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Managing Nonnative Invasive Species: A CALFED Bay-Delta Program Strategic Plan for the San Francisco Bay-Delta Estuary/Sacramento-San Joaquin Rivers and Associated Watersheds

CALFED Member Agencies:

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California -

Department of Fish and Game
Department of Water Resources
California Environmental Protection Agency
State Water Resources Control Board

Federal - National Marine Fisheries Service

Environmental Protection Agency
Fish and Wildlife Service
Bureau of Reclamation
Army Corp of Engineers
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SUMMARY

The purpose of this Nonnative Invasive Species (NIS) Strategic Plan is to provide guidance for management actions to prevent introductions, provide control and mitigate impacts of nonnative species that have invaded or may invade the ecosystems of the San Francisco Bay-Delta, the Sacramento/San Joaquin Rivers and their watersheds. This document has been developed for the CALFED Bay-Delta Program. It is an important first step in the coordinated response to this serious problem and communicates the scope of activities necessary to effectively deal with NIS.

The plan discusses the problem and identifies the goals and major issues relevant to feasible, cost-effective management practices and measures to be taken by federal, state, local and other programs to prevent and control NIS infestations in a manner that is environmentally sound. It is important to note that the information developed by NIS activities will be provided to the CALFED Program Managers and the Comprehensive Monitoring, Assessment and Research Program in order to assist these CALFED elements to more effectively achieve CALFED goals and objectives.

The focus of this plan is directed at the San Francisco Bay-Delta estuary, the Sacramento-San Joaquin Rivers and the associated watersheds in California, though it is recognized that the solution area may be statewide and beyond.

The goals of this strategic management plan are designed to address different stages of NIS invasion: 1) the introduction of NIS transported from other parts of the continent or world; 2) the spread of established, reproducing NIS populations to uninfested ecosystems and 3) the colonization of NIS populations within habitats, including the harmful impacts resulting from that colonization, which may include hybridization, ecosystem alteration and displacement of native species.

This strategic management plan is based on the following three goals:

- Goal I: Preventing new introductions and establishment of NIS into the ecosystems of the San Francisco Bay-Delta, the Sacramento/San Joaquin Rivers and their watersheds.
- Goal II: Limiting the spread or, when possible and appropriate, eliminating populations of NIS through management.
- Goal III: Reducing the harmful ecological, economic, social and public health impacts resulting from infestation of NIS through appropriate management.

This plan is being developed as part of the CALFED NIS Program which has been initiated this year in response to the recognition of NIS as a major stressor of the Bay-Delta

ecosystems. The template for much of this document comes from the efforts to develop a State Plan for California. Contributions for that effort came from the California Resources Agency, California Department of Food and Agriculture, US Fish and Wildlife Service, US Department of Agriculture - Agricultural Research Service and US Army Corps of Engineers. Also contributing to this document were staff from the CALFED agencies and participants from academia, non-profit groups, stakeholder groups and individuals with technical experience with NIS. The information contained in the Strategic Plan for the Ecosystem Restoration Program (September 30, 1998) and the draft Ecosystem Restoration Program Plan, Volume I (October 1, 1998), both CALFED Bay-Delta Program documents, provided further information for this plan. Public comments also will be solicited from local governments and regional entities, and public and private organizations that have expertise in the control of NIS. Comments will be considered and revisions made to the plan, as appropriate.

While this plan provides guidance, it does not stand alone as an instrument to deal with the problem. With this coordinated effort, California will have a more efficient approach for implementing California NIS strategies. Besides the CALFED Bay-Delta Program, California entities should find the document useful for designing projects, preparing proposals, and prioritizing activities related to the NIS issue.

INTRODUCTION

Background

Exotic, introduced, nonindigenous or nonnative invasive species are terms which are used in this document to refer to organisms that live beyond their normal geographic range and, in some way, negatively impact the new environments. Most often, the suitability of environmental conditions determines a species range. Normal changes in a species range can also occur over great distances as a result of transport mechanisms such as wind and ocean currents and dispersion by migrating species.

Over the past one hundred years, many NIS have been introduced to the San Francisco Bay-Delta. Within the last few decades, the frequency of intra- and international transfer has been greatly accelerated by various human activities. Some scientists fear that the international trend is toward species homogeneity. Some of the species introductions have been intentional, such as ornamental plants, certain agricultural crops and livestock. Others have been inadvertent; introduced through releases from the horticulture trade, pet trade, aquaculture activities, dumping of ballast water, escapees, etc.

Many of these NIS may not survive in their new surroundings. But for some, the conditions are right and they are able to reproduce and establish a viable population, which can have devastating effects on the ecosystem. NIS affect ecosystems in several ways that are of concern. The extinction of native species can be attributed first to habitat destruction and secondly to introduced species, whose impacts may include habitat alteration, trophic alteration, community spatial alteration, gene pool deterioration, introduction of diseases and parasites, and contaminant dynamics (Kohler and Courtenay).

One of the many underestimated affects of NIS is the potential for contaminants to be consumed, resuspended and incorporated into the food chain by organisms that have been introduced. In the Great Lakes, there are reports that PCBs and cadmium are being cycled from the water column and sedimented to the bottom of the lakes due to the presence of zebra mussels. In a similar fashion, Asian clams are bioaccumulating contaminants at a remarkable level (Cd and Se in particular) in northern San Francisco Bay. Since it's arrival, there are much higher levels of Se in the livers of demersal feeders (diving ducks and sturgeon) in Northern San Francisco Bay.

Genetic pollution refers to the process by which NIS threaten natives with alien genes. Though this is not a new phenomeron, comprehensive treatments of invasion ecology in the mid-1980s did not include genetic competition as a threat. Increasing numbers of NIS and their interfertility mean that hybridization is a substantial threat to native biotas.

Ecological "engineers" are species with particularly great habitat effects; they change the physical and chemical environment through various means. This often results in rendering the habitat unsuitable for historic use, often leading to habitat loss for native species. A

good example of this is the plant *Spartina alterniflora*, which invades mudflats and converts them into extensive stands of cordgrass. This alteration disturbs sediment dynamics and reduces shorebird feeding and reproduction habitat.

Some species may find themselves adapting to NIS as a matter of necessity. When riparian habitats are taken over by giant reed or aquatic habitats are taken over by water hyacinth or Egeria, the animals that use these environments to reproduce, feed or escape predation must develop the means to utilize the diminished habitats to survive. This can complicate strategies to remove or otherwise manage non-native invasive plant species, especially if listed wildlife species are observed using the undesirable vegetation. Strategies to remove or control NIS must consider possible conflicts of this nature to avoid causing unnecessary, significant harm to special status species or other species of concern.

The Program

This Strategic Plan has been made possible through the funding of CALFED and the support of CALFED agency, academic, non-profit and stakeholder participants. As CALFED has developed the goals and objectives of their program, they have come to recognize that NIS is a significant stressor of the Bay-Delta. The result has been the initiation of a CALFED NIS Program charged with the responsibility to develop a long-term Strategic Plan, an Implementation Plan, directed projects, an open solicitation for proposals, and coordination of the resulting projects. The U. S. Fish and Wildlife Service has agreed to develop and coordinate this program, in cooperation with CALFED programs and members. The initial funding is \$1.25 million, which will be allocated over FY99 and FY 00. It is anticipated that at least \$1,050,000 will be available for on-the-ground work over this two year period and that CALFED funding will become available in future years to continue with implementation actions as identified in the Plans.

In May 1995, the CALFED Bay-Delta Program was established to "restore the ecological health and improve water management for beneficial uses in the Bay-Delta system". To accomplish this, a draft Ecosystem Restoration Program Plan has been developed to increase aquatic and terrestrial habitats, improve ecosystem functions and reduce the effects of stressors, which includes non-native invasive species. Management actions of this Strategic Plan will be consistent with the objectives identified in the **Strategic Plan for Ecosystem Restoration Program (ERP)** dated September 30, 1998. Goal 5 of the ERP plan is "Prevent establishment of additional non-native invasive species and reduce the negative biological and economic impacts of established non-native species." The ERP objectives identified for this goal are to:

- Objective 1: Eliminate further introductions of new species in ballast water of ships.
- Objective 2: Eliminate the use of imported marine baits.
- Objective 3: Halt the introduction of freshwater bait organisms into the waters of Central California.

- Objective 4: Halt the deliberate introduction and spread of potentially harmful species of fish and other aquatic organisms in the Bay-Delta and the Central Valley.
- Objective 5: Halt the release of fish and other organisms from aquaculture operations into Central California waters, especially those imported from other regions.
- Objective 6: Halt the introduction of invasive aquatic and terrestrial plants into Central California.
- Objective 7: Halt the release and spread of aquatic organisms from the aquarium and pet trades into the waters of Central California.
- Objective 8: Reduce the impacts of exotic mammals on native birds and mammals.
- Objective 9: Develop focused control efforts on those introduced species for which control is most feasible and of greatest benefit.
- Objective 10: Prevent the invasion of the zebra mussel into California.

The NIS program will work to develop close linkages with the CALFED Program Elements and CMARP. These linkages will enable those programs to take advantage of the information generated by the NIS program activities and facilitate recognition of the special issues and concerns that NIS present to the estuary in general and to specific Program Elements. This insight will allow development of a better understanding of effective ways to address NIS as the work to accomplish the CALFED goals and objectives proceeds.

The purpose of this strategic plan is to provide a planned approach for management actions to address prevention, eradication, control and impacts of NIS that have invaded or may invade the ecosystems of the San Francisco Bay-Delta estuary, the Sacramento/San Joaquin Rivers and their watersheds. This plan should serve as a basic model for resource managers responsible for implementing programs to protect and enhance ecosystems in California.

The mission of this CALFED Nonnative Invasive Species Program is consistent with Goal #5 of the ERP Strategic Plan:

THE MISSION OF THE CALFED NONNATIVE INVASIVE SPECIES PROGRAM:
Prevent establishment of additional non-native species and reduce the negative ecological and economic impacts of established non-native species.

The three goals of the NIS Program Strategic Plan are:

- **Goal I: Prevent new introductions of NIS into the ecosystems of the San Francisco Bay-Delta, the Sacramento/San Joaquin rivers and their watersheds.**

- **Goal II: Limit the spread or, when possible and appropriate, eliminating populations of NIS through management.**
- **Goal III: Reduce the harmful ecological, economic, social and public health impacts resulting from infestation of NIS through appropriate management.**

The strategic approach to this plan recognizes prevention as the most practical, economic and environmentally safe method for dealing with new or incipient infestations. An effective prevention program must include an exclusion component to prevent introductions into California, a detection component to identify incipient infestations and an integrated pest management component to eradicate or control species with minimal or transitory impact to the habitat and nontarget species. All three components need to have strong research, public information and awareness support to be effective, timely and responsive. For NIS already widely established and distributed, this plan emphasizes an ecosystem approach to management, (as opposed to a species by species approach) utilizing integrated pest management methods that are flexible and environmentally sound.

Implementation:

To achieve the goals set forth in this strategic plan for NIS, several major issues will be addressed. Resolution of these issues is critical to the establishment and operation of a successful program. These issues are:

- I. Leadership, Authority and Organization
- II. Coordination, Cooperation and Partnership
- III. Education and Outreach
- IV. Funding and Resources
- V. Monitoring, Mapping , Assessment
- VI. Research
- VII. Technology and Information Transfer
- VIII. Enforcement and Compliance
- IX. Program Evaluation

A CALFED NIS Implementation Plan will be developed in accordance with this strategic management plan. Strategies will be identified to address prevention, management, control and eradication. The Implementation Plan will develop and define objectives for every applicable major issue identified above, as well as the tasks and activities necessary to address the major issues and achieve the three goals, including development of priorities and criteria. It will address these issues in a manner that identifies the who, what, when, where, and how for proposed tasks or actions.

Each year a new implementation plan will be developed to direct and focus future activities. These plans will adopt the adaptive management strategy identified by CALFED, reflecting an evaluation of progress made, new information learned, and necessary actions remaining as projects are completed.

THE PROBLEM

THE BAY-DELTA SITUATION

In the last one hundred years, there have been over 212 introductions of species into the Sacramento-San Joaquin Estuary. Many of these species are believed to have traveled here via ballast water of ships. The incidence grows with the increase in trade between Pacific Rim nations because many species are carried in the ballast water of ocean-crossing vessels. Since 1970, many new species of zooplankton, clams, amphipods, crabs and fish have become established in the Sacramento-San Joaquin Estuary (Cohen and Carlton, 1995).

Aquatic ecosystems such as the Sacramento-San Joaquin Delta are comprised of many interrelated organisms which include phytoplankton (algae), macrophytes (vascular plants), invertebrates, fish, birds and mammal. These organisms require a certain set of chemical and physical conditions to exist, such as oxygen, light, nutrients adequate movement of water and adequate space.

Scientists and other NIS experts have recognized the fact that healthy ecosystems are impacted by the establishment and spread of exotic species. A habitat that is disturbed seems to be at even higher risk for establishment and negative impacts due to introduced species. The CALFED program includes an aggressive and expensive effort to increase shallow water habitats in the Delta, as well as restore the health of those already in existence. Failure to identify and develop a comprehensive strategic approach to the problem associated with invasive aquatic species could negate or undermine benefits gained from these efforts (increasing flows, reclaiming agricultural lands and eliminating or redistributing levees) to improve and expand habitat for native, beneficial, and endangered aquatic species.

In the last hundred years, human mobility has greatly accelerated and with this movement plants and animals have been introduced, either deliberately or accidentally into new environments with unforeseen consequences. Starlings, the boll weevil, rats in Hawaii, the zebra mussel and sea lamprey in the Great Lakes, and water hyacinth in California's Sacramento-San Joaquin Delta are some of the infamous cases of species becoming pests when introduced into new environments. The Nature Conservancy in a recent report entitled "America's Least Wanted" details how approximately 4000 exotic plant and 2300 exotic animal species have threatened native species and how some of these exotics have ended up costing the economy an estimated \$97 billion.

AQUATIC PLANTS

Submersed, emersed, and floating aquatic plants are natural and important components of aquatic ecosystems. In a well balanced aquatic ecosystem, aquatic plants provide protective cover for fish as well as habitat and a source of food for organisms consumed by fish. Aquatic plants also provide nesting sites and food for birds and other animals. In addition, aquatic plants can increase water clarity and quality and improve the appearance of a water body. While ecosystems are dynamic, NIS alter the rate of system change and modify the ecological balance of our ecosystems.

The spread of nonnative flowering aquatic plants has increased dramatically over the past 25 years in California and has created many economic and ecological impacts. Demands on the state's water resources, which include irrigation water delivery, recreational and domestic (drinking) uses, and fisheries and waterfowl habitats, have exacerbated these impacts. The introductions of NIS have consistently upset the delicate ecological balance of many aquatic systems. Furthermore, large-scale infestations of aquatic NIS have proven to be a severe impediment to boating, fishing, swimming, water delivery, and generation of hydroelectric power. The hallmark of aquatic invaders is their ability to grow in low light levels and their rapid, prolific, and varied reproductive abilities.

According to the California Department of Food and Agriculture, the aquatic plant species causing most of the problems in California are: *Eichhornia crassipes* (water hyacinth), *Egeria densa* (Egeria), and *Myriophyllum spicatum* (Eurasian water milfoil). There is also an intensive *Hydrilla verticillata* (Hydrilla) control program underway to limit the spread and reduce the impacts from this aquatic plant. This program intends to contain this pest and prevent it from causing widespread problems.

Water hyacinth has been under management for 15 years, and a bill authorizing the management of Egeria passed the state legislature in 1996. The combined costs of these efforts to control fewer than 25% of the infestations will probably equal or exceed the \$1 million annual Hydrilla eradication expenditures. Management of water hyacinth and Egeria by using biological control agents may be the long-term goal, yet safe and effective herbicides and mechanical control strategies need to be used in the interim to prevent further spread of these weeds.

WETLAND PLANTS

Several invasive plant species on the California Exotic Pest Plant Council's (CALEPPC) list of plants of greatest ecological concern threaten the wetland habitats of the Bay-Delta system. Cordgrass introduced from the Atlantic coast has spread very rapidly in Pacific estuaries in northern California, Oregon, Washington, and British Columbia and now invades the San Francisco Estuary. The introduction of smooth cordgrass (*Spartina alterniflora*) has led to dense coverage of about 30% of the intertidal area in Willapa Bay, Washington. The introduction to San Francisco Bay has resulted in rapid colonization of the south end of the bay. It is now known to hybridize with *Spartina foliosa*, the native cordgrass, which confounds the problem of identification and eradication.

Spartina alterniflora and *S. densiflora* are the introduced cordgrass species of greatest concern (Grossinger and Cohen, 1998). *Spartina patens* and *S. anglica* are of secondary concern according to this report, based on input from regional wetland scientists and managers.

Smooth cordgrass is a substantial threat to wildlife, fisheries, and traditional uses of Pacific estuaries. Replacing the naturally open mud of Pacific estuaries with monospecific grass prairie, the dense canopy and tightly interlocked rootmats of these weeds exclude shorebirds, native vegetation, fish, and many invertebrates. NIS which invade in this manner, altering the physical characteristics of the habitat, are sometimes referred to as "ecological engineers" by scientists that study and document these impacts.

Other wetland invasive species include those found in upland-wetland transitions, but are now invading high-marsh terraces. Pepperweed (*Lepidium latifolium*) is a particularly aggressive invader and is proving difficult to eradicate. Its rhizomes can be resistant to herbicide applications and it is fairly euryhaline. *Salsola soda*, a member of the Chenopodiaceae family, is another plant that threatens native pickleweed marshes. In a recent survey Tamasi (1998) reports *S. soda* in the Bay-Delta system from Calhoun Cut near Hastings Tract down to the southern end of the South Bay. Both of these species are cited by Grossinger and Cohen (1998) as needing attention.

RIPARIAN PLANTS

Recent introduction and spread of purple loosestrife (*Lythrum salicaria*) threaten the state's riparian systems. It has recently been observed invading some Delta levees (e.g. White Slough). According to CALEPPC's 1996 list of exotic pest plants of greatest concern, purple loosestrife status is "red alert". Giant reed (*Arundo donax*) is another species that is receiving considerable attention both nationally and in California. There are now five regional teams dedicated to control and eradication of giant reed in the state. This plant is known to aggressively displace native riparian vegetation and is so disruptive that it affects water quality and quantity, exacerbates flooding, and alters the geomorphology of the waterway it invades. Giant reed is widespread throughout the CALFED problem and solution areas.

Other plants that threaten our riparian or wetland systems include blue gum eucalyptus (*Eucalyptus globulus*), salt cedar (*Tamarix* spp.), Russian olive (*Eleagnus angustifolia*), Himalayaberry (*Rubus discolor*), Cape ivy (*Delairea odorata*; formerly known as German ivy, *Senecio mikanioides*), hoary cress (*Cardaria draba*), tree of heaven (*Ailanthus altissima*), thistles (*Cirsium arvense* and *C. vulgare*), and periwinkle (*Vinca major*).

The above species are only a few of the approximately 80 species listed as "problem exotic plants reported in California wetlands" from a survey of resource managers representing six bioregions of the state (Dudley, 1998). Clearly, much work remains to be done in identifying the threats to wetland and riparian habitats posed by these invasions, prioritizing research and eradication, and monitoring progress.

INVERTEBRATES -

CLAMS and ZOOPLANKTON

One species having a major impact is the small Asian clam, *Potamocorbula amurensis*. After it first appeared in 1986, the clam rapidly colonized the brackish water portion of the estuary throughout San Francisco Bay to the western edge of the Delta. It was the dominant bivalve south of San Mateo Bridge by 1991. The clam has affected the base of the food web by removing much of the algae, which is food for zooplankton. This clam is so abundant that calculations indicate that the population can filter a volume of water equal to the entire water column in 24 hours. It has apparently greatly reduced abundance of the native copepod *Eurytemora affinis*, a dominant zooplankton species providing food for many larval fish. Ironically, some recently accidentally introduced zooplankton species now provide food for young fish and may help fill the void caused by the decline in *Eurytemora affinis*. The mysid *Acanthomysis bowmani* was first reported here in 1993 and has increased in abundance, while the native mysid *Neomysis mercedis*, another important food item for young fish may have been greatly reduced in abundance through competition for food with the Asian clam.

CRABS

Two exotic crabs, the Chinese mitten crab *Eriocheir sinensis* from Asia and the green crab *Carcinus maenas* native to Europe, have also become established in the Estuary. The mitten crab, first found in South San Francisco Bay in 1992, was collected in the Delta in the fall of 1996 and since then has traveled upstream in the Sacramento River north of Colusa and upstream in the San Joaquin to Gustine. The mitten crab may have been deliberately and illegally introduced or it may have been introduced via ballast water. It is known to damage rice crops in China, and it is a potential competitor of crayfish, which supports a commercial fishery and is an important forage species for fish in the Delta. The mitten crab potentially could burrow into and weaken the levee system in the Delta if it becomes more abundant. The green crab is non-burrowing but inhabits the intertidal zone in San Francisco Bay, San Pablo Bay and has been found in Suisun Bay where it may compete with shorebirds and other crabs for food. The green crab is a voracious predator of shellfish and native shore crabs, and it is believed that it could fundamentally alter Bay-Delta invertebrate species distributions, and imperil aquaculture such as oyster farming. It has apparently spread rapidly from San Francisco Bay, where it was first captured in 1989 or 1990 (Cohen and Carlton, 1995), up the coast of California to Willapa Bay and Grays Harbor, Washington. In 1999 numerous reports were documented of the crab well into the waters of British Columbia.

VERTEBRATES-

FISH

It is well known that a number of introduced fish have become established in this estuary over the past one hundred years. They include striped bass, catfish and several members of Centrarchidae. Some of these fish now support popular fisheries and are considered by

many to be a valued recreational feature of the watershed. Outside of the Sacramento-San Joaquin Delta, unauthorized planting of the Inland silverside, *Menidia beryllina*, into Clear Lake occurred in 1967, and it was likely dispersed into the Delta from Clear Lake by high winter flows. The fish was established in the estuary by 1975. It is suspected to prey upon larvae of other fish and may compete for food with the delta smelt, *Hypomesus transpacificus*, a threatened species. The delta smelt is also faced with the threat of hybridization and competition with a morphologically similar smelt species, the wakasagi, *Hypomesus nipponensis*. A growing problem in California is ill-advised anglers who desire and introduce exotic species. Intentional illegal introductions can have great economic consequences. The white bass, *Morone americana*, a species native to the Midwest, was eradicated from Kaweah Reservoir in Tulare County with rotenone in 1987. Northern pike, *Esox lucius*, another species native to the Midwest, was illegally stocked into Frenchman Reservoir, Plumas County, in the 1980s. In March 1991, the Department of Fish and Game treated Frenchman Reservoir and successfully eradicated northern pike. A similar program was conducted in 1997 to eradicate northern pike from Lake Davis in Plumas County. Biologists were concerned that if these two predatory fish species became established throughout the watershed, they would decimate populations of salmon, trout and other fish, including some that are threatened or endangered. These eradication efforts cost over one million dollars each. These expenditures are necessitated by the irresponsible behavior of a few individuals who either do not understand or do not care about the environmental and economic consequences of their illegal actions.

NONNATIVE WILDLIFE

Nonnative wildlife is present throughout the Sacramento-San Joaquin Valleys in a variety of habitats. These include aquatic, riparian scrub, woodland and forest habitats; valley oak woodland; grassland and agricultural land. Non-native wildlife species negatively impact native organisms mainly through predation or competition. These nonnatives often have a competitive advantage because of their location in hospitable environments where the normal controls of disease and natural enemies are missing. The result is diminished abundance of native species. Some of the common but harmful species found in the Bay-Delta area are:

- The European red fox, which threatens many native endangered wildlife species, such as the clapper rail and several other San Joaquin Valley animals.
- The Norway rat, which threatens ground-nesting wildlife, has experienced large increases in the populations living along the bay shores.
- The feral cat which is a major predator to bird and mammal populations in the wetland areas of the Bay-Delta estuary.

MAJOR ISSUES

The development of this Plan has led to the conclusion that there is one element that is necessary to the success of any program which addresses the prevention, management and eradication of NIS. That essential element is a group of individuals that come together to form an advisory council to monitor and coordinate the efforts of the program. For this Plan, the formation of this group is identified as a Programmatic Action below.

PROGRAMMATIC ACTION

Programmatic Action: Formation of an interagency Non-native Invasive Species Advisory Council (NISAC) to monitor management efforts and assure effective coordination of this program with CALFED and other NIS programs.

California natural and man made water conveyance and impoundment systems are available and utilized for multiple purposes. In addition, there is a complex mosaic of federal, state and local laws and regulations which not only address intended use of these resources but will impact efforts to prevent the introduction, establishment and management of NIS. To facilitate accomplishment of the strategic goals, this program must coordinate with jurisdictions within and outside the state and build tasks and actions upon sound science. Therefore, mechanisms will be established to ensure that all prevention, control and abatement tasks and actions developed and implemented by this program under this plan are (1) done in cooperation with federal agencies, local governments, interjurisdictional organizations and other entities, as appropriate (2) based upon the best scientific information available, (3) conducted in an environmentally-sound and conscientious manner and (4) coordinated through NISAC.

As presented in the Implementation Section on page 7, there are also a number of major issues critical to achieving the goals as presented in this plan. These issues are discussed below and will be addressed as objectives of the Implementation Plan with specific Tasks and Actions.

LEADERSHIP, AUTHORITY AND ORGANIZATION

As the program develops, one of the components essential to actual implementation will be to identify the leadership, authority and organization that is necessary to accomplish each goal. In some cases, there will be existing organizations that have the leadership and authority to carry out the actions identified in the plan. The CALFED NIS Program will develop relationships and support the efforts of these organizations. It may be that other tasks and actions determined to be essential to the success of the program do not have the leadership, authority or organization in place. In these instances, we will work to identify and/or develop the appropriate component needed to carry out the work as a part of the CALFED NIS Program.

COORDINATION, COOPERATION AND PARTNERSHIP

For all of the work undertaken as part of this program, the value and necessity of the elements of coordination, cooperation and partnership to the success of the program can not be overstated. At all times and in all aspects of the work, priority will be given to these ideals and we will strive to incorporate them into every aspect of plans made and actions taken. There are many entities and organizations developing or operating programs to address NIS, including local, regional, state and national. The programs and organizations that deal with the issues and organisms that are of concern to the CALFED objectives will be identified and cooperative relationships will be developed with these entities. Emphasis will be given to projects where partnerships can be developed to improve efficiency, support and effectiveness of activities. There is further discussion of this issue in the Policy Background section.

EDUCATION AND OUTREACH

A comprehensive awareness and education program is critical for an effective NIS management program. Except for isolated cases that have attracted substantial media attention, the general public does not understand how NIS negatively impact the environment, the economy and the use of the natural aquatic resources that are important to them. Therefore, a strategic approach to NIS must include an education and awareness component for all actions and tasks presented. Developing and implementing a coordinated and comprehensive information program will expand understanding by all California citizens of the impacts and risks associated with the introduction and spread of NIS.

Information about the nature, characteristics, and the impacts of NIS on the environment, economy, and quality of life needs to be made more available. This information should be presented concurrently with information about related issues such as native species, natural history, threatened and endangered species, water quality, habitat restoration, and ecosystem health. An important aspect of this program will be developing outreach to inform and educate not only the public, but private entities that may be contributing to the problems and/or may be affected by project actions. The need for understanding and managing NIS should be institutionalized in public and environmental education curricula. A well-coordinated effort is needed because of the costs and complexities associated with developing and delivering a comprehensive, high caliber outreach program.

A successful education and information program must utilize individuals and institutions with expertise on raising public awareness and influencing attitudes towards NIS management. Public information specialists can be utilized to develop, distribute and coordinate information state-wide. In addition, information specialists can enhance public interest and improve citizen and organizational involvement to reduce the spread of NIS. Raising awareness can be achieved via television spots, ad campaigns, outreach to schools, and public service announcements.

An increased awareness and concern of California citizens should precipitate an increased level of commitment by elected officials toward NIS management. Many federal and state legislators have little understanding of the risks associated with NIS and this has had a negative impact on obtaining sufficient long-term funding. An immediate priority should be the development of briefing packages and presentations for national, state, and local officials and interest groups.

FUNDING AND RESOURCES

In California, the funding for management of NIS is not reliable or consistent and in many cases is inadequate or nonexistent. This is especially true in the areas of exclusion, education, emergency response, research and management. Funds are generally available on a reactive basis and do not effectively deal with infestations before they become unmanageable. Except for the Hydrilla Program conducted by California Department of Food and Agriculture, or the Northern Pike Program conducted by California Department of Fish and Game, funds for NIS are usually provided only after the problems become widespread, provide resources for only limited control efforts and do very little to prevent further spread to uninfested areas.

Costs associated with this management plan and associated implementation plans must be identified. The CALFED Program has provided initial funding for development of the NIS Program and to begin high priority projects. It is the intent of the CALFED Program that as future funding becomes available, the CALFED NIS Program will continue to receive support to carry out the NIS projects that will contribute to the success of the CALFED Program objectives. Also, traditional sources of financial support which will be pursued include the US Fish and Wildlife Service, ANS Task Force, US Army Corps of Engineers, US Environmental Protection Agency, Natural Resource Conservation Service and the National Fish and Wildlife Foundation. For federal agencies, allocations of discretionary funds will likely be inadequate. It is necessary to acquire dedicated funding to assure the continuity and viability of this Program. At the state level, one or more agencies may have to submit Budget Change Proposals to obtain long-term funding in support of a statewide management program. It should be recognized that discretionary funding will not be adequate to address the full scope of this problem. Funding needs are substantive and appropriations will be necessary to carry out this Plan.

In addition to traditional funding sources, a working group within the NISAC, should develop a number of nontraditional funding options for NISAC consideration and recommendation. These funding options should recognize that management of NIS benefits all Californians and will actually prove cost-effective over the long term.

Other nontraditional sources of revenue and resources involve cooperative agreements and partnerships. Federal, state, local agencies and private organizations with NIS management responsibilities should be encouraged to coordinate, share, or pool resources. This can include shared purchase of supplies and use of equipment, savings for bulk purchases of chemical supplies, use of staff and other human resources, sharing of mapping and monitoring data and expertise, biological control and educational materials.

MONITORING, MAPPING AND ASSESSMENT

As part of the CALFED program, a Comprehensive Assessment, Monitoring and Research Program (CMARP) is under development to address the needs of CALFED's common programs and related agency programs regarding monitoring, research and assessment. The CALFED NIS Program will communicate and coordinate with all pertinent CMARP programs and activities.

Ecosystems infested with NIS are not consistently identified and delineated. Complete up-to-date maps, displaying the distribution and severity of NIS infestation are available in only a few areas. Knowledge of which species are located where is paramount for: 1) increasing public awareness and concern, 2) obtaining support and funding for developing a strategic program, 3) accurately predicting where new infestation may occur from already infested areas and, 4) developing effective integrated management and prevention plans with specific actions to mitigate or prevent NIS impacts.

Risk assessment involves identifying geographic areas which may be at risk for successful establishment of particular species. This type of assessment can be an essential element of a successful prevention program by identifying areas of specific concern and affording the opportunity to direct resources in the most beneficial and efficient manner.

A georeferenced ecosystem inventory, mapping and monitoring system will be based on standards which allow for easy exchange of information among federal, state and local agencies as well as private organizations and form the basis of a Bay-Delta GIS for NIS.

An integral component of the goals to prevent and limit spread of NIS is early detection monitoring and rapid response. It is important to identify and monitor susceptible areas on a regular basis in an effort to detect invasions early and allow the best possible chance of successful management for the least cost and disruption. Examples of areas more susceptible to invasions include those in close proximity to ports with ballast water discharges and areas of physical ecosystem disturbance such as newly restored areas.

RESEARCH AND TECHNOLOGY TRANSFER

A strong commitment to research and information/technology transfer is critical towards achieving the goals presented in this management plan. The CALFED NIS Program will communicate and coordinate with CMARP, the coordinating entity for the common programs of monitoring, research and assessment, in their efforts to identify research needs. A subcommittee within NISAC will meet annually to review and prioritize research needs already identified by various entities, as well as newly identified research gaps relative to the goals and objectives of the plan. A report and recommendations, including suggested opportunities for funding critical research should be submitted to the NISAC and other interested groups following the annual review. This commitment also extends to the transfer of information to a wide audience through many venues to assure coordination and cooperation with others involved in the same type of endeavors.

ENFORCEMENT AND COMPLIANCE

In those areas where enforcement and compliance are identified as an issue, this program will develop the information base to illustrate and define the issue, describe possible approaches, and make recommendations to appropriate agencies to enhance the adherence to regulations. As programs to prevent, control, and manage NIS are cooperatively developed, certain practices or prohibitions may emerge as mandatory requirements for specific entities in order for the three management goals to be accomplished. It will be necessary for responsible agencies to monitor the compliance with such requirements. In these cases, enforcement mechanisms will be essential to encourage compliance with recognized standard practices.

PROGRAM EVALUATION

To be effective and responsive this management program and associated implementation plans must include an evaluation component to identify progress, evaluate implementation problems and needs, and make necessary corrections at any time. The adaptive management strategy will be highlighted. The evaluation process will include:

1. Develop a peer review process for program evaluation using the technical expertise and experience of the national, regional, and local groups identified in this report as entities familiar with the issues of NIS.
2. Coordinate and communicate with CMARP for the CALFED program evaluation process.
3. Establishment of an evaluation subcommittee within NISAC responsible for reviewing performance measures, conducting the evaluation efforts, reporting the results to NISAC and others if required, and identifying program or plan adjustments that address projected outcomes.
4. The three program goals, as previously presented, provide the focal point for evaluation. Quantifiable milestones for each goal and objective will be developed and have realistic, feasible time-frames.
5. The evaluation process will involve those with implementation responsibility, resource user groups, and others affected by the program implementation.
6. An annual report highlighting progress and achievements will be prepared and distributed. The annual report will include evaluation of the efficacy of the programs strategies and tasks and identify revisions as needed. The annual report will be readily available on the Internet and distributed to local and federal agencies and legislative decision makers and CALFED program managers.

POLICY BACKGROUND

The complex environmental and economic impacts posed by the intrusion of NIS require policies and programs to address prevention and control at various levels of government. In addition, improved coordination of new and existing policies could more effectively focus attention on the problems and achieve more positive results. The following overview describes the basic role of the federal, regional and state governments in implementation of efforts to address NIS. The contents of this section includes:

- The CALFED role in implementing restoration of the San Francisco Bay-Delta estuary and Sacramento-San Joaquin Rivers and their watersheds and the objectives of that program with regard to nonnative invasive species.

- The federal Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA, Public Law 101-646) and the reauthorization of The National Invasive Species Act of 1996 (NISA).

- Executive Order on Invasive Species issued by President Clinton in February of 1999 which was intended to coordinate a federal strategy to address the growing environmental and economic threat of NIS.

- An assessment of California's existing laws and programs that address prevention and control of NIS.

Immediate and strategic coordinated federal and state action is critical for effective NIS prevention and control in North American waters. For example, over 212 aquatic nuisance species have already become established in the San Francisco Bay-Delta estuary watershed alone. The rate of invasion appears to be increasing due in part to expanded national trade and travel. Reducing the acceleration of invasions will require managing transport mechanisms including the discharge of ship ballast water, aquaculture activities, global trade in aquarium organisms, live seafood and live bait. Prevention of new NIS introductions coupled with long-term research on control strategies are priorities.

CALFED ROLE

The CALFED Bay-Delta Program was established to develop a long-term solution to the problems affecting the Bay-Delta system. Building on the spirit of cooperation reflected in the December 1994 Bay-Delta Accord, a group of state and federal agencies have come together to work cooperatively at developing and implementing a long-term comprehensive plan that will restore the ecological health and improve water management for beneficial uses of the Bay-Delta system.

The Ecosystem Restoration Program (ERP) is the principal Program component designed to restore the ecological health of the Bay-Delta ecosystem. The ERP represents one of the most ambitious and comprehensive ecosystem restoration projects ever undertaken in the United States. The goal of the ERP is to restore or mimic ecological processes and to

increase and improve aquatic and terrestrial habitats to support stable, self-sustaining populations of diverse and valuable species.

The CALFED program recognizes the necessity of addressing non-native invasive species by identifying the problem in GOAL 5 of their Strategic Plan: Introduced Species:

Prevent establishment of additional nonnative species, and reduce the negative biological and economic impacts of established non-native species.

As part of the ERP, the U.S. Fish and Wildlife Service has accepted the responsibility of developing, implementing, managing, and coordinating a non-native invasive species program in the San Francisco Bay-Delta estuary which will include terrestrial as well as aquatic species. This program, with the contributions of CALFED staff, agencies, academia, non-profits and interested stakeholders, will focus on the San Francisco Bay-Delta, the Sacramento and San Joaquin Rivers and their watersheds.

CALFED Member Agencies:

California -
Department of Fish and Game
Department of Water Resources
California Environmental Protection Agency
State Water Resources Control Board

Federal -
Environmental Protection Agency
Fish and Wildlife Service
Bureau of Reclamation
Army Corp of Engineers
Department of Agriculture - NRCS
National Marine Fisheries Service

FEDERAL ROLE

The expanded federal effort to address NIS includes the Executive Order on Invasive Species signed by President Bill Clinton on February 3, 1999. This action is intended to build upon existing laws such as the National Environmental Policy Act, NANPCA, The Lacey Act, Federal Plant Pest Act, Federal Noxious Weed Act, and the Endangered Species Act. The order creates an Invasive Species Council which has eighteen months to develop a comprehensive plan to minimize the economic, ecological, and human health impacts of invasive species and determine the steps necessary to prevent the introduction and spread additional invasive species. This council will be co-chaired by Secretary of the Interior, Secretary of Agriculture, and Secretary of Commerce and will work in cooperation with the Secretary of State, Department of Defense, Secretary of Transportation, the Administrator of the Environmental Protection Agency, states, tribes, scientists, universities, shipping interests, environmental groups and farm organizations to combat invasive plants and animals. In addition, the President's fiscal year 2000 budget proposes an additional \$29 million to support these efforts.

NANPCA was primarily a federal response to the Great Lakes invasion of the zebra mussel which has caused extensive ecological and socioeconomic impacts. Although the zebra mussel issue played a key role in prompting passage of the legislation, NANPCA clearly

was established to prevent the occurrence of new unintentional introductions of aquatic nuisance species (ANS) and to limit the dispersal and adverse impacts of invasive species currently in United States waters.

The actions identified in NANPCA are a first line of defense against aquatic nuisance invasions. The Act provides an institutional framework that promotes and coordinates research, develops and applies prevention and control strategies, establishes national priorities, educates and informs citizens, and coordinates public programs. The Act calls upon states to develop and implement comprehensive state management plans to prevent introduction and control the spread of aquatic nuisance species (ANS). Section 1002 of NANPCA outlines five objectives of the law, as follows:

- To prevent further unintentional introductions of nonindigenous aquatic species;
- To coordinate federally funded research, control efforts and information dissemination;
- To develop and carry out environmentally sound control methods to prevent, monitor, and control unintentional introductions;
- To understand and minimize economic and ecological damage; and
- To establish a program of research and technology development to assist state governments.

Section 1201 of the Act established the national Aquatic Nuisance Species Task Force (ANSTF), co-chaired by the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA). The Task Force is charged with coordinating governmental efforts related to prevention and control of ANS. The ANSTF (consisting of seven federal agency representatives and eight ex-officio members representing nonfederal governmental agencies) has adopted the ANS program under Section 1202 of NANPCA. This program recommends the following elements:

Prevention: Establish a systematic risk identification, assessment and management process to identify and modify pathways by which ANS spread.

Detection and Monitoring: Create a national ANS information center to coordinate efforts to detect the presence and monitor the distributional changes of all nonindigenous ANS, identify and monitor the impacts to native species and other effects, and serve as a repository for that information.

Control: The Task Force or any other potentially affected entity may recommend initiation of a nonindigenous ANS control program. If the Task Force determines that the species is a nuisance and control is feasible, cost effective and environmentally sound, a control program may be approved.

The ANSTF recommends research, education and technical assistance as strategies to support the elements listed above. The Task Force also provides national policy direction as a result of protocols and guidance that have been developed through the efforts of working committees. The ANSTF currently has three regional panels. The Great Lakes Panel, the Western Regional Panel and the Gulf Coast Panel. The new law of 1996 (NISA) expanded the focus of the original legislation from zebra mussels to all potential ANS and enlarged the area of concern from the Great Lakes/Hudson River to all of the U.S. In addition, NISA requires that the Coast Guard (USCG) draft regulations to implement a ballast water management program nation-wide. This new program was to be patterned after the program established under NANPCA for the Great Lakes/Hudson River.

The USCG regulations will apply to all vessels with ballast on board that enter U.S. waters from outside the Exclusive Economic Zone (EEZ). These vessels will be encouraged to *voluntarily* comply with the International Maritime Organization's (IMO) guidelines for ballast exchange at sea, and will be *required* to submit a report form to the USCG documenting where, when and how they dealt with their ballast.

Ballast procedures allowed under the proposed regulations:

- (1) open ocean exchange in at least 500 meters of water, or
- (2) retain ballast on board, or
- (3) obtain approval for using an alternate method in a given situation, or
- (4) discharge ballast in an approved "alternate exchange zone".

Reporting requirements under the new regulations:

- (1) record ballast procedures on the IMO form;
- (2) fax the information to the USCG upon arrival in port;
- (3) retain records on board for at least 2 years.

The USCG regulations were widely circulated for public review and comment. The rule became final in May 1999. The voluntary guidelines will become mandatory if vessels fail to comply with ballast exchange procedures or fail to submit the report forms to the USCG. The statute requires the USCG to report to Congress within 18 months of the effective date of the regulations, providing information on the level of voluntary compliance. It is anticipated that a mandatory program, if needed, would be implemented in 2000 or 2001.

A Clearinghouse will also be established by the USCG to retain the report forms and to be a central repository for ballast management-related information/studies. Such information will include; patterns of invasion, measures of compliance and effectiveness of IMO procedures, a national database of exotic species, the economic and environmental impacts of the invaders, and the economic impacts of control measures. The Clearinghouse will be maintained by the Smithsonian Environmental Research Center (SERC).

Locally, the proposed federal project to deepen the Oakland Harbor Channel to allow larger ships into the Port of Oakland has raised concerns about increases in ballast water releases. San Francisco Baykeeper and the Center for Marine Conservation have been actively encouraging the Port of Oakland, the Army Corp. of Engineers and the consulting agencies, (U.S. Fish and Wildlife Service and the National Marine Fisheries Service) to fully

evaluate the potential impacts of non-native species introduction into the San Francisco Bay. The Port of Oakland has agreed to require that all ships calling at the Port exchange their ballast water at sea, except in emergencies. While applauding this step as a positive effort to reduce introductions, a full consultation under the Endangered Species Act is desired by these groups, as they feel that it may result in more information and more effective and stable control measures.

CLEAN WATER ACT

The objective of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters, and where attainable, to achieve a level of water quality that provides for the protection and propagation of fish, shellfish, and wildlife, and for recreation in and on the water.

Discharges of pollutants and fill material to waters of the United States are regulated under various sections of the CWA. In California, the U.S. Environmental Protection Agency (EPA) has delegated the authority to implement the CWA to the State Water Resources Control Board (SWRCB), which in turn has designated the nine Regional Water Quality Control Boards (RWQCBs), established under the State's Porter-Cologne Water Quality Control Act, as the implementing agencies.

The mission of RWQCBs, under the State's Porter-Cologne Act, is consistent with the objective of the CWA, namely, to protect beneficial uses of waters of the state. To accomplish this objective, RWQCBs use various planning and permitting programs authorized under the CWA. Section 402 authorizes the National Pollutant Discharge Elimination System (NPDES), which is a permit program intended to reduce and eliminate the discharge of pollutants from point sources that threaten to impair beneficial uses of water bodies. The State's Waste Discharge Requirements, discussed below, incorporate the authority of the federal NPDES permitting program for discharges of wastes to surface waters.

The CWA defines point sources to include vessels (Section 502(14)); and prohibits all point source discharges of pollutants into U.S. waters unless a permit has been issued either under Section 402 (NPDES) or Section 404 (dredge and fill activities). The CWA provides a narrow exemption from the usual CWA regulations for certain discharges (including ballast water) only for Armed Forces vessels (Section 502(6)(A)). However, these discharges are to be regulated by an EPA- and DOD-sponsored proposed rule under Section 312(n) of the CWA, Uniform Discharge Standards for Vessels of the Armed Forces.

Under Section 305(b) of the CWA, RWQCBs are required to assess water bodies for attainment of beneficial uses every two years, and report to the EPA. In cases where beneficial uses of water bodies are shown to be impaired, Section 303(d) requires the RWQCBs to list the impaired water bodies and "establish a priority ranking for such waters, taking into account the severity of the pollution and the uses to be made of such waters." Section 502(6) defines "pollutant" as dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials,

radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water.

Ballast water is considered to be a "waste" by the RWQCBs, based on the above definition and definitions in the State Water Code, described below. Based on these federal and state definitions and scientific evidence, the San Francisco Bay RWQCB has made a finding that ballast water has created "pollution" in the estuary. In February 1998, the San Francisco Bay RWQCB listed the waters of the San Francisco Bay-Delta Estuary as impaired under Section 303(d) because of introductions of NIS.

Section 303(d) of the CWA requires implementing agencies to establish and allocate "a total maximum daily load (TMDL) for those pollutants which the (EPA) Administrator identifies under Section 304(a)(2) as suitable for such calculation." This section of the CWA was developed to support a water quality-based system of effluent limits for chemical pollutants, and the interpretation of what an allowable load of invasive species has not been defined. Historically, for instance for sewage treatment plants, the regulations of the CWA have supported a permitting sequence of (1) technology-based effluent limits, and (2) water quality-based effluent limits. Water quality-based limits, of which TMDL is an example, are considered necessary if technology-based limits do not lead to attainment of adequate water quality to protect beneficial uses.

100th MERIDIAN INITIATIVE

The U.S. Fish and Wildlife Service is developing the 100th Meridian Initiative: A Control Plan to Prevent the Westward Spread of Zebra Mussels and other Aquatic Species. The goal of this initiative is to prevent the spread of zebra mussels and other ANS west of the 100th meridian. It is comprised of 6 components: 1) information and education 2) voluntary boat inspections and boater surveys 3) commercial boat hauling 4) monitoring 5) rapid response 6) evaluation. This initiative will be coordinated with the jurisdictions that straddle the 100th meridian and those further west, tribes and private entities such as water and power companies. The CALFED NIS Program will work with the 100th Meridian Initiative in an effort to address the CALFED Strategic Plan Objective #10) Prevent the invasion of zebra mussel into California.

Federal agencies with regulatory authority over introduction and transport of aquatic species which may be invasive or noxious include, US Department of Agriculture Animal Plant Health Inspection Service (USDA-APHIS), USDA Agricultural Marketing Service (USDA-AMS), US Fish and Wildlife Service (USFWS), US Department of Commerce (USDC) and US Coast Guard (USCG).

REGIONAL ROLE

On July 8 and 9, 1997 the Western Regional Panel on Aquatic Nuisance Species held their first organizational meeting. The general goals of the WRP are to prevent nuisance species introductions, coordinate activities of the western states among federal, local, and tribal agencies and organizations and minimize impacts of already established nuisance species.

Though much emphasis to date has been on the zebra mussel, there is a general recognition of the need to limit introductions of all non-native species.

The WRP will eventually include representatives from the 17 western states, several federal agencies, native Americans and Canada. The panel which meets annually, is chaired by an executive committee consisting of a state, federal, and at-large representatives. The basic structure of the Panel reflects the varying interests and concerns of the western states and is comprised of elements; the Coastal committee and the Inland committee. It appears that the potential for this group to help California minimize impacts of introduced aquatic species is could be substantial. The purposes of the WRP are to:

- identify western region priorities for responding to aquatic nuisance species;
- make recommendations to the Task Force regarding an education, monitoring (including inspection), prevention, and control program to prevent the spread of the zebra mussel west of the 100th Meridian;
- coordinate, where possible, other aquatic nuisance species program activities in the West not conducted pursuant to the Act;
- develop an emergency response strategy for Federal, State, and local entities for stemming new invasions of aquatic nuisance species in the region;
- provide advise to public and private individuals and entities concerning methods of preventing and controlling aquatic nuisance species infestations;
- submit an annual report to the Task Force describing activities within the western region related to aquatic nuisance species prevention, research and control.

STATE ROLE

State and regional management plans for ANS are addressed in Section 1204 of NANPCA. The intent of this Strategic Plan is to focus on the identification of feasible, cost-effective management practices and measures to be taken by various entities to prevent and control NIS infestations of the San Francisco Bay-Delta and its' watersheds in an environmentally sound manner. Section 1204 also states that in the development and implementation of the management plans, the state or region needs to involve appropriate local, state, and regional entities as well as public and private organizations that have expertise in ANS prevention and control. These management plans should also identify federal activities dealing with prevention and control measures, including direction of how these activities should be coordinated with state and local efforts. This CALFED NIS Strategic Plan and the Implementation Plan which will follow will be submitted to the ANS Task Force as a Regional Management Plan for the San Francisco Bay-Delta estuary and its' watersheds. It is anticipated that a State Management Plan will also be developed and submitted that will

include and expand upon the information in this document. There is a Colorado River Basin Regional Plan currently under development as well.

CALIFORNIA'S AUTHORITIES and PROGRAMS

The State of California currently has several statutory and regulatory authorities that address or potentially can address the issue of prevention and control of NIS that impact aquatic and riparian ecosystems. All of these authorities have been developed over time in response to individual target species and their associated concerns. Therefore, no comprehensive, coordinated and vigorously enforced policy framework to deal with problem species and their impacts exists. Clearly, gaps must be identified within the state's policies and statutes and recommendations made. Such improvements may entail developing methods for improving enforcement, coordination, and information dissemination regarding new or existing authorities.

The following existing authorities and policies have been identified relative to California's management of NIS that impact aquatic and riparian ecosystems. Some of these deal more broadly with all species that may invade terrestrial or transitional ecosystem, as well as aquatic ecosystems.

PORTER-COLOGNE WATER QUALITY CONTROL ACT (CALIFORNIA WATER CODE)

The Porter-Cologne Act (also known as the California Water Code or CWC) establishes the system of water quality regulation for the State, including the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCBs). The Porter-Cologne Act establishes the authority of these agencies to develop statewide water quality control plans and regional basin plans. These plans designate beneficial uses for specific water bodies, the water quality objectives to protect those uses, and implementation plans for the attainment of uses and associated water quality objectives. NPDES permits, described above under Clean Water Act, are an important element of the implementation plans of all California basin plans.

Section 13260 of the CWC authorizes RWQCBs to issue waste discharge requirements (WDR) to dischargers of waste into waters of the state, which include ground waters. For discharges to surface waters, WDR are federal NPDES permits, discussed above, which implement both the Clean Water Act and the Porter-Cologne Water Quality Control Act.

Section 13050(l) of the Porter-Cologne Act defines "pollution" as "an alteration of the quality of the waters of the state by waste to a degree which unreasonably affects either beneficial uses or facilities which serve the beneficial uses." Section 13050(d) defines "waste" as sewage and any and all other waste substances, liquid, solid, gaseous, or radioactive, associated with human habitation, or of human or animal origin, or from any producing, manufacturing, or processing operation of whatever nature, including waste placed within containers of whatever nature prior to, and for the purposes of, disposal."

Ballast water is considered to be a "waste" by the RWQCBs, based on the above definitions and definitions in the Clean Water Act. Based on these federal and state definitions and scientific evidence, the San Francisco Bay RWQCB has made a finding under its Clean Water Act authority that ballast water has created "pollution" in the estuary and that it threatens beneficial uses. Therefore, vessels discharging ballast water could be required to obtain WDR/NPDES permits which may contain conditions that could result in requirements for open ocean exchange or treatment of ballast water.

CALIFORNIA ENVIRONMENTAL QUALITY ACT

Requires that agencies adopt feasible mitigation measures in order to substantially lessen or avoid the otherwise significant environmental impacts of a proposed project. This act could be used to ensure appropriate mitigation of projects which result in increased discharges of ballast water.

Code Regulations

IMPORTATION, TRANSPORTATION AND POSSESSION OF WILD ANIMALS (PROHIBITED SPECIES) (Sections 671-671.7, Title 14, California Code of Regulations, Sections 2116-2118, Fish and Game Code)

Sections 2116-2118 define wild animals, provide a list of prohibited wild animals, provide specific restrictions regarding Atlantic salmon in the Smith River, extend authority to the Fish and Game Commission to prohibit animals not listed in Sections 2116-2118 and to adopt certain other restrictions which appear in Sections 671-671.7, Title 14, CCR.

Section 671 Title 14, CCR, lists animals designated by the Fish and Game Commission as members of one of two classes of animals which are prohibited: "W" or "welfare animals" (listed to prevent their depletion and/or to assure their welfare), and "D," or "detrimental animals" (listed because they pose a threat to native wildlife, the agricultural interests of the State, or to public health or safety). Live animals listed in Section 671 may not be imported, transported or possessed, except under special permits issued pursuant to Sections 671.1 through 671.7.

IMPORTATION OF LIVE AQUATIC PLANTS AND ANIMALS (Section 236, Title 14, California Code of Regulations)

Section 236 requires an importation permit for the importation of live aquatic plants and animals, except:

(1) Molluscs and crustaceans intended directly for the live seafood market, and which will not be introduced to waters of the State nor held in waters discharged to waters of the State,

(2) Live ornamental tropical plants or animals not utilized for human consumption or bait, which are maintained in closed systems for personal, pet industry or hobby purposes, and which will not be placed into waters of the State, and

(3) Brine shrimp.

The Department regulates importation of live aquatic plants and animals through review and approval or disapproval of permit applications. Permit applications must be submitted at least ten day before the proposed date of importation. When importations are approved by the Department they are permitted by either a "Standard Importation Permit" or a "Long-Term Importation Permit". The type of permit issued is determined by the species and by its proposed use.

Standard Importation Permits are issued for importations which are normally inspected by Department of Fish and Game pathologists. Examples are salmon, trout, largemouth bass and other species destined for stocking into aquaculture facilities. An approved Standard Importation Permit permits only one shipment, and the date of shipment and inspection scheduling information is on the permit.

Long-Term Importation Permits are issued for importations which are not normally inspected by Department pathologists and which generally represent little environmental risk. Examples include largemouth bass or Sacramento blackfish destined for direct sale in the live food markets. Long-Term Permits are issued for a period of up to one year, and the number of shipments permitted is normally unlimited.

STOCKING (Sections 6400 and 6431, Fish and Game Code)

Section 6400 prohibits the stocking of plants or animals into State waters without permission of the Department. Amendments to this section in 1998 provided new, severe penalties for violation of this section. Penalties are more severe when the violation involves a nuisance species. Section 6431 defines "nuisance species".

ASSEMBLY BILL 1625 (Sections 12023, 12024, and 12026, Fish and Game Code)

Assembly Bill 1625: This Act, approved by the Governor on September 12, 1998, adds Sections 12023, 12023, and 12026 to the Fish and Game Code.

Section 12023: Any person that violates Section 6400 through the use of aquatic nuisance species, as defined in Section 6431, is guilty of a misdemeanor punishable by all of the following:

- 1) Imprisonment in county jail for not less than six months or more than one year, a fine of not more than fifty thousand dollars for each violation or both imprisonment and fine.
- 2) Revocation of all of the defendant's licenses and permits issues pursuant to this code. A defendant is also liable to the owner of any private or publicly owned property for any monetary damages directly, indirectly and proximately caused by the violation. This also covers escape of aquatic nuisance species, but exempts release through discharge or

exchange of ballast water. Also exempt are persons unaware that he or she dis in possession of a plant.

Section 12024: A person that violates Section 6400 is liable for all public and private response, treatment, and remediation efforts resulting from the violation, including administrative, legal and public relations costs.

Section 12026: Any person that provides information or evidence leading to the arrest and conviction of a person or persons found guilty of violating Section 6400 is eligible to obtain a reward of up to fifty thousand dollars.

BALLAST WATER (Sections 6432, 6433, Fish and Game Code)

Section 6432: Requires the adoption of International Maritime Organization guidelines for ballast water exchange for all vessels prior to entering California waters.

Section 6433: Requires the department to adopt a ballast water control report form, consistent with the U. S. Coast Guard (USCG) to monitor compliance and shall assist with distributing these forms to vessels.

This has been deferred at the suggestion of USCG pending release of their regulations, expected in April 1999. The State of California (OSPR) and USCG have signed a cooperative agreement affecting various maritime programs; ballast water programs would be subject to such an agreement.

SALE AND TRANSPORTATION OF AQUATIC PLANTS AND ANIMALS (Section 238, Title 14, California Code of Regulations)

Section 238 regulates the sale and transportation of live aquaculture products by requiring sales invoices and waybills and requiring that all aquaculture products be killed before leaving retail sale premises.

STOCKING OF AQUACULTURE PRODUCTS (Section 238.5, Title 14, California Code of Regulations)

Section 238.5 is designed to prevent the unwanted introduction of exotic species, by regulating the private stocking of live fish. It requires a stocking permit for the private stocking of all waters except (1) lakes operated under a Cooperative Stocking Agreement with the Department, and (2) private ponds in the central valley and southern California when the species are limited to certain species designated in this section (common game fish species already established in these parts of the State).

TRIPLOID GRASS CARP STOCKING (Section 238.6, Title 14, California Code of Regulations, Sections 6450-6458, Fish and game Code)

These regulations and statutes regulate the private stocking of triploid grass carp for the control of nuisance aquatic vegetation. Restrictions include stocking permit application

review requirements to assure stocking only in safe areas, testing and verification of triploidy (sterility), tagging requirements, monitoring of stocked areas to prevent unauthorized movement of fish, and other restrictions.

BAIT FISH (Sections 4.00 through 4.30, 200, 200.10, 200.12, 200.13, 200.29 and 200.31, California Code of Regulations).

Sections 4.00 through 4.31 provide general statewide restrictions on the species allowed for use as live bait, specific restrictions by regulation district, and in some cases, specific restrictions by water body. Sections 200 through 200.12 provide license requirements for live freshwater bait dealers and restrictions on the transportation and sale of live bait. Sections 200.13 and 200.31 restrict the species sold by live bait. Section 200.29 provides restrictions by species and location on the sources of live bait.

CONTROL MEASURES FOR NON-NATIVE FLORA AS PART OF MANAGEMENT PLANS FOR DFG-MANAGED ECOLOGICAL RESERVES AND WILDLIFE AREAS (FISH AND GAME COMMISSION POLICY; CCR, TITLE 14 § 550 AND 630)

Each ecological reserve and wildlife area is managed by the Department of Fish and Game by separate specific plan. The management plans are written in conformance with the California Environmental Quality Act, usually as mitigated Negative Declarations. The Department of Fish and Game's goals to manage and control impacts of prohibited/detrimental species on natural ecosystems in California through (a) leading efforts to eradicate detrimental animal and plant species from wildlife communities and (b) seeking legislation to reduce the number of exceptions in the law that allow prohibited species to be imported and to increase fines and penalties for the introduction of illegal species into the wild.

TAKING OF HARMFUL FISH (Section 5501, Fish and Game Code)

The department may, or prescribe the terms of a permit to, take any fish that is unduly preying upon any bird, mammal or fish or is harmful to other species and should be reduced in numbers.

Hydrilla (FOOD AND AGRICULTURAL CODE SECTIONS 6048-6049)

These code sections deal specifically with the aquatic plant Hydrilla (*Hydrilla verticillata*). The codes specifically prohibit the production, propagation, harvest, possession, selling or distribution of Hydrilla. Fines and penalties are described for unlawful activities. The director of CDFA is also required to conduct an ongoing survey and detection program for Hydrilla. When discovered, the director is directed to immediately investigate the feasibility of eradication and do so if determined feasible.

In cooperation with the University of California, the U.S. Department of Agriculture or other agencies, the director of CDFA may develop and implement biological control methods to

eradicate or control Hydrilla in any area of the State and may conduct studies for these purposes.

In addition to exercising its statutory and regulatory authorities, the State also fosters research and education/outreach programs through various State and federal agencies and local organizations and institutions. Examples include the US Department of Agriculture-Agricultural Research Service, University of California and California State University system, the San Francisco Bay-Delta Interagency Ecological Program, the San Francisco Bay Institute and the Water Education Foundation. Implementation of this management plan is intended to assist the State in enhancing and better coordinating these programs and activities.

The Goals

Following are the three goals of the CALFED NIS Program with a brief explanation of the problem and some insight into the issues, current activities and necessary actions.

Goal I: Prevent new introductions of NIS into the ecosystems of the San Francisco Bay-Delta, the Sacramento/San Joaquin rivers and their watersheds.

Problem: The introduction of NIS into California, including inland state waters, frequently causes environmental, socioeconomic, and public health impacts. The severity of these impacts is not widely known or recognized which impedes the investment of resources needed to prevent new NIS introductions. Also, a delayed "crisis-response" approach often limits the vision and opportunity for the prevention of new introductions, leaving California with NIS management problems that are economically costly, technically challenging, if not infeasible to solve, and frequently irreversible. Although numerous NIS already have been introduced into California ecosystems, new introductions continue to occur. The prevention of new introductions is critical in the amelioration of NIS problems in California.

California has a long and successful history of preventing the introduction of exotic invasive pests that threatened California agricultural and natural resources. The strategy of CDFA's Pest Prevention System is consistent with the strategies of the Aquatic Nuisance Species Plans currently developed by other states (Washington, Ohio, New York, etc.) and regions (Colorado River Basin). A major component of CDFA's Pest Prevention systems is the Pest Exclusion Program which includes a statewide network of border station and port inspection activities. Although these areas of inspection concentrate on agricultural pests, they have intercepted non-native aquatic species. For example, California border station employees have intercepted 18 vessels, from eastern and mid-western states, that contained zebra mussels. Three of these vessels contained live zebra mussels. A fourth vessel was so heavily infested that live specimens were probably present and treatment was recommended prior to allowing the vessel into California waters.

Detection of zebra mussels and other NIS at the border stations has potentially saved hundreds of millions of dollars in economic losses associated with impacts to water conveyance systems, hydroelectric power plants and loss or alteration of natural aquatic habitats. California will benefit by expanding CDFA's Exclusion Program to include NIS. The US Department of Agriculture and US Department of Interior should enter into partnership with CDFA and the California Resource Agency to identify ways to expand CDFA's Exclusion Program and obtain the needed funding to accomplish this task. The CALFED Program could play a vital role in facilitating this effort.

Multiple mechanisms transport NIS into California's waters and some mechanisms transcend the authority of a single state to control. A prime example is ballast water discharge from transoceanic shipping, the largest source of nonindigenous aquatic species invasions worldwide {Carlton 1985}. Cooperative efforts are necessary between state, federal (i.e., Coast Guard and USDA), and international agencies to promulgate and enforce

regulations to ensure that ballast management practices and other related transport mechanisms are employed to prevent NIS introductions. There is much attention currently directed at the efforts in the San Francisco Bay to encourage responsible ballast water management practices through the use of existing regulations. There is more extensive discussion of these activities in the Policy Background section.

Current technology is frequently inadequate to prevent new introductions of NIS into California ecosystems. Research on prevention strategies to minimize NIS transport, such as innovative ballast water management technology, is critical in the effective prevention of NIS introductions. Ongoing studies by the U.S. and Canadian Coast Guards indicate that it is especially important to deal with the difficult problem posed by vessels entering the coastal and major navigable waters with residual un-pumpable ballast water and sediment in their tanks. This medium, potentially harboring a variety of NIS, is often mixed with California's fresh water and discharged at another California location or port. In order to achieve more effective emptying or flushing of these tanks, the feasibility of altering the current design of ballast tanks needs to be examined. Other significant transport mechanisms increasing the potential for new introduction of NIS into California include the aquaculture business, commercial barge traffic, recreational boating, the bait industry, the pet shop trade, plant nurseries, and fish stocking activities- all of which have the potential to introduce NIS as well as associated parasites and other disease organisms. The pet shop and aquatic plant nurseries trade are quite problematic, offering increasing numbers of easily introduced aquatics like Hydrilla. In some cases, such activities are subject to little or no regulation. In cases where laws and regulations do exist, they are frequently not well publicized or enforced. There are often gaps in the current laws. There is further explanation of the existing laws in the Policy section. An extensive effort must be made to reach out to user groups that could potentially introduce NIS into California and are generally not adequately informed of NIS prevention practices.

Goal II: Limit the spread or, when possible and appropriate, eliminating populations of NIS through management.

Problem: The spread of established populations of NIS into uninfested areas is often via human activity, such as boat transfers, ballast exchange, bait handling, water transport, intentional introduction by anglers, and ornamental and landscape practices. Limiting the spread of such populations is problematic due to the numerous pathways of dispersal, the complex ecological characteristics associated with NIS populations, and the lack of technology that is needed to limit the spread.

Many public and private resource user groups are not aware of existing infestations of NIS in San Francisco Bay, Sacramento-San Joaquin Estuary, or the inland waters of California, and why they cause problems. The probability of NIS spread to other waters can increase when resource user groups are not aware of the consequences of illegal introductions of NIS, or how their routine activities can cause the dispersal of NIS into uninfested areas. An information and education program is needed to provide information on why the spread of NIS populations needs to be limited, how the NIS populations can be reduced, and also the value of healthy ecosystems that support a diverse native community. Information and

education is also critical to strengthening public and private support for statewide participation in NIS management strategies.

It is also difficult to manage the spread of NIS since infestation frequently occurs in watersheds that occupy more than one county. Cooperation among all counties in California sharing NIS infested watersheds is needed to implement consistent management strategies that will effectively limit the spread of NIS populations.

Goal III: Reduce the harmful ecological, economical, social and public health impacts resulting from infestation of NIS through appropriate management.

Problem: The NIS infestations in California can have ecological, economic, social and public health impacts. Strategies to control NIS and efforts to abate their impacts are not always known or technically and/or economically feasible. It should be recognized that these efforts are no substitute for prevention, which should always be the highest priority.

The NIS infestations in California's aquatic ecosystems can alter or disrupt existing ecological processes. Without co-evolved parasites and predators, some NIS out-compete and even displace native plant or animal populations. As part of this process, the invading species can also influence the foodwebs, nutrient dynamics, and biodiversity of the ecosystems. To abate the ecological impacts of the invading organism, it is necessary to understand the mechanisms by which the species disrupts the natural balance of the ecosystem.

Some introduced NIS to California have provided economic benefits, such as those supporting the aquaculture business and sportfishing industry. However, several NIS have been found to cause adverse economic impacts. Organisms invading California's waters can threaten public health through the introduction of disease, concentration of pollutants, contamination of drinking water, and other harmful human health effects. An extensive abatement system for these NIS needs to be established to prevent human health problems from occurring in California.

It is often difficult to assess the ecological, socio-economic and public health impacts of NIS in terms that are meaningful to decision makers and the general public. Actions to abate NIS impacts through control strategies are frequently impeded by circumstances, such as the absence of political support and the lack of resources needed to effectively develop and implement control strategies.

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