ANS
Aquatic Nuisance Species
DIGEST

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FRESHWATER FOUNDATION

Providing current information on monitoring and controlling the spread of harmful nonindigenous species.

Salvinia molesta: Around the World in 70 Years

By Colette Jacono and Bob Pitman

Salvina molesta, a U.S. Federal Noxious weed, is becoming a significant ecological and economic issue in the United States. Due to its adaptations and aggressive growth, this plant has the potential to infest the country's ponds, lakes, streams, and wetlands at alarming rates. Populations of *Salvinia molesta* can negatively impact boating, irrigation, drinking water, hydroelectric plants, and water recreation. Once introduced to a water body, *Salvinia molesta's* rapid growth rate can have devastating ecological impacts, choking out all aquatic life.

Biology and Characteristics

Salvinia represents a single genus in a family of remarkably adapted water ferns that are free-floating and covered with a velvety coat of hairs. Ten species occur worldwide; seven originate in the neotropics (South America, West Indies, and tropical North America) including *Salvinia molesta* or giant salvinia. None of the species in this genus is native to North America.

Giant salvinia grows naturally in a small region of southern Brazil, along the coast between latitudes 24° and 32° S and inland to elevations of 900m (Forno and Harley 1979; Forno 1983). In these areas, this species is not especially abundant. Yet, outside of its native range,

***Salvinia** continued on page 14*

Figure 1. *Salvinia molesta*
Photograph by Randy J. Helton, Texas Parks and Wildlife Department

Caulerpa taxifolia: Marine Algal Invader Provokes Quick Response in U.S. Waters

By Lars W. J. Anderson and Sandra Keppner

The U.S. got a wake-up call on June 12th, 2000 when a notoriously invasive and destructive marine alga, *Caulerpa taxifolia*, was discovered just 30 miles north of San Diego, CA, in the small, protected lagoon, Agua Hedionda. Fortunately, earlier alarms had been sounded in the mid 1980s when the spread of this plant, in the Mediterranean Sea off the coast of Monaco, was documented and publicized. In this case, there was a great deal of controversy about the algae's introduction, but observers soon became clear that this particular strain of a very common marine aquarium-type plant was spreading rapidly, smothering native plants, and altering the littoral and lower-littoral habitats.

Dr. Alexandre Meinesz (1999) recently chronicled the interesting history of the European reaction to this invader. Dr. Meinesz, who has worked on this plant extensively, has long been a strong advocate for aggressive control and eradication. In spite of what seemed to be a clear threat to the marine habitat off Monaco, the response to the Mediterranean spread was plagued with delays and disagreements about the severity of the situation. As a result, within a few years, the population spread from a few square meters in 1984 to

***Caulerpa** continued on page 21*

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Direct questions and comments about *ANS Digest* to: Jeanne Prok, Freshwater Foundation, Gray Freshwater Center, 2500 Shadywood Road, Excelsior, MN 55331; (888) 471-9773; e-mail: Jeanne@freshwater.org.

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Sea Grant Minnesota

ANS Task Force

Salvinia *continued from page 1*

Salvinia molesta has a reputation as bad as its name. Since the 1930s, when it was first introduced to Sri Lanka, the distribution has expanded tremendously, becoming established in tropical and subtropical regions. In India, Southeast Asia, Australia, New Zealand, and South Africa plants can grow to enormous proportions on slow moving rivers and lakes and become a vigorous weed in rice paddies.

Giant salvinia bears little resemblance to familiar terrestrial ferns. The smallest individual plant consists of three leaves attached to a horizontal, floating stem. Two are green, emergent or floating, and ovate in shape. The surfaces of these leaves are covered with rows of white, bristly, cylindrical hairs topped with four branches that are joined at the tips to form a cage, similar to an eggbeater. These hairs give the plant a velvety appearance and repel water. A third leaf is found underwater, is brown in color, and highly divided. This leaf grows to great lengths and stabilizes the plant. Although looking much like a root, it is not known to function as one. However, it is considered a leaf because it bears sori, or sporocarps. All ferns bear sori on their fronds or leaves. Although the sori may become quite numerous, this species is believed to be functionally sterile (Loyal and Grewal 1966).

Like many aquatic plants, giant salvinia reproduces vegetatively. Its stems fragment easily and daughter plants arise from lateral buds. Stems carry as many as five buds at each node (Lemon and Posluszny 1997). This helps explain giant salvinia's prolific growth and potential for dormancy.

Depending upon environmental conditions, giant salvinia assumes variable sizes and forms. Colonizing or immature individuals have small leaves, less than a centimeter in length, that lie flat on the water surface. As leaves expand to several centimeters, populations become crowded and leaves start to turn upward. Eventually the leaves turn vertically as plants press into dense mats (Mitchell and Thomas 1972). Under proper conditions, mats may develop up to a meter thick, becoming nearly impenetrable by large boats (Thomas and Room 1986a).

Dominant features of giant salvinia are its phenomenal growth and reproductive rates. A single plant can multiply quickly to cover 40 square miles in only three months (Creogh 1991-1992). Under optimal conditions, an individual plant can double in size from every two to four days in the laboratory, to about a week's time in the field (Gaudet, 1973; Mitchell and Tur 1975; Mitchell 1979), forming thick mats that can cover the entire surface of ponds, lakes, and wetlands. It is able to withstand persistent drought conditions in moist soil. However, giant salvinia is strictly a freshwater species and will not tolerate salinity above 7ppt (Divakaran et al 1979).

Introduction and Spread in the U.S.

For decades giant salvinia has been listed as a U.S. Federal Noxious Weed. This helped to prohibit its importation and transport across state lines. The first sighting in the U.S., outside of cultivation, was an outbreak reported in 1995 in a 1.5-acre South Carolina pond. *Salvinia molesta* has not reappeared at this site since control measures were completed in 1995. This is the only site in the United States considered eradicated. *Salvinia molesta's* presence in the aquatic plant market in the early 1990s is likely the mode in which this malignant fern began escaping in other southern states.

Giant salvinia was first identified in Texas in May 1998, at a schoolyard demonstration pond. This infestation was most likely the result of an aquarium release. Within a few months, populations were found at farm ponds and by summer 2000, at the Toledo Bend Reservoir, a 186,000-acre impoundment on the Texas/Louisiana border. To date, four public reservoirs, five rivers or streams, and more than 20 ponds have been confirmed with *Salvinia molesta* in the two states. While more than 1200 acres of giant salvinia were treated at Toledo Bend Reservoir during the 2000 growing season, extensive coverage still remains. Aerial photography in July 1999 revealed a dense infestation, 300-400 yards wide and 2-3 miles long, in the Swinney Marsh complex, a vast swamp on the Lower Trinity River (Helton 2000). Inaccessible by boat and full of obstructions, sites such as Swinney Marsh are very difficult to treat with chemicals. While drought conditions reduced the water level in the marsh in 2000, the plants are expected to persist in damp soil.

Many infested sites in southeast Texas are on private property, but adjacent to federal conservation lands. This region is valued for the habitat it provides to migrating waterfowl. Big Thicket National Preserve (an international Biosphere Preserve), Texas Chenier Plane National Wildlife Refuge Complex, and Brazoria National Wildlife Refuge Complex are highly vulnerable. A newly acquired 800-acre forested lake at Trinity River National Wildlife Refuge was

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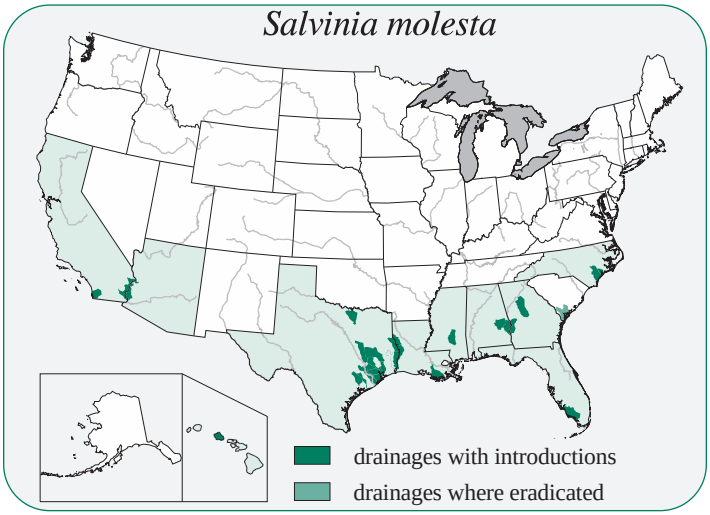

Figure 1. *Salvinia molesta* has been found at over 60 locations in 28 drainages of ten states: Texas, Louisiana, Mississippi, Alabama, North Carolina, Georgia, Florida, Arizona, California and Hawaii.

infested in the summer of 2000.

Since May 1998, giant salvinia has been found at over 60 locations in 28 drainages of ten states: Texas, Louisiana, Mississippi, Alabama, North Carolina, Georgia, Florida, Arizona, California and Hawaii. Important western infestations were discovered August 1999 on the Lower Colorado River at Imperial National Wildlife Refuge, bordering Arizona and California. The weed apparently originated in the Palo Verde Irrigation District Western Drain and fragments floating downstream found their way to the Lower Colorado River. Here, this invasive fern threatens the fish and wildlife backwater habitats of the Colorado River.

Control Measures

Extensive control efforts at relatively small, contained sites hold promise. Mississippi Department of Wildlife and Fisheries completed herbicide measures at the only site containing giant salvinia in that state, a quarter acre farm pond. *Salvinia molesta* has not returned to this site. Four ponds in Alabama appeared *Salvinia*-free following herbicide treatment in 2000 by the Alabama Department of Conservation and Natural Resources and the Army Corps of Engineers, just as a new pond was found infested in October 2000. Both systemic and contact herbicides have been used at ponds in these two states. In September 2000, the Florida Department of Environmental Protection and the Florida Department of Agriculture and Consumer Services identified the source of reoccurring plants in the Naples canal, giving them a good chance at eliminating plants in the only known infested area in Florida.

Repeated volunteer efforts to mechanically remove giant salvinia from the freshwater portion of a lagoon in Oahu, Hawaii, have abated an occurrence there. Unfortunately, funding remains unavailable to treat less than one acre of plants at a large public lake. New infestations of giant salvinia have since been identified in two streams on Oahu.

The coldest winter in 80 years was not enough to freeze out giant salvinia in North Carolina. Stratford Kay and Steve Hoyle, North Carolina State University, discovered giant salvinia rampant along the coast in three low lying regions in September 2000. Concern now centers on a swampy riverside site that serves as a source of infestation for distribution down the North East Cape Fear River. In January 2001, Hoyle photographed new green leaves developing on frost-damaged plants along the shoreline of golf course ponds in Wilmington following exposure to 14-19° F over a two-week period. However, these observations, based on resistance to cold air temperatures, should not be a surprise. Whiteman and Room (1991) warned that giant salvinia will persist in areas that experience frost, but not the formation of ice on fresh waters. During heavy frosts, emergent growth may be killed back, but submersed stems, insulated by the water, often survive. In the spring, populations can resurge from many dormant lateral buds embedded deep in the stems. Nursery dealers in North Carolina (34.4°N) and a pond owner in northern Texas (33°N) reported plants resurging after top growth was killed by frost.

Control or eradication of giant salvinia is difficult. Three characteristics of the fern make it resistant to herbicides and freezing; (1) buds and stems are below the water surface, (2) the leaves are virtually unwettable due to air trapped in the specialized hairs that cover their upper surface, and (3) the thick mats protect plants embedded within it. If chemical control is explored, surfactants will be necessary as an ingredient to penetrate the surface tension of leaf hairs. Giant salvinia is susceptible in varying degrees to common herbicides such as 2,4-D, hexazinone, and diquat. A recently developed chelated copper herbicide, Nautique®, used in combination with Reward® (diquat) was very effective on thinly matted infestations at Toledo Bend Reservoir (Hyde and Temple 1998).

Mechanical methods of management are limited. Extreme growth rates along with the weight of the matted plant make these options very expensive and labor intensive. Floating booms and nets may be useful to isolate certain areas, but pressure from windblown mats has been known to break 3- inch steel cables and rip their anchors from the banks (Thomas and Room 1986a).

Biological control should be central to any plan to control and manage giant salvinia. Releases of *Cyrtobaguous salviniae*, the salvinia weevil, have achieved great success in many parts of the world, such as

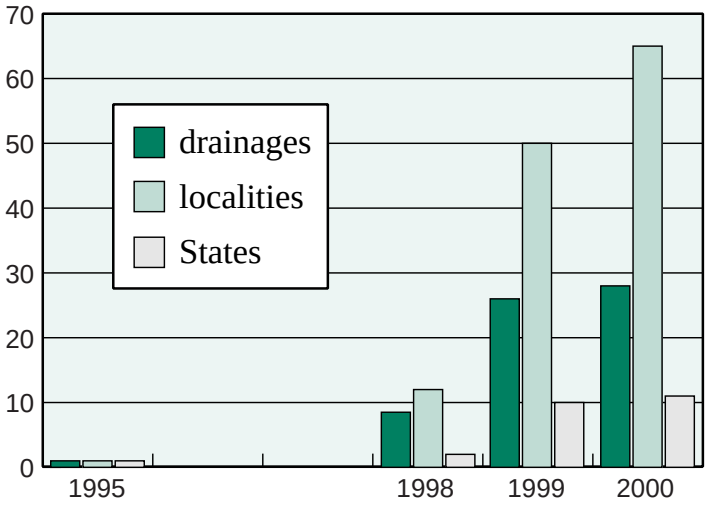

Figure 2. Yearly new occurrences of giant salvinia have increased since 1995.

on the Sepik River in New Guinea (Thomas and Room 1986b) and in South Africa (Cilliers 1991). Originating from the home range of *Salvinia molesta*, it selectively damages the plant by feeding on buds and tunneling through stems. Large populations can be reduced and maintained at low densities (Room et al 1981). The salvinia weevils were accidentally introduced to southern Florida sometime before 1960. Jacono et al (2001) found it abundantly on common salvinia throughout Florida, but not in other southern states. Feeding by the salvinia weevil is believed to account for the lesser aggressiveness of

Salvinia *continued on next page*

common salvinia in Florida, compared to its extreme growth observed in Louisiana and Texas (Jacono et al, 2001). However, recent molecular evidence indicates that weevils in Florida may be genetically different from those released in Australia. While apparently suppressing the growth of common salvinia, this weevil may not have a similar appetite for giant salvinia. Currently the U.S. Department of Agriculture's Invasive Plant Research Laboratory, Ft. Lauderdale, FL, is working on importing Australian weevils, but field releases will be delayed until the Aussie weevils are held and tested to ensure they pose no threat to native North American plants.

"A single plant can multiply quickly to cover 40 square miles in only three months."

Public education and awareness are the most important measures to prevent new introductions and contain existing infestations. Spreading the word about giant salvinia to field biologists, horticulturists, sportsman, etc., continues by scores of hard workers in many states. Newspaper articles, TV spots, magazine and journal pieces, public workshops, flyers, and increased visits to plant nurseries have all contributed to a heightened awareness of this new invader.

An added benefit of the awareness resulted in several state agencies listing or initiating legislation to prohibit this and other nonindigenous aquatic species. In the case of *Salvinia*, it is recommend that the entire genus be included in noxious weed legislation. *Salvinia molesta, S. minima, S. oblongifolia* and *S. natans* have all been recently advertised in the nursery trade. *Salvinia minima* has naturalized as far north as central Arkansas. *Salvinia oblongifolia* is sensitive to cold temperatures, likely not tolerating drops below 50 ° F, but could naturalize in southern Florida. On the other hand, *S. natans*, a sexually reproducing, temperate species is quite capable of becoming naturalized in our truly temperate states. *Salvinia sp*. generally look alike and even botanists often mistake the similarly appearing species. Without training or the presence of sporocarps on specimens, the *Salvinia* species can be difficult to distinguish. In addition, since no *Salvinia* species are native to North America, excluding the entire genus may prove appropriate.

Without adequate control measures, environmental consequences of giant salvinia are expected throughout the southern U.S. Giant salvinia has the potential to alter aquatic ecosystems by overgrowing and replacing native plants. Dense mats block sunlight and decrease oxygen concentrations to the detriment of fish and other aquatic animals. When plant masses die, decomposition lowers dissolved oxygen still further. Rice, an important crop in coastal and river delta areas, requires flooded, nutrient rich fields. These areas also provide ideal conditions for the propagation of giant salvinia. The crawfish and catfish industries, of great importance in the central Gulf area, are equally susceptible to environmental modifications. Large numbers of commercial and private fishing boats are dependent for transportation on bayou and canal systems, which are often eutrophic, making them ideal habitats for giant salvinia. Recreation activities such as sport fishing, waterfowl hunting, boating, and swimming may be curtailed if this malignant weed is allowed to invade this area.

Progress has been made in early detection, alert schemes, and education on giant salvinia since the first Texas discoveries in 1998. Many states experiencing infestations responded immediately by eliminating plants in small water bodies; increasing nursery inspections and expanding survey efforts. In other states, however, natural resource agencies are under-funded and lack adequate aquatic plant surveying, monitoring, and management programs, so that many populations remain untreated and are allowed to spread. Fundamental questions on the biology of *Salvinia* need to be answered for accurate range predictions and to support management decisions, yet little funding is currently available for researching this genus. State agencies need help on a wide range of related issues, from assistance in drafting noxious weed legislation to supporting the availability and success of the biological control agent. While there have been some successes, there is still much to do before this high profile genus is under complete control in our vital aquatic environments.

Colette C. Jacono is a botanist at the United States Geological Survey's Florida Caribbean Science Center. She is also a member of the Salvinia Task Force representing USGS.
Contact Colette at: U.S. Geological Survey (352-378-8181 X315) or email: Colette_Jacono@usgs.gov

Bob Pitman is the Invasive Species Coordinator for the Southwest Region of the U.S. Fish and Wildlife Service. Mr. Pitman is the co-chair of the Lower Colorado Giant Salvinia Task Force and chairman of the National Conference to Coordinate Efforts to Prevent the Spread of Giant Salvinia.
Contact Bob at: U.S. Fish & Wildlife Service (505-248-6471) or email: bob_pitman@fws.gov

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News from the Great Lakes Panel on Aquatic Nuisance Species

ANS UPDATE

Fall/Winter 2000 *Volume 6, No. 4*

Great Lakes Panel Update

The Great Lakes Panel on Aquatic Nuisance Species convened in Ann Arbor, Mich., on Dec. 12-13, 2000, where several important Panel initiatives were addressed. It was announced that seven of the eight Great Lakes governors have signed the Great Lakes Action Plan to date, and signatures from the remaining governor and two premiers are anticipated soon. This is a significant indication that decision makers are focusing their attention on the critical problems caused by biological invasions. Panel members also established a process for adoption of the Ballast Water Management Policy Statement. The statement, drafted by a Panel subcommittee, offers guidance to regional policymakers in the development and implementation of measures that are both effective and economically viable. The policy statement will be finalized by the end of the calendar year with incorporation of input offered at the meeting. The Panel's draft Information/Education Strategy on Aquatic Nuisance Prevention and Control was also presented for approval. The strategy's associated implementation plan, providing details on responsible parties, funding sources, proposed budgets, and timelines regarding information/education strategic actions, was discussed, with approval expected by February 2001.

Panel members also initiated planning for a spring symposium that will serve as the primary component of a project titled, "Preparing for the Next Decade in ANS Prevention and Control" (see feature story for more information). The symposium, to be held May 16-17, 2001, in Ann Arbor, Mich., will explore the steps needed to advance ANS prevention and control in the Great Lakes-St. Lawrence region in light of the upcoming reauthorization of the National Invasive Species Act. There will be a special focus on ballast water management, along with the other significant vectors of ANS introduction and spread. Funded by U.S. EPA's Great Lakes National Program Office, the project is being conducted by the Great Lakes Commission in cooperation with the Panel. **Contact:** Katherine Glassner-Shwayder, Great Lakes Commission, 734-665-9135, shwayder@glc.org

News from Around the Basin

ILLINOIS: The state has received its first ANS Task Force grant through the U.S. Fish and Wildlife Service to implement its comprehensive state management plan. Efforts are currently focused on establishing a contractual position of Aquatic Nuisance Species Coordinator, along with clerical support staff. **Contact:** Mike Conlin, IL DNR, 217-782-6424, mconlin@dnrmail.state.il.us.

INDIANA: The DNR's Division of Fish and Wildlife welcomes Gwen White to the position of Fisheries Program Specialist and ANS Coordinator. Anglers are reporting catches of more large tropical fish (pacu, aruana, piranha) in natural lakes and streams. Grants were provided to 17 lake associations for cost-share on chemical treatment of invasive aquatic plants. A three-year study is underway to test effectiveness of weevils for biological control of Eurasian watermilfoil. **Contact:** Gwen White, IN DNR, 317-232-4093, gwhite@dnr.state.in.us.

MINNESOTA: The infestation of zebra mussels in Duluth-Superior harbor is growing and expanding. Divers report that nearly all hard-bottom surfaces in the lower harbor, including native mussels, are covered with zebra mussels. Marinas report that recreational boats removed for the season are also heavily fouled. Despite new sightings and expansions, boater and angler education continues to be effective in preventing and slowing the spread of aquatic nuisance species. ANS news releases have resulted in significant coverage on major television and radio stations and in newspapers. **Contacts:** Doug Jensen, MN Sea Grant, 218-726-8712, djensen1@d.umn.edu; Jay Rendall, MN DNR, 651-297-1464, jay.rendall@dnr.state.mn.us.

NEW YORK: Federal ANS funding was received by the state this fall to support the following programs: 1) Finger Lakes Zebra Mussel Monitoring and Ecological Assessment Program (FLZMMEAP) and 2) Purple Loosestrife Control in the Lower Hudson Valley. The FLZMMEAP will continue an ongoing study to monitor water chemistry and ecological parameters in nine morphologically similar lakes, some of which have been colonized by zebra mussels since 1995. The purple loosestrife project will focus efforts on the release of a large number of herbivorous insects for control of purple loosestrife stands in the Lower Hudson Valley that will be monitored over the next year. **Contact:** Timothy Sinnott, NYSDEC, txsinnot@gw.dec.state.ny.us.

WISCONSIN: Attack Packs, which are used as a teaching kit for exotic species, continue to gain popularity. More than 30 Attack Packs, prepared by Wisconsin Sea Grant, have been distributed to high schools around the state. The teaching kit is available from Phil Moy of Wisconsin Sea Grant, who can be contacted by email: pmoy@uwc.edu or phone: 920-683-4697. The state has established an ad hoc committee to develop a permitting policy for nonindigenous species used in aquaculture activities. **Contact:** Ron Martin, WI DNR, 608-266-9270, martir@dnr.state.wi.us.

National ANS Task Force

The ANS Task Force convened Nov. 28- 29, 2000, in Arlington, VA. A major focus of the meeting was to look at the relationship between the regional panels and the ANS Task Force to determine how to improve the integration process. The ANS Task Force members also discussed recent activities relative to their ballast water program, including recommendations on development of ballast water standards and research activities. The executive director of the Invasive Species Council provided an overview of the development of the National Management Plan, as well as ways that the Task Force and Council could work together to address invasive species issues. The Task Force recognized Sally Yozell, former Task Force co-chair representing NOAA, for her years of work and dedication in support of the Task Force. Several committees provided updates and recommendations, including the Communication, Education, and Outreach Committee and the Risk Assessment and Management Committee. **Contact:** Sharon Gross, executive secretary, ANS Task Force, 703-358-2308, sharon_gross@fws.gov.

Upcoming Events

Symposium: Looking Back Forward: Assessing ANS Prevention and Control. May 16-17, 2001, Ann Arbor, MI **Contact:** Michael J. Donahue, Great Lakes Commission, 734-665-9135.

Meeting of the Great Lakes Panel on Aquatic Nuisance Species. May 18, 2001, Ann Arbor, MI **Contact:** Kathe Glasssner-Shwayder, Great Lakes Commission, 734-665-9135.

11th International Conference on Aquatic Invasive Species (formerly known as the Zebra Mussel Conference). Oct. 1- 4, 2001, Alexandria, VA. **Contact:** Elizabeth Muckle-Jeffs, 800-868-8776.

On The Bookshelf

2001 Calendar - Exotic Invasive Species of Illinois. Includes color pictures and species descriptions. **Contact:** Illinois Natural History Survey Publications Office, 217-333-6880, or rjohnson@mail.inhs.uiuc.edu.

Exotic Species Compendium of Activities to Protect the Ecosystem (ESCAPE). 2000. **Contact:** Division of Soil Conservation, IDNR, 317-233-3870, jhoffmann@dnr.state.in.us. For a courtesy copy, contact above or download from www.ai.org/dnr/soilcons/lare/plantcon.htm.

Managing Aquatic Plants in Indiana Lakes. **Contact:** Division of Soil Conservation, IDNR, 317-233-3870, jhoffmann@dnr.state.in.us. For a courtesy copy, contact above or download from www.ai.org/dnr/soilcons/lare/plantcon.htm.

National Ballast Survey 1st Annual Report. 2000. National Ballast Water Information Clearinghouse. Download from: invasions.si.edu/NABS1stAnnualReport.pdf

Purple Loosestrife WATCH ID cards. 2000. **Contact:** Mike Klepinger, MI Sea Grant, 517-353-5508, klep@pilot.msu.edu

Full copies of the ANS Update, a quarterly newsletter prepared by the Great Lakes Panel on Aquatic Nuisance Species, are available upon request from the Great Lakes Commission. **Contact:** Katherine Glassner-Shwayder, Great Lakes Commission, 734-665-9135, shwayder@glc.org.

Management of Aquatic Nuisance Species in

By John Christmas, Daniel Terlizzi, and Eric May

As elsewhere in the United States, concerns about aquatic nuisance species (ANS) have greatly increased in the Chesapeake Bay basin (Figure 1). This 64,000 square mile basin is comprised of portions of six states: Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia, as well as the District of Columbia. The Chesapeake Bay supports more than 200 species of fish, 40 species of bivalves, 28 species of submerged aquatic vegetation, and 27 species of waterfowl, as well as commercial fisheries for several species of finfish and shellfish. Concern about the ecological diversity and productivity of this ecosystem, and the potential effects of introductions of nonindigenous species such as zebra mussels, *D. polymorpha*; grass carp, *Ctenopharygodon idella*; Atlantic sturgeon, *Acipenser oxyrhynchus*; Pacific oyster, *Crassostrea gigas*; and Suminoe oyster, *C. ariakensis* served as the impetus for the development and evolution of a regional ANS policy.

A regional approach to the ANS issues in the Chesapeake Bay basin was first proposed by the Chesapeake Bay Commission (CBC), a tri-state legislative commission representing the General Assemblies of Maryland and the Commonwealths of Pennsylvania and Virginia. The CBC developed a statement on ANS, stating that: "It is the Policy of the Chesapeake Bay Commission to oppose the introduction of nonnative species into the Chesapeake Bay watershed for any reason unless comprehensive environmental and economic impact studies are conducted and thoroughly evaluated in order to ensure that risks associated with the introduction are minimized."

Although the Chesapeake Bay Commission provided a strong and clear position, the need for a more comprehensive policy was emphasized by several decisions about nonindigenous introductions into one jurisdiction that conflicted with the policies of other jurisdictions. For example, in 1992 Virginia approved a controlled, experimental introduction of the Pacific oyster, *Crassostrea gigas*, to evaluate resistance to the oyster diseases MSX and Dermo. These diseases have been responsible, in part, for the decline of the native eastern oyster, *C. virginica*. Ironically, it is believed MSX and Dermo are introduced pathogens that arrived in the Chesapeake Bay basin in oysters from other waters of the U.S. Maryland and Delaware resisted the introduction of the Pacific oyster because of concern that it might threaten the native eastern oyster, if successful reproduction, proliferation, and dispersal occurred.

Virginia's proposed introduction of the Pacific oyster led to divisiveness among some of the Chesapeake Bay basin jurisdictions. However, the threat of zebra mussels, sparked by the collection of veligers in New York's portion of the Susquehanna River during the early 1990s, created an atmosphere of common concern among all Chesapeake Bay jurisdictions. This threat encouraged cooperation and contributed to the eventual development of a cohesive regional ANS policy.

In 1992, the Living Resources Subcommittee (LRSC) of the Chesapeake Bay Program gave the Exotic Species Work Group (ESWG), created by the LRSC in 1991, a directive to formulate a comprehensive policy relating to ANS in the Chesapeake Bay basin. The adoption of the *Chesapeake Bay Policy for the Introduction of Non-Indigenous Aquatic Species* in 1993 represented a one-year, multi-jurisdictional effort by members of the ESWG, representing the signatory jurisdictions of the Chesapeake Bay Program (CBP): Maryland,

Figure 1. Chesapeake Bay Basin

Virginia, Pennsylvania, the District of Columbia, the Chesapeake Bay Commission, and the U.S. Environmental Protection Agency. The *Policy* was subsequently adopted by West Virginia and Delaware. The *Policy* addressed both intentional and unintentional introductions. The main thrust of the *Policy* is that it directs the signatory jurisdictions of the CBP to "oppose the first time introduction of any ANS into the unconfined waters of the Chesapeake Bay and its tributaries for any reason unless environmental and economic evaluations are conducted and reviewed in order to ensure that risks associated with first-time introductions are acceptably low." The signatories to this *Policy* are also committed to working together to prevent unintentional introductions of nonindigenous species within the Chesapeake Bay ecosystem." An implementation plan for the *Policy* was developed in 1994. The *Policy* is discussed at length in various other articles (Christmas and Terlizzi, 1995, Christmas et al. 2000, Terlizzi 1996).

A critical feature in the success of the *Policy* has been the open communication on proposed introductions facilitated by the *Ad hoc* panel, a procedure recommended in the ANS protocols of Kohler and Stanley (1984) and formally adopted in the *Policy*. To date, four introductions have been evaluated by *Ad hoc* panels: grass carp, introduced oyster, (Pacific and Suminoe oysters) and Atlantic sturgeon.

The *Ad hoc* panel process provides a unique opportunity for all jurisdictions to review risks associated with intentional first-time introductions of ANS. It also provides each *Policy* signatory the opportunity to approve or oppose proposed ANS introductions and to recommend protocols that will minimize risks associated with intentional introductions. Such a consensus approach for dealing with ANS issues is desirable, but has limitations. Adoption of an *Ad hoc* Panel's recommendations by the jurisdictional agency to which they are directed is voluntary, as the *Policy* has no regulatory authority. In addition, the Panel typically meets on a one-time basis, so responsibility for a follow-up on Panel recommendations is not always clear. The creation of these *Ad hoc* Panels, however, has achieved the *Policy* goal of carefully assessing, through a joint review process, proposed first-time introduc-

***Chesapeake Bay** continued on next page*

the Chesapeake Bay Basin: Past and Present

Chesapeake Bay *continued from previous page*

tions of ANS, and providing all signatory jurisdictions with an opportunity to comment.

Ballast Water

Ballast water is a major vector for the transport of aquatic organisms and is believed to be responsible for the introduction of zebra mussels into the U.S. Ballast water has only been a problem since the advent of iron-hulled ships. Prior to that time solid ballast was used, and ballast water has only been addressed in literature since the 1970s. Ballast water in the U.S. has been a major issue only since the 1980s. Today, it is estimated that every minute 40,000 gallons of foreign ballast water is dumped into U.S. waters. It is also estimated that on any given day as many as 3,000 aquatic species, ranging in size from bacteria to fish, are moving around the earth in ballast water tanks. Nationally, Norfolk, VA, and Baltimore, MD, rank 2nd and 5th in ballast water received, respectively receiving, nine million and three million metric tons of ballast water annually (Chesapeake Bay Commission 1995).

The first federal ballast water legislation in the U.S. occurred in 1990, as part of the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA), requiring the development of ballast water regulations and education for the Great Lakes Region. Funding was provided by NANPCA for the National Biological Invasion Shipping Study, which evaluated ballast water discharge into 226 U.S. ports.

The first Ballast Water Task Group in the Chesapeake Bay basin was formed in 1994 by the Chesapeake Bay Commission, in response to ballast water concerns addressed by the *Chesapeake Bay Policy on the Introduction of Non-Indigenous Species*, which was adopted in 1993 by the Chesapeake Bay Program. It was charged with the responsibility of identifying and developing "options to eliminate, or substantially minimize, the risks associated with discharge of ballast water into the Chesapeake Bay."

In 1995, a Ballast Water Resolution was drafted by the Chesapeake Bay Commission and introduced to the General Assemblies of Maryland, Pennsylvania, and Virginia. Later in 1995 the Task Group published *The Introduction of Nonindigenous Species to the Chesapeake Bay via Ballast Water*. Subsequently, having fulfilled its objectives, the formal task group dissolved. In early 1996, the Chesapeake Executive Council issued a directive to the Living Resources Subcommittee, which required that the Exotic Species Work Group submit an annual report to the Chesapeake Executive Council summarizing all efforts made during the preceding year to minimize the adverse effects of ballast water discharge in the Chesapeake Bay Region.

With the enactment of the National Invasive Species Act (NISA), in October 1996, activities relating to ballast water concerns became increasingly important and the first annual report was prepared in 1998. In 1999 federal regulations were developed, pursuant to NISA, for voluntary ballast water exchange and reporting for all ships entering the U.S. Economic Exclusion Zone. Also, a National Ballast Water Clearinghouse was established as part of the Smithsonian Environmental Research Center's responsibilities relating to ballast water management.

Summary

In recent years, concerns about aquatic nuisance species have increased in the Chesapeake Bay basin, as well as elsewhere in the United States. In 1993, the Chesapeake Bay Program (CBP) adopted a regional policy which provides two primary mechanisms for addressing concerns associated with the first-time introduction of aquatic nuisance species: the critical issues forum and the *Ad hoc* panel review process. The critical issues forum has been used once, as the venue for a regional symposium on the pros and cons of stocking triploid grass carp. *Ad hoc* review panels have been used more frequently to evaluate the environmental risks associated with proposed introductions of Atlantic sturgeon, grass carp, Pacific oysters, and Suminoe oysters. Such processes allow for informed discussion and negotiation before actions with irreversible consequences are taken. Additionally, protocols have been developed to minimize the risks associated with zebra mussel research.

In the Chesapeake 2000 Agreement, exotic species were formally addressed for the first time. The relevant goals are as follows: 1) by 2002 identify exotic species with significant effects on the Bay ecosystem, 2) by 2004 develop and implement management plans for exotics species, and in 2000 work with federal authorities to encourage and support more stringent ballast water management (Chesapeake Bay Program 2000).

As part of a comprehensive restructuring of the CBP's Living Resources Subcommittee, in the spring of 2000, the Exotic Species Work Group was reformed as the Non-Native Invasive Species *Ad Hoc* Work Group (NISAW) (2000a). In part, this was undertaken to fulfill better the goals established by the Chesapeake 2000 Agreement, with NISAW establishing two task groups: 1) ballast water and 2) nonindigenous species (Noble 2001). The mission of NISAW is to: "coordinate, integrate, and promote non-native invasive species (NIS) programs and activities of signatory jurisdictions in order to establish CBP policies and plans for the prevention, control, and risk management of established, introduced, or documented potential non-native invasive species, and for the development of CBP intentional introduction policies. [Also] NISAW will coordinate with regional and national NIS efforts to control and prevent the spread of non-native invasive species (CBP 2001a,b)."

In closing, the *Policy* developed by the Chesapeake Bay Program in 1993 is one of the earliest regional policies relating to aquatic nuisance species in the United States. Experience with this *Policy* during the past seven years has proven that a non-regulatory, consensus-based approach to addressing inter-jurisdictional differences, relating to ANS, can be effective, and provides a useful model. As concerns about aquatic nuisance species have increased, many jurisdictions within the United States have adopted federally-funded Aquatic Nuisance Species Management Plans, an option that is presently being considered by the Chesapeake Bay Program. The majority of the components for such a regional plan have already been developed in the course of preparing the Chesapeake Bay Program's *Policy* and *Implementation Plan*. When developed and approved, such a regional plan could serve to more clearly focus efforts to better address issues relating to nonindigenous species in the Chesapeake Bay Basin. With the recent development of a National Invasive Species Management Plan, pursuant to the Invasive Species Executive Order of 1999, the desirability of such a regional plan is intensified.

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ANS Digest Volume 4 No. 1 included an article entitled *Cercopagis Invades the Great Lakes*. This article was written by the following: Carla Caceres, Illinois Natural History Survey; Patrice M. Charlebois, Illinois History Survey, Illinois-Indiana Sea Grant, University of Illinois Department of Natural Resources and Environment Sciences; and John Dettmers, Illinois History Survey.

Task Force Marks Ten Years of Achievement

The Aquatic Nuisance Species Task Force was established in 1990 as a result of the passing of the Nonindigenous Aquatic Nuisance Prevention and Control Act (reauthorized as the National Invasive Species Act, NISA, 1996), by the U.S. Congress. The Task Force consists of seven federal agency representatives and ten ex officio members. The purpose of the Task Force is to provide, in an advisory capacity, an intergovernmental mechanism for the development of a coordinated federal program to prevent and control nonindigenous aquatic nuisance species (ANS).

Over the past ten years, the ANS Task Force has focused their responsibilities on the objectives of the Nonindigenous Aquatic Nuisance Prevention and Control Act:

1) To prevent unintentional introduction and dispersal of nonindigenous species into waters of the United States through ballast water management and other requirements;
2) To coordinate federally conducted, funded or authorized research, prevention control, information dissemination and other activities regarding the zebra mussel and other aquatic nuisance species;
3) To develop and carry out environmentally sound control methods to prevent, monitor and control unintentional introductions of nonindigenous species from pathways other than ballast water exchange;
4) To understand and minimize economic and ecological impacts of nonindigenous aquatic nuisance species that become established, including the zebra mussel; and
5) To establish a program of research and technology development and assistance to States in the management and prevention of zebra mussel populations.

In 2000, the U.S. Fish and Wildlife Service hired Joe Starinchak as the ANS Task Force's new Outreach Coordinator. Previously, Joe worked for the Utah Division of Wildlife Resources, where he led the state's aquatic education program. As Outreach Coordinator, Starinchak initiated Task Force efforts by organizing a committee to address the areas of communication, education, and outreach (CEO). The CEO committee is charged with developing, implementing, and evaluating a comprehensive program that will:

- Raise awareness about the ANS issue on a national level by broadening the re-distribution of excellent outreach materials produced over the past ten years.
- Empower targeted audiences with prevention behaviors that will give them responsibility for the ANS issue, and allow them to become part of the solution in preventing and controlling ANS populations in the United States.
- Celebrate the 10th Anniversary of the ANS Task Force by highlighting past achievements.
- Support NISA reauthorization efforts by fully leveraging the collective experience of the ANS Task Force and CEO Committee members.

While this committee does provide new direction for the Task Force, one of its primary objectives is to use existing resources while engaging the Task Force infrastructure of the Regional Panels, other committees, and member organizations. The CEO Committee is currently in its formative stages of developing its program. If you have any questions or suggestions, please feel free to call Joe Starinchak at (703) 358-2018 or email: joe_starinchak@fws.gov or visit www.anstaskforce.gov.

more than 1,500 hectares presently (1 hectare is 10,000 square meters). While this situation still persists in Europe, scientists, researchers, and public action/regulatory agency staff in the U.S. recognized the threat and responded in an effort to protect valuable coastal resources.

The U.S. takes a pro-active approach

As early as October 1998, two years before *Caulerpa taxifolia* populations were found off the coast of California, the Department of Interior (DOI) was alerted to the possibility that the aquarium-bred tropical green algae *C. taxifolia* could become established in U.S. coastal waters. Over 100 research scientists requested the Secretary of Interior (Secretary) to initiate immediate action to prevent this strain of *C. taxifolia* from entering and becoming established in U.S. waters. The Secretary assigned leadership to the U.S. Fish and Wildlife Service (USFWS) and requested an investigation of *C. taxifolia* and its potential for establishment in U.S. waters.

In November 1998, the Service presented its findings to the Aquatic Nuisance Species (ANS) Task Force, an intergovernmental entity established under the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990. The report, *Caulerpa taxifolia: A Potential Threat to U.S. Coastal Waters*, provided an overview of important biological and ecological characteristics of the species, pathways and mechanisms of dispersal, ecological and economic impacts, and its potential range in the U.S. (Keppner et al. 1998). Based on the report findings, the ANS Task Force determined that the risk of an unintentional introduction of *C. taxifolia* (Mediterranean strain) through identified pathways was significant and the adverse consequences of an introduction would likely be substantial. According to provisions of NANPCA of 1990, these findings warranted development and implementation of a cooperative comprehensive prevention program to minimize risks of introduction.

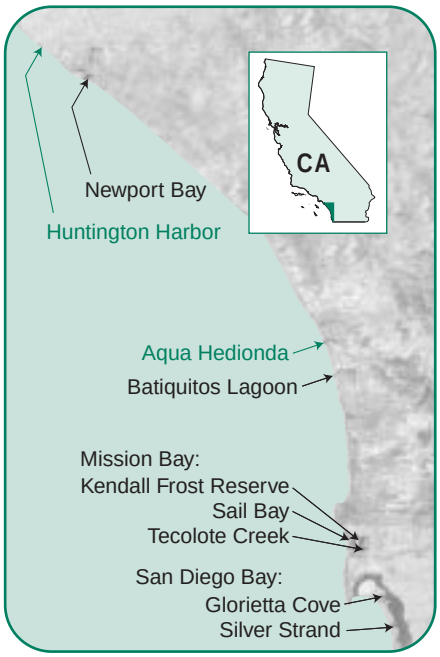

Figure 1. Location of Agua Hedionda Lagoon and Huntington Harbor, site of *Caulerpa taxifolia*, in relation to other southern California wetlands
Map by Rachel Woodfield

The ANS Task Force requested that the USFWS and the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) jointly develop a comprehensive program to prevent the introduction and establishment of *C. taxifolia* in U.S. waters. These agencies subsequently drafted *A Prevention Program for the Mediterranean Strain of Caulerpa taxifolia* (Prevention Program)(Keppner and Caplen 1999). Development was guided by existing legislative authorities including the NANPCA of 1990, existing programs such as the *Aquatic Nuisance Species Program* developed by the ANS Task Force, the Federal Noxious Weed Act of 1974, and the Executive Order 13112: Invasive Species.

The goal of the Prevention Program is to prevent the introduction, establishment, and dispersal of the invasive Mediterranean strain of *Caulerpa taxifolia* in U.S. waters. The draft Prevention Program consists of nine comprehensive components. Within each component, action items are recommended to achieve the overall goal of the Prevention Program through long-term and short-term strategic planning. The nine components include: Coordination and Leadership; Dispersal Mechanisms and Pathways Analysis; Surveillance and Detection; Control; Research; Regulatory; Legislation; Education; and International Activities. Successful implementation of the program is dependent on establishing and maintaining effective partnerships among international, federal, state, tribal, private, and public organizations. Future revision and updates to the Prevention Program will be necessary to refine prevention strategies and to ensure that implementation is effective, efficient, and environmentally sound.

The ANS Task Force established a *Caulerpa taxifolia* Prevention Committee (Committee) to review and refine the draft Prevention Program, prioritize recommended actions, and oversee implementation. Representatives from various affected entities including federal and state resource agencies, research, education, and industries such as both large and small aquaria and zoos, pet and aquaria shops, shipping, seafood, and bait were invited to participate on the Committee. Committee members met in April 2000 to review the draft Prevention Program and identify priorities. The revised Prevention Program is expected to be completed by Spring 2001, and pending approval from the ANS Task Force, will be announced in the Federal Register for public comment. A final revision will be completed in accordance with comments received, and forwarded to the ANS Task Force for approval. Due to the comprehensiveness of the Prevention Program, the Committee agreed to develop a short-term Action Plan to effectively identify immediate needs and priorities and outline an implementation strategy. The Committee also agreed that the urgency of the issue demanded an Action Plan for the interim during which the comprehensive Prevention Program is being finalized. The Committee also expects to present the first Action Plan to the ANS Task Force in Spring 2001.

The findings of the Prevention Program in 1998 also provided support to an effort by APHIS to amend the Federal Noxious Weed Act, adding the Mediterranean strain of *C. taxifolia* to the list of Federal Noxious Weeds. In April 1999, the awareness of scientists, researchers, and government agencies in the U.S. was likely responsible for the quick and decisive response to the discovery of *C. taxifolia* off the coast of California. Notably, within 30 days of its discovery, eradication efforts were underway.

Caulerpa taxifolia *continued on next page*

Caulerpa taxifolia *continued from previous page*

Biology of *Caulerpa taxifolia*

In the Mediterranean Sea, *C. taxifolia* spread from a few square meters in 1984 off the coast of Monaco, to over 1,500 hectares today, aggressively crowding out native marine algae by forming extremely dense "astroturf-like" mats. Common to all successful invaders, *C. taxifolia* possesses physiological, morphological, and ecological characteristics that contribute to its ability to rapidly displace native species and alter existing habitats. *C. taxifolia* is a true single-celled organism possessing adequate architectural strength to form large, persistent colonies in spite of the wave and tidal action of coastal environments. Like all truly "submersed" type plants, whether macrophytic algae or flowering plants, the density of water provides structural support. *C. taxifolia*, therefore, does not invest energy in creating elaborate support structures. It can grow in very low light conditions, having been found at depths more than 100 meters. The ability to thrive in low light is typical of most truly submersed plants, especially algae. *Caulerpa* tolerates a wide range of water temperatures ranging from approximately 10° to 31ºC, but exhibits maximum growth in temperatures at 20ºC and above (Komatsu et al. 1997). Based on this thermal tolerance, much of the mild marine coastal waters of Mexico and the U.S. may be suitable for *Caulerpa taxifolia*, including the coasts and bays of southern California. Since this plant is a true marine species, inland incursion will be limited by fresh water. (An interesting exception might be the Salton Sea, the largest inland body of water in California, with salinity nearly 20-30% higher than seawater.)

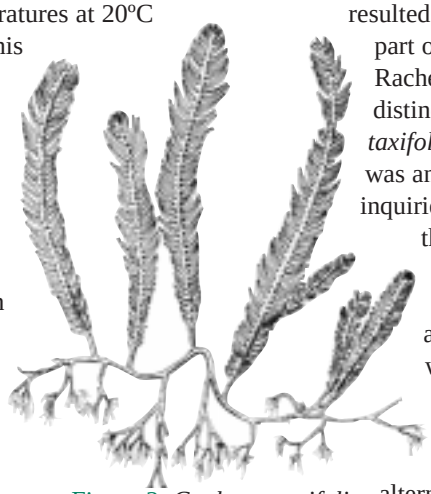

Figure 2. *Caulerpa taxifolia*
Drawing by D. Chiavérini,

Reproduction and spread appear to be almost solely vegetative (asexual), although the plant is probably capable of forming viable zygotes (eggs) as a result of the production of male and female gametes. Environmental and physiological influences on sexual reproduction are poorly understood, especially for the aggressive Mediterranean strain. This information is crucial since any significant formation of microscopic eggs could provide easy dispersal and subsequent establishment of new colonies.

In spite of what seems to be a low incidence of sexual reproduction, *Caulerpa's* ability to spread depends upon growth characteristics that are very typical of invasive freshwater plants: diffuse lateral spread and dispersal through very small, viable fragments. Clonal growth of *C. taxifolia* is by rapidly elongating horizontal stolon-type runners that are periodically punctuated by anchoring pillars (downward growth parts) from which fine rhizoids are formed. The rhizoids not only function to secure the plants against tidal and wave surge, they also provide an avenue for obtaining nutrients in the substrate. The ability to obtain major nutrients from the sediment is another way in which *Caulerpa* resembles invasive freshwater flowering plants such as hydrilla *(Hydrilla verticillata)*, egeria *(Egeria densa)*, and Eurasian watermilfoil *(Myriophyllum spicatum)* which have true roots.

From the plants horizontal runners or stolons, vertical, feather-like, fronds are formed. These bright green fronds grow to lengths ranging from a few inches to several feet. This growth allows the plant to gradually spread over a wide variety of substrates (from sandy or muddy bottoms to hard rocky shores), anchoring itself while it extends horizontally. As the colony expands in several directions, the plant gradually fills in the available substrate. Consequently, it either smothers existing organisms, or prevents them from occupying the same space. Mature stands have the appearance and feel of a rubbery, resilient carpet with a "pile" one foot to almost three feet high! The result is a dense, persistent covering over what would normally be a diverse community of organisms. This growth pattern, and the ability to spread, perhaps as fast as a few inches per day, results in the displacement of native algae and flowering marine plants such as eelgrasses. This condition was beginning to become evident in Agua Hedionda, San Diego.

The California Response – what made it work?

The discovery of a relatively small population of *Caulerpa taxifolia* in a small southern California lagoon, Agua Hedionda, resulted from routine monitoring surveys conducted as part of an eelgrass restoration program. Biologist Rachel Woodfield (Merkel and Associates) noticed the distinctively bright green submerged mats of *Caulerpa taxifolia*. Fortunately, Woodfield suspected this plant was an interloper and immediately started making inquiries to various state agencies. She sent samples to the University of California - Berkeley (Jepson Herbarium) for confirmation. Within days of the discovery, state and federal agencies were alerted and the first of a series of meetings of what would become the Southern California *Caulerpa* Action Team (SCCAT) took place. In less than a month, field operations began to eradicate the aggressive, invasive alga. Control alternatives were carefully examined and considered. Based on feasibility, effectiveness, and minimal environmental risk, the SCCAT selected localized applications of liquid chlorine. Colonies of *Caulerpa* were covered and sealed with anchored PVC tarps for treatment. Subsequent treatments at Huntington Harbor were made with solid chlorine formulations.

The swift and successful response in California is attributable to several factors. First, the staff at Merkel and Associates conducting the eelgrass restoration project was aware of the invasion and devastating impacts of the *C. taxifolia* in the Mediterranean. Second, the key agency representatives were also aware of the threat posed by a potential invasion of this species. Third, California is experienced in instituting important pest eradication programs. This experience contributed to the quick identification of regulatory and administrative coordination needs, and the environmental issues to be resolved. An example is the Hydrilla Eradication Program, initiated in 1977, when this exotic freshwater plant was found in the Imperial Irrigation District, 120 miles east of San Diego. Fourth, the San Diego Regional Water Quality Control Board assumed a lead agency role, treating the infestation as a "contaminant". Also, Cabrillo Power (electrical

Caulerpa taxifolia *continued on next page*

Caulerpa taxifolia *continued from previous page*
utility located on the lagoon) provided direct support and participation, enabling field operations to begin almost immediately by Merkel and Associates. Finally, the regulatory action and research agencies reached consensus on operational approaches and maintained a strong and firm focus on the primary objective of SCCAT to eradicate *Caulerpa taxifolia*.

In summary, three key elements contributed to the effectiveness and efficiency of the *Caulerpa* eradication effort: 1) Consensus to Act (Eradicate!); 2) Consensus of Authority to Act (lead and responsible agencies), and 3) Immediate Availability of Resources (emergency funds from the Water Quality Control Board, Cabrillo Power, and the in-field action team, Merkel and Associates). The eradication effort exemplified and depended on a coordinated multi-agency approach. Its success serves as a model for broader rapid response strategies for other incipient invasive species.

What's next?

Beyond the short-term rapid response, long-term actions and goals have been identified by the SCCAT. Although public education and outreach activities were initiated almost immediately, additional efforts are needed. Research gaps have been identified as well as some limited initial funding. Follow-up monitoring and surveillance is essential to evaluating eradication success and implementing future control initiatives. However, it is clear that to pursue successful eradication programs and to safeguard U.S. coastal waters, long-term funding commitments are essential.

The need for long-term planning and control readiness was emphasized in August 2000, when additional colonies of *C. taxifolia* were reported and confirmed in Huntington Harbor, Orange County, just south of Los Angeles, CA. Response to this sighting was immediate, with surveillance and control measures being implemented quickly. However, through effective and strategic long-term planning, a pro-active approach to detection and control will minimize the need for large-scale emergency responses. Long-term monitoring in locations where *Caulerpa* has been reported and eradicated is critical to success. Surveillance in coastal areas, lagoons, and bays vulnerable or susceptible to new populations is necessary, accounting for the various vectors that could contribute to its spread. As a step towards long-term planning, the scope of the current SCCAT will be expanded to at least a state level purview.

Protection of coastal waters in California requires a multi-million dollar commitment of funds and a pledge from agencies and organizations to support and implement prevention and eradication measures. Costs for eradication of *C. taxifolia* in Agua Hedionda Lagoon alone will exceed $1 million, including local, post-treatment monitoring. The nature of this issue necessitates that these commitments be long-term. The SCCAT is already planning for a minimal term of at least 5-10 years. Research initiatives on the biology, reproduction, ecology, and control of *C. taxifolia* will advance control efforts leading to the implementation of the most cost-effective and environmentally sound strategies. However, California cannot wage this battle alone. National leadership is required to provide a framework to protect all coastal habitats vulnerable to invasion, including the Florida, Texas, Hawaii, and Carolina shores. Emergency response protocols should be established to ensure eradication in a manner consistent with that exemplified by SCCAT. National public education and outreach initiatives are necessary to increase awareness, which will promote early detection and increase the likelihood of successful eradication. Early detection is paramount to the successful control of any invasive species, especially for one with international consequences. Concern for a potential invasion in the sub-tropic shores of Mexico was clearly voiced by representatives of the Universidad Autonoma de Baja California attending the February 2001 SCCAT meeting. Through national leadership, legislative initiatives, international cooperation, and technology transfer, action must be taken to minimize the risks of new introductions of *C. taxifolia*.

The coastal waters of the U.S. are a valuable resource, and their protection is more than justified. The risks of complacency are too high. Strategic action planning, control readiness, and a strong commitment to the protection of our natural resources provide the framework to successfully minimize the risks associated with the introduction and spread of invasive species like *Caulerpa taxifolia.*

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For more information, log on to the following websites:
http://swr.ucsd.edu/hcd/caulerad.htm
http://www.anstaskforce.gov/Caulerpa.htm
http://www.sbg.ac.at/ipk/avstudio/pierofun/ct/caulerpa.htm

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Upcoming Meetings

Great Lakes Commission Special Symposium:
"Looking Back, Looking Forward:
Assessing Aquatic Nuisance Species Prevention and Control"
May 16-17, 2001 in conjunction with:
Great Lakes Regional Panel Annual Meeting
May 18, 2001
Ann Arbor, MI
Contact: Mike Donahue, 734-665-9135
e-mail: mdonahue@glc.org

11th International Conference on Aquatic Invasive Species
October 1-4, 2001
Hilton Alexandria Mark Center
Alexandria, Virginia
Contact: Elizabeth Muckle-Jeffs, 800-868-8776 or 613-732-7068
e-mail: profedge@remc.igs.net
Website: http://www.aquatic-invasive-species-conference.org

Send meeting announcements to:
Jeanne Prok, ANS Digest
2500 Shadywood Rd., Excelsior, MN 55331
e-mail: Jeanne@freshwater.org
Deadline for the next issue is May 15, 2001.

We don't want to be a nuisance...

...but we would like your help! The *ANS Digest* is published by the Freshwater Foundation and is funded by the National Sea Grant Program through the Minnesota Sea Grant College Program. Due to budget limitations and escalating costs, we ask that you help by making a donation to support the *Digest.* Your assistance is appreciated.

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