased by 1.0 to 10.0 percent (i.e., from \$34 to \$34.34-\$37.40 per year), approximately \$9.6 million to \$95.5 million could be generated annually. A comparable percentage increase in VLF fees would result in an effective assessment rate of 1.01 to 1.10 percent and would generate about \$21.4 million to \$213.7 million per year.

Alternatively, a flat-fee surcharge could be added to each vehicle registered in California. The average number of vehicle registrations in California between 2003 and 2007 is nearly 28.1 million.¹³⁸ A surcharge of \$1 to \$10 applied to annual vehicle registrations is estimated to generate approximately **\$28.1 million to \$280.8 million** per year. This funding option is similar to California Proposition 21 in the 2010 election, which was rejected by voters. This measure would have established an \$18 annual state vehicle license surcharge and would have provided

¹³⁴ California Department of Finance, Economic Research Unit. 2009. 2008 California Statistical Abstract. Website http://www.dof.ca.gov/html/fs_data/stat-abs/statistical_abstract.php, accessed January 15, 2011.

¹³⁵ California Department of Motor Vehicles. Vehicle Registration and Vessel Fees. Website http://dmv.ca.gov/vr/fees/reg_fees.htm, accessed January 15, 2011.

¹³⁶ California Department of Motor Vehicles. Revenue and Taxation Code Section 10752. Website <http://dmv.ca.gov/pubs/vctop/appndxa/revtax/rvtax10752.htm>, accessed January 15, 2011.

¹³⁷ California Department of Finance, Economic Research Unit, 2009, op. cit.

¹³⁸ California Highway Patrol. Statewide Integrated Traffic Records System (SWITRS), 2008 Annual Report of Fatal and Injury Motor Vehicle Traffic Collisions. Website <http://www.chp.ca.gov/switrs/>, accessed January 15, 2011.

free admission to all state parks to surcharged vehicles. The surcharge revenues would have been deposited in a new trust fund called the *State Parks and Wildlife Conservation Trust Fund*, with use of the fund restricted to state parks and wildlife conservation. The \$18 surcharge would have generated about \$500 million in revenues annually for the trust fund, with savings to the general fund and other special funds up to \$200 million annually. Based on recent election results, this funding option may prove difficult to implement.

Motor Vehicle Fuel Taxes. In California, motor vehicle fuel is taxed at both the federal and state level. The federal excise tax on fuel is \$0.18 per gallon. The state fuel tax is \$0.353 per gallon, which was increased in 2010 from \$0.18 per gallon in conjunction with a decrease in the sales tax on fuel.¹³⁹ On average, approximately 15.3 billion gallons of fuel are sold in California every year.¹⁴⁰ Prior to the tax increase, state fuel tax revenues averaged approximately \$3.4 billion per year (based on 2005-6 and 2006-7 data).¹⁴¹ With the recent increase, fuel tax revenues are expected to be substantially higher.

A surcharge to the state fuel tax could generate substantial revenue for the RRF. It is estimated that a relatively modest surcharge of 0.1 cents to 1 cent (\$0.001-\$0.01) per gallon of fuel would generate about **\$15.3 million to \$153.4 million** in new fuel tax revenues on an annual basis.

Bond Financing. California has used bond financing extensively as a funding tool for conservation in the past. A sample of recent bond financing programs implemented by the California Resources Agency includes:¹⁴²

- Proposition 1E - The Disaster Preparedness and Flood Protection Bond Act of 2006;
- Proposition 12 - Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Act of 2000;
- Proposition 13 - Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Bond Act;
- Proposition 40 - California Clean Water, Clean Air, Safe Neighborhood Parks, and Coastal Protection Act of 2002;
- Proposition 50 - Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002; and
- Proposition 84 - Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006.

¹³⁹ California Board of Equalization. Fuel Taxes Division – Tax Rates. Website <http://www.boe.ca.gov/sptaxprog/spfdrates.htm>, accessed January 15, 2011.

¹⁴⁰ California Board of Equalization. Net Taxable Gasoline Gallons. Website http://www.boe.ca.gov/sptaxprog/reports/MVF_10_Year_Report.pdf, accessed January 15, 2011.

¹⁴¹ California Department of Finance, Economic Research Unit, 2009, op. cit.

¹⁴² California Natural Resources Agency. Resources Agency Bonds Program. Website <http://resources.ca.gov/bonds.html>, accessed January 12, 2011.

Most of the conservation-based bond measures passed in California are used to fund large-scale regional programs and projects. For example, bond funding outlined under Proposition 84 totals nearly \$5.4 billion spread over eight broad project areas, including water quality; flood control and subventions; statewide water planning and design; protection of rivers, lakes and streams; forest and wildlife conservation; protections of beaches, bays and coastal waters; state parks and natural education facilities; and sustainable communities/climate change. It is unlikely that the AIS RRF would be large enough to require bond financing on its own, and further, it would require voter approval. However, there may be opportunities for grant funding for the RRF from these larger bond measures for the distinct purpose of early response and eradication of AIS in the state. No revenue estimates have been developed for this study, however.

6.2.3 Grant Funding & Contributions

The RRF could also seek additional funding through grant programs at the state and federal level as outlined in Strategy 1C1 in the CAISMP. In fact, federal law¹⁴³ enables state governors to request federal assistance for up to 75 percent of the cost incurred to implement state aquatic invasive species management plans. Because rapid response planning and funding are clearly goals of the California plan, these federal grant monies may be a viable source of funding for the RRF. Alternatively, state-funded monies from an RRF could be used as a source of matching funds for other federal grant programs (see Strategy 1C of the CAISMP).

However, grant funding represents “soft” money that cannot serve as a reliable funding option, and using state grants to fund the RRF is a zero-sum game for California. Further, the pursuit of grant funds may be inefficient, requiring the diversion of staff time to grant solicitation rather than RRF management. To effectively pursue grant funding, the RRF administrative structure may need to include a funding development specialist to track and apply for available grant opportunities (see Strategy 1C5). Because the probability of securing grant funding is unknown, potential grant revenues for the RRF are unknown.

6.3 Summary of Funding Options

There is a wide range of potential funding sources for an AIS RRF (Table 6-2), each with its own advantages and disadvantages. Identifying the most viable options is a complex process. Funding options that are tied directly to entities that are either AIS vectors or beneficiaries of AIS control might be most acceptable. Adoption of new or increased fees or taxes should consider the ability to pay so that financial burdens are not excessive.

¹⁴³ The Nonindigenous Aquatic Nuisance Prevention and Control Act (1990).

Table 6-2 Summary of Potential Funding Sources for AIS RRF

Source	Responsible Entity	Funding Estimate		Notes
		Low	High	
CA Marine Invasive Species Program – Fund Allocation	Shipping Industry	\$587,000	\$1,174,000	10%-20% allocation of existing fee revenues
CA Marine Invasive Species Program – Ballast Water Fee Increase	Shipping Industry	\$345,000	\$1,036,000	Increase in fee from \$850 to \$900-\$1,000 per voyage
Port Capacity Charge – Per 20-foot Equivalent Container	Shipping Industry	\$17,000,000	\$85,000,000	\$1-\$5 charge per 20-foot equivalent container; at southern California ports only
Port Capacity Charge – Per Gross Tonnage	Shipping Industry	\$17,684,000	\$176,842,000	\$0.10-\$1.00/ton charge
Cruise Passenger Excise Tax	Cruise Passengers	\$11,119,000	\$55,594,000	\$10-\$50/passenger charge
Cruise Passenger Voluntary Donations	Cruise Passengers	\$1,112,000	\$6,671,000	\$10-\$60/passenger donation and 10% participation rate
Commercial Fishing Landings Tax	Fishing Industry	\$1,191,000	\$4,926,000	Increase in tax rate on fish land values from approx. 1% to 2-5%
Commercial Fish Business License Fee	Fishing Industry	\$40,000	\$200,000	5-25% increase in fees
Commercial Fishing License and Permit Fees	Fishing Industry	\$173,000	\$863,000	5-25% increase in fees
Aquaculture License Fees	Aquaculture Industry	\$5,000	\$25,000	5-25% increase in fees
Recreation Fishing License Fees	Anglers	\$3,038,000	\$15,190,000	5-25% increase in fees
Recreational Fishing Equipment Excise Tax	Anglers	\$3,270,000	\$32,698,000	New excise tax at rate of 1-10%
Recreation Watercraft and Trailer Registration Fee	Boaters	\$540,000	\$2,701,000	5-25% increase in fees
Recreational Watercraft Excise Tax	Boaters	\$4,170,000	\$41,700,000	New excise tax at rate of 1-10%
Boat Launch Ramp Fees	Boaters	<i>Unknown</i>	<i>Unknown</i>	Data not available to estimate
Boater Education Fee	Boaters	<i>Unknown</i>	<i>Unknown</i>	Data not available to estimate

		Funding Estimate		
General Recreation Activity – Various Fees and Charges	Varies	<i>Unknown</i>	<i>Unknown</i>	Not estimated
CVP/SWP Water Delivery Surcharge	Water Contractors	\$10,363,000	\$103,631,000	Surcharge of 1-10% on existing water rates
Direct Transport and Other Fines and Penalties	Varies	<i>Unknown</i>	<i>Unknown</i>	Data not available to estimate
General Fund - Direct Appropriations	Public	<i>Unknown</i>	<i>Unknown</i>	Not estimated
Sales Tax Revenues	Public	\$16,957,000	\$169,575,000	Sales tax rate increase of 0.0025% to 0.025%
Motor Vehicle Registration or Vehicle License Fees	Public	\$28,085,000	\$280,845,000	\$1-\$10 surcharge on vehicle registrations
State Fuel Tax	Public	\$15,335,000	\$153,353,000	0.1 - 1 cent surcharge
Conservation Bonds	Public	<i>Unknown</i>	<i>Unknown</i>	Not estimated
Grant Funding	Public	<i>Unknown</i>	<i>Unknown</i>	Not estimated

Chapter 7

Administrative Scenarios

A key purpose of this study is to consider different scenarios for administration of the Rapid Response Fund (RRF). Discussion below considers fund administrators (§7.1), the funding decision-making structure (§7.2), funding eligibility and criteria (§7.3) and fund management (§7.4).

7.1 Fund Administrator

Efficient fund administration will require a program coordinator within a state agency who would be responsible for all administrative duties related to the fund. CDFG might be an appropriate home for this program, since it serves as the state's coordinating agency for AIS activities, leads the CAAIST, and organized the development of the CAISMP.¹⁴⁴ One option would be to make the RRF program coordinator a staff position reporting to the CDFG Invasive Species Program Manager.

7.2 Financial Management

It is recommended that the RRF be established as a nonlapsing revolving fund from which moneys are paid for critical AIS eradication and control programs and into which moneys are deposited from the funding sources selected. The moneys in the RRF should be carried as a separate account in the California state treasury, and be invested in instruments comparable to other treasury funds. Earnings on moneys in the fund should accrue back to and be deposited in the fund. Any moneys remaining in the fund at the end of a fiscal year should be carried over fully to the following fiscal year.

7.3 Institutional Structure for Funding Decisions

7.3.1 Single Agency or Multiple Entity Structures

Possible institutional structures to be used for deciding which projects to fund range from keeping decision-making authority in the hands of a small number of individuals (or even a single individual) within a single agency to a large, multiple entity panel. The key benefit of a single agency structure is the potential for making quicker decisions on which rapid response proposals to fund, though it could also modestly reduce administrative costs. The benefits of a multiple entity panel include decision-making based on broader knowledge, experience and/or perspectives: broader buy-in by more entities and better support for the program; better coordination among entities to assist funded responses; the development of greater AIS rapid response awareness and judgment in multiple agencies; building more stable institutional knowledge and experience for fund decisions; and guarding against agency capture of the fund

¹⁴⁴ California Department of Fish and Game. 2008. California Aquatic Invasive Species Management Plan.

(i.e. the administering agency awarding most of the funds to its own proposals) or misuse of the fund (awarding funds to projects that address agency priorities other than rapid response).

A multiple-entity panel could be composed of representatives from state agencies, but could also include representatives or advisors from federal or local agencies, AIS scientists or managers, or stakeholder representatives. However, it is recommended that such a panel be predominantly composed of individuals with substantial experience in AIS management, including rapid response and eradication efforts. It is possible that CAAIST or AISWG, or a subcommittee from one of those groups, could serve as the decision-making panel. Alternately, a separate panel could be formed drawing on individuals with the appropriate experience and knowledge.

7.3.2 Timing of Decision-making

Because timing is critical for AIS rapid response. Hence, regardless of the institutional structure used for decisions about funding, the decision-making parties should meet either on a regular and frequent basis (e.g. at least quarterly or even monthly), or on an “as-needed” basis, to make prompt funding decisions on proposed rapid response projects.

7.4 Funding Eligibility and Criteria

This section discusses RRF fund eligibility requirements, and criteria to prioritize eligible requests for RRF funding. The pros and cons of some alternative criteria are discussed.

7.4.1 Entities Eligible for Funding

In California, the types of activities that would be eligible for RRF funding, including eradication efforts, have been undertaken by many types of entities. These include federal, state and local agencies; non-profit organizations and associations; academic programs; and for-profit consulting firms and other businesses (e.g. see Tables 7-1 and 7-2 on the entities that have managed eradication projects in California’s marine waters). This arises in part because AIS may turn up in waters under many jurisdictions (e.g. in state or federal parks or forests, on lands administered by local park or water districts, in open space owned or managed by nonprofit organizations, or on private lands). In many cases too, non-governmental agencies may be able to respond more quickly or implement responses less expensively than government agencies. For these reasons, it is recommended that there be no constraint on what types of parties are eligible to receive funding from the RRF.¹⁴⁵

¹⁴⁵ There may, however, be some circumstances in which RRF funds are more properly provided as a loan. For example, an entity has clear responsibility for completing certain work that is needed for interim containment of an AIS, but cannot mobilize funds quickly enough, it might be in the state’s interest for the RRF to provide gap funding in the form of a loan.

Table 7-1 Management of Implemented and Planned Eradication Efforts in California Marine Waters

Species Name	Location	Agency/Organization	Organization Type
<i>Caulerpa taxifolia</i>	Aqua Hedionda Lagoon	Merkel & Associates	Private
<i>Caulerpa taxifolia</i>	Huntington Lagoon	Merkel & Associates	Private
<i>Ascophyllum nodosum</i>	San Francisco Bay	NOAA Restoration Center; Smithsonian Environment Research Center	Federal
<i>Ascophyllum nodosum</i>	San Francisco Bay	NOAA Restoration Center; Smithsonian Environment Research Center	Federal
<i>Undaria pinnatifida</i>	Santa Catalina Island	UC Berkeley-Jepson Herbarium; CDFG	Academic; State
<i>Undaria pinnatifida</i>	Monterey Harbor	NOAA; Monterey Bay National Marine Sanctuary; Monterey Bay Sanctuary Foundation	Federal, Nonprofit
<i>Undaria pinnatifida</i>	San Francisco Bay	NOAA; Smithsonian Environment Research Center	Federal
<i>Zostera japonica</i>	Humboldt Bay	CDFG; Sea Grant; Ducks Unlimited	State; Federal; Nonprofit
<i>Zostera japonica</i>	Eel River Estuary	CDFG; Sea Grant; Ducks Unlimited	State; Federal; Nonprofit
<i>Spartina alterniflora</i>	Humboldt Bay	CDFG	State
<i>Spartina alterniflora</i>	Drakes Estero	?	?
<i>Spartina alterniflora</i>	Bolinas Lagoon	?	?
<i>Spartina alterniflora</i>	San Francisco Bay	SCC, Invasive Spartina Project, USFWS, East Bay Regional Park District, Alameda County Flood Control District, San Mateo County Mosquito Abatement District, Cities of Palo Alto, Alameda and San Leandro, California Wildlife Foundation	State, Federal, Local, Private, Nonprofit
<i>Spartina anglica</i>	San Francisco Bay	SCC, Invasive Spartina Project	State, Private
<i>Spartina densiflora</i>	Humboldt Bay	Humboldt Bay National Wildlife Refuge	Federal
<i>Spartina densiflora</i>	Eel River estuary	SCC	State
<i>Spartina densiflora</i>	Mad River Estuary	SCC	State
<i>Spartina densiflora</i>	Tomaes Bay	Hog Island Oyster Company	Private
<i>Spartina densiflora</i>	Tomaes Bay	?	?
<i>Spartina densiflora</i>	San Francisco Bay	SCC, Invasive Spartina Project, East Bay Regional Park District, Friends of Corte Madera Creek Watershed	State, Private, Local, Nonprofit
<i>Spartina patens</i>	San Francisco Bay	SCC, Invasive Spartina Project, California State Parks	State, Private
<i>Salsola soda</i>	Bodega Harbor	UC Davis?	Academic?
<i>Salsola soda</i>	Limantour Estero	USFWS	Federal
<i>Limonium ramosissimum</i>	San Francisco Bay	Bay Area Early Detection Network	Nonprofit
<i>Avicennia marina</i>	San Diego Bay	UC San Diego?	Academic?

Species Name	Location	Agency/Organization	Organization Type
Avicennia marina	San Diego Bay	UC San Diego?	Academic?
Avicennia marina	San Diego Bay	UC San Diego	Academic
Terebrasabella heterouncinata	Cayucos	UC Santa Barbara; CDFG?	Academic; State?
Batillaria attramentaria	San Francisco Bay	The Bay Institute, Smithsonian Environment Research Center	Nonprofit; Federal
Littorina littorea	San Francisco Bay	UC Davis	Academic
Littorina littorea	San Francisco Bay	Center for Research on Aquatic Bioinvasions	Private
Littorina littorea	Anaheim Bay	UC Davis	Academic
Crassostra gigas	San Francisco Bay	San Francisco Estuary Institute; Center for Research on Aquatic Bioinvasions	Nonprofit; Private
Carcinus maenas	Tomales Bay	UC Davis	Academic

Table 7-2 Management of Implemented and Planned Eradication Efforts in California Marine Waters, by Organization Type

Organization Type	Number of Organizations Involved	Number of Projects they are Involved in	Percent of Projects they are Involved in
Federal Government	7	10	29%
State Government	3	11	32%
Local Government	7	2	6%
Academic Institution	4	9	26%
Nonprofit Organization	7	8	24%
Private Business	4	8	24%
Unknown	-	3	9%
Total	33	-	-

Task 4 of the Draft California Rapid Response Plan¹⁴⁶ calls for developing “a protocol for responding to a private entity or local government agency that wants to conduct a rapid response under its own direction but requests assistance or permits from one or more agencies signatory to the statewide Rapid Response Plan.” Opening the eligibility for RRF funding to all entities would address that issue.

7.4.2 Eligible Activities

As defined in §1.1.2, rapid response consists of actions taken while there is a realistic potential for eradication or long-term containment of an isolated AIS population and which contribute to

¹⁴⁶ Appendix A of the CAISMP, at p. 17.

or support either eradication or initial or interim containment. An “isolated AIS population” is an AIS population in a part of a water system that is sufficiently isolated from other populations of the AIS that it would not be readily re-invaded if eradicated (§1.1.3). Consistent with these definitions, partial or full funding for the following actions could be eligible for funding from the RRF:

- Surveys to determine the spatial extent, abundance or reproductive status of an isolated AIS population, if needed to support an eradication or containment effort;
- Analysis and assessment to determine whether to attempt to eradicate or contain an isolated AIS population;
- Initial containment of an isolated AIS population, that is, containment actions to prevent spread of the population while determining whether to attempt eradication or longer-term containment;
- Planning, environmental documentation and/or permit acquisition needed to eradicate or contain an isolated AIS population;
- Interim containment of an isolated AIS population, that is containment actions to prevent spread of the population during the planning, environmental documentation or permit acquisition activities needed for eradication or longer-term containment, during the implementation or assessment of an eradication effort, or until a long-term containment effort can be put in place with funding from sources other than the RRF;
- Implementation of an effort to eradicate an isolated AIS population;
- Follow-up surveys or monitoring during a defined period to assess whether the eradication effort has been successful; and
- Public outreach or agency coordination needed to support the above actions.

Actions that would not be eligible for RRF funding include:

- Eradication or containment efforts that do not target an isolated AIS population;
- Control efforts that are not intended or expected to result in the eradication of an isolated AIS population;
- Actions to mitigate the impacts of AIS on facilities or other resources;
- Surveys or monitoring that are not needed either to support an eligible eradication or containment effort or to assess the success of an eligible eradication effort;
- Analysis, assessment, planning, environmental documentation or permit acquisition that is not necessary to support an eligible eradication or containment effort;
- Long-term containment or any containment effort that is not initial containment or interim containment as defined above; and
- Any public outreach or agency coordination that is not necessary to support the eligible activities described above, including public outreach about AIS in general and public outreach about the particular AIS species that is the target of eligible activities if it is not specifically needed to support those activities.

It is recognized that many activities defined as not eligible may be highly important and beneficial activities, but they are nonetheless outside the scope of RRF funding.

Rapid response as defined in this report thus covers a variety of activities supporting and leading up to a decision to attempt eradication, a decision to attempt long-term containment, or a decision to do neither of these. If a decision is made to attempt eradication or long-term containment, interim containment would be included in rapid response activities, as well as implementing and assessing the success of an eradication effort.

The question arises as to when a long-term containment strategy might be a good option, given the possibility that containment would fail at some point, and that successful containment activities would need to be maintained in perpetuity. One type of circumstance in which this might arise is if eradication is very expensive and containment is both highly effective and has low annual costs, so that even when maintained in perpetuity the present value of the total containment cost would be less than the cost of eradication. It is unclear whether this would ever occur, however, as eradication is likely to be most expensive when the target population is widespread or is present in a large water body, but in these cases containment is unlikely to be inexpensive.

A second possible circumstance is when eradication is simply not possible and the expected impacts from further spread of the AIS are extremely large, so that even if long-term containment is very expensive it might nonetheless be the best option available. An example might be the recent invasion of several southern California water bodies by quagga mussels, where the consequences of spread to other parts of California may be so high that expensive long-term containment measures may be justified. But it is hard to imagine such circumstances occurring often.

Thus, although actions that support and lead to the implementation of long-term containment are included in the definition of rapid response, circumstances where that would be a good option are probably rare. This report has therefore focused on eradication as a major component of rapid response. This is consistent with the approaches of other agencies and authorities, whose definitions of rapid response often focus on eradication.¹⁴⁷

7.4.3 Limits on Award Size

The typical and maximum size of grants will be determined in part by the size of the RRF (see Chapter 5, especially §5.1.3.3 on Funding Scenarios) and the scope of activities that it is intended to support. Since the RRF is intended to support essentially emergency responses to situations that are largely unpredictable, it is not recommended that the RRF set an absolute maximum limit on the size of individual grants. Rather, it is recommended that potential applicants be provided with guidance on the typical size of grants and on the normal maximum grant award barring extraordinary circumstances. These limits should be adjusted over time based on the RRF's funding experience and inflation.

¹⁴⁷ See, e.g., in Table 1-1: New York State Department of Environmental Conservation, 2005.; Washington State Aquatic Nuisance Species Committee, 2005; Maine Department of Environmental Protection, 2006; and Locke and Hanson, 2009,

It is recommended that normal grant limits be set sufficiently high to fully fund the cash needs of smaller rapid response projects, those which are small enough such that finding and obtaining funding from multiple sources would substantially increase the proportion of effort and cost that goes to administration. If these smaller projects are forced to obtain funding from multiple sources, the potential for delay is increased, which could substantially increase costs or side effects and reduce the chance of success. The RRF should attempt to provide full funding for projects up to at least the \$100,000-\$300,000 range, if total RRF funding permits this, and expect to provide only partial or start-up funding for larger projects. Data and experience suggest there may even be a significant number of projects—involving the hand removal and disposal of an AIS from a small, isolated site—that could be completed for a few tens of thousands of dollars.

7.4.4 Scope of Response Plan and Phasing

As discussed above, the RRP should address the containment or eradication of an entire isolated AIS population. In some invasion situations, however, the need to respond quickly may preclude developing a single project that covers all parts of such a population or effort. It may be more feasible to assemble a proposal for and to begin to address certain elements, while other more complicated or more challenging aspects might require further thought or additional work before a suitable project proposal could be put together. If funding the first part is delayed until the proposal for the second part is developed, spread of the AIS in the interim could increase the overall costs of the response or reduce the probability of success. Thus, in some cases it may be appropriate for the RRF to provide funding for the initial part of the work, even if planning for the later part is incomplete.

For example, in the *Limonium ramosissimum* situation described in §1.1.3, it might be appropriate to fund and execute the project in phases. A first phase could focus on the removal of the population from the marshes to prevent its spread to additional marsh sites; and also investigate the distribution of *L. ramosissimum* along creeks in the watershed and possible mechanisms for preventing its sale and planting in the watershed. The second phase would then focus on removing and preventing the replanting of *L. ramosissimum* in the watershed upstream of the marshes.

With a phased project, the RRF's funding decision-makers should consider whether there is, given the circumstances, a sufficiently comprehensive and realistic overall plan to address all the necessary aspects of response (even if some details on the later aspects are lacking). If the remaining phase(s) are not expected to be funded from the RRF, they should also consider whether other sources are likely to provide the additional funding. A thoughtful overall plan, and a reasonable estimate of any additional funding needs and where the additional funding would come from, should accompany a proposal for initial funding.

7.4.5 Probability of Success

The rationale for funding an eradication or containment effort is strengthened if the probability of success is high or if the expected impacts from the invasion if not eradicated or contained are large. The rationale is weakened if the expected side effects (negative impacts) from the

eradication or containment effort are large or if the expected cost of the effort is high. Expressed as a conceptual model, this is¹⁴⁸:

$$\text{Support for Eradication/Containment Effort} = \text{Probability of Success} \times \text{Expected Invasion Impacts} \\ \text{Expected Side Effects} + \text{Costs}$$

The estimated probability of success is thus an important element in prioritizing among proposed efforts. In general, the probability of success can be assessed based on such factors as the abundance, distribution and biology of the target species in relation to the potential effectiveness of the eradication or containment plan. Important considerations include the size and spatial extent of the target population and the certainty with which these are known; how the water body containing the target population is connected to other waters; the fecundity and dispersive capabilities (both natural and anthropogenic) of the target species; the difficulty of finding all individuals in the target population or effectively exposing them to the control method; the specific effectiveness of the control method; and the success or failure of efforts to eradicate or contain the AIS in other locations.

7.4.6 Establishment Status

In some cases, eradication or other response activities may be proposed for a target population whose known abundance and distribution are so limited that it may be unclear whether it is established—that is, whether it might die out on its own even if no response is implemented. In that case, funds spent on the response would bring no benefit, and to the extent that the response activities have negative side effects, could do harm. On the other hand, if one were to wait until it became clear that the AIS population was established, at that point containment or eradication would tend to be more costly and have greater side effects, and might be impossible.

In marine/estuarine situations particularly, because of the connectedness of water bodies and the high fecundity and large capacity for larval dispersal in many species, it may often be that by the time it is clear that an AIS population is established it will be too late to eradicate or contain it. In addition, as early detection capabilities are improved, we will be faced with an increasing number of decisions in both marine and fresh waters about implementing response or eradication efforts at an early invasion stage when the target population may not in fact be established and any expenditure of funds on these activities might simply be unnecessary.

The RRF's funding decision-makers will need to decide on an approach to these situations. Funding responses when the known target populations are very small and might die out on their own may risk wasting funds, but waiting until these populations are larger and more clearly established may increase costs and side effects and miss opportunities to stop large-scale invasions before they become unmanageable. Generally, for low cost eradication efforts targeting very limited AIS populations that have regional significance, the value of stopping even a single large invasion when it is still small would likely outweigh the cost of funding a large number of such eradication efforts. It is therefore recommended that the funding decision-makers not be too influenced by uncertainties about whether an AIS population is established when

¹⁴⁸ Bax, N., J.T. Carlton, A. Mathews-Amos, R.L. Haedrich, F.G. Howarth, J.E. Purcell, A. Rieser and A. Gray. 2001. The control of biological invasions in the world's oceans. *Conservation Biology* 15:1234-1246.

considering proposed eradications of small AIS populations, especially when these involve methods with limited side effects and low costs (such as may be the case with removing small populations by hand). Rather, it is recommended that eradication efforts generally be supported in cases with small populations whose establishment is still uncertain.

7.4.7 Probability of Reintroduction

The potential for the re-introduction and re-invasion of an AIS after eradicating a population should be considered when assessing an eradication proposal. If re-introduction is likely, a proposed eradication should rank higher as a candidate for funding if it is part of a realistic plan that includes measures to reduce that likelihood (though such measures might not be part of rapid response or funded from the RRF). The earlier discussion of *Limonium* provides an example of a situation where consideration of the potential for re-introduction is highly relevant to assessing eradication plans.

7.4.8 Regional Significance

A rapid response proposal should be given a higher priority for funding if it targets a sole known population of an AIS in California or in the region, compared to a proposal targeting one of several known populations of an AIS species in the region. The reduction in the risk of spread and large-scale impacts is greater (and thus the value of the avoided impacts larger) from eliminating or containing a sole population in the region compared to eliminating or containing one of many.

7.4.9 Invasion History

Although the science on the topic is highly uncertain, the best indicator of whether an AIS discovered in a region is likely to have large impacts (a factor in the conceptual model described above) is probably its past history of invasion. Thus, past invasion history should be given some, but not too much weight in assessing rapid response proposals. RRF administrators should bear in mind that sometimes species with no invasion history at all may have very large impacts, for example the massive invasion of San Francisco Bay by the Asian or Overbite Clam *Corbula amurensis*, and ensuing large-scale changes in phytoplankton blooms and trophic dynamics. Conversely, impact predictions made from the behavior and impacts of a species in one ecosystem may not apply to circumstances in another ecosystem. For example, predictions made in the 1990s that the Green Crab *Carcinus maenas* would quickly reach great abundance and decimate the West Coast shellfish industry—based on its impacts in New England and elsewhere—have not come true.

Daehler and Strong¹⁴⁹ assert that beyond taking the natural history of an invader into account (e.g., whether it has an effective method of dispersal), there is little predictive power to be gained based on AIS life history characteristics or on models of AIS interactions with target communities. It is recommended that this perspective be taken regarding funding decisions from the RRF, that is, placing less weight on which AIS are thought to be more “invasive” and more

¹⁴⁹ Daehler, C.C. and D.R. Strong. 1993. Prediction and biological invasions. *Trends in Ecology and Evolution* 8(10): 380.

weight on which response efforts are most likely to be successful at reasonably low cost and with limited side effects.

7.4.10 Side Effects

Surveys, containment efforts, and eradication efforts can all have negative impacts on the ecosystems in which they occur. The potential for impacts from biocide applications or releases of biocontrol agents are obvious and extensively addressed in the scientific and environmental management literature. However, even such activities as surveying or removing organisms by hand may have significant impacts if they involve entry into sensitive habitats. In general, however, work done on invasions of limited extent in less sensitive habitats is unlikely to have large or widespread negative impacts. (An exception is the release of non-native biological control agents, which even if done in relatively small numbers over a small area, carry a risk of reproduction and spread over large areas.) The potential for side effects should be assessed and considered in accordance with the conceptual model described earlier.

7.4.11 Independent Oversight of Eradication Efforts

Eradication efforts are necessarily exercises in adaptive management. That is, eradication plans may need to be rapidly modified depending on the spread of the invasion, the response of the invader to the control methods, discoveries of new infestations, and other factors. Because of these factors, along with the use of public funds and the potential for negative environmental impacts from eradication actions, it is recommended that higher rankings be given to eradication proposals that include provisions for some degree of independent oversight, at least for projects of significant size (perhaps projects requiring at least \$100,000). Oversight could be provided by an advisory panel of appropriate scientists, resource managers and others. To ensure independence, these should not be employed by the organization conducting the eradication. The nature, extent and frequency of the oversight should be commensurate with the nature and budget of the project.

7.4.12 Other Criteria

Other factors will be important in funding decisions, e.g.:

- The clarity, completeness and overall quality of the proposal;
- The qualifications of the proponents including their experience with and past performance on rapid response projects;
- Whether the budget is appropriate for the work proposed; and
- Whether necessary permits have been or are likely to be obtained.

The overall value received (the value, quality and extent of work that will be done relative to the funds requested from the RRF) plus the specific need for RRF funding (whether the response would be implemented effectively, or at all, without RRF funding) should be the overall decision criteria. It is not recommended that specific priority or higher scores be given for such extraneous elements as the number of collaborators, whether there is a certain percentage of matching funds or in-kind contributions, whether volunteers are used, or whether there is education or outreach value other than what is needed to implement the response. Rather, such elements should be considered only in terms of their contribution to the overall value of the rapid

response produced. The critical importance of effective rapid response argues for basing funding decisions on the value of the response obtained for a given amount of funding, rather than on extraneous considerations.

Chapter 8

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