



A Real Threat to America's Coastal Marine Ecology, the Mediterranean Clone of *Caulerpa taxifolia*

By

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The aquatic habitat management community has been making progress in addressing the conservation of aquatic vegetation important to the health of ecosystems. Examples of progress made include the development of a Fishery Management Plan for Sargassum by the South Atlantic Fishery Management Council and the protection of submerged aquatic vegetation. Now an unanticipated threat by the common coastal green alga, *Caulerpa taxifolia*, looms on the eastern horizon.

Caulerpa taxifolia, found in abundance along our southern coast, has undergone a transformation in the Mediterranean Sea to become a "terrorist super plant." Alexandre Meinesz¹ has labeled it a "killer algae." Since its discovery off the coast of Monaco in 1984, this clone of the green alga has been spreading rapidly throughout the Mediterranean. Endless mats of the bright green plant now dominate large expanses of seafloor that were previously rich in native flora and fauna. It is feared that the introduction of this strain of *C. taxifolia* into the United States could lead to the colonization of large expanses of American coastal waters.

C. taxifolia^(Med. Clone) is believed to be a genetic clone of a single plant, having been probably introduced into the Mediterranean Sea by an aquarium release. This variety of *C. taxifolia* is now found in the Mediterranean off the coasts of Spain, France, Monaco, and Italy, and off of the coast of Croatia in the Adriatic Sea. It exhibits different physiological characteristics than that of

the native "parent" plant found only in more tropical regions. The new strain of *C. taxifolia* is able to tolerate a wider range of environmental conditions than the parent plant in its native range. For example, it survives in water temperatures as low as 9 to 10°C and as high as 32 to 33°C. It is tolerant of both high and low water quality, can colonize a variety of substrates, including mud, sand, cobble, and rock, and can thrive in high energy zones. This invader has been observed at depths from 1 to 99 meters, with maximal colonization occurring from 2 to 6 meters. In addition to differences in habitat tolerance, the new strain of *C. taxifolia* also grows much larger than the native parent plant. The Mediterranean variety can grow to heights of 75 cm, while the native variety reaches approximately 25 cm in height.

The invasive *C. taxifolia* has had adverse effects on the native biota of the Mediterranean Sea. It outcompetes native flora for habitat, and is capable of synthesizing and releasing a chemical (Caulerpanene) that is toxic to potential predators, as well as other algae. Reductions in native invertebrates, fish, bacteria, algae, and parasites have all been documented in areas where the plant has become colonized.

Based on thermal tolerance data, the potential range of colonization within the United States could include the Atlantic coastal waters south of Virginia Beach, VA, the Pacific coastal waters of California, the Gulf of Mexico, Guam, the Solomon

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Islands, Puerto Rico, and the U.S. Virgin Islands.

If introduced into American waters, *C. taxifolia*^(Med. clone) could have adverse economic and ecological impacts. For example, the tourism industry could experience a reduction in revenues due to a loss of coastal seabottom aesthetics (SCUBA diving, boat tours, beach use). Also, commercial and charter fishing industries could incur increased operational costs due to fouling of nets and traps, and other related gear. In addition, the potential ecological impacts (lower fish abundance and diversity) may lead to reduced catches. Finally, electrical power and other industrial water users may also be affected by *C. taxifolia*^(Med. Clone) colonization of near-shore areas.

Currently, the only known method of removing *C.*

taxifolia^(Med. Clone) from colonized areas is through repeated extraction by trained divers. Generally, mechanical action, such as anchoring, dredging, fishing activity, and storms lead to rapid range expansion due to the



creation of cuttings, or plant fragments. These cuttings disperse and regenerate into new plants. Other potential pathways for the introduction and dispersal of this plant throughout the U.S. are the aquarium trade, with fishery products for the fresh seafood market, or in the ballast water of ships entering U.S. waters from areas of *C.*

taxifolia^(Med. Clone) colonization.

As of March 1999, *C. taxifolia*^(Med. Clone) was listed as a "Federal Noxious Weed." This makes its importation, sale, and distribution an illegal activity. However, the door for unintentional introductions remains wide open.

To obtain more information on this or other exotic species issues, please contact Sandra Keppner or Mike Weimer, USFWS, Lower Great Lakes Fishery Resources Office, 405 N. French Rd., Amherst, NY 14228 (Ph: 716-691-5456).

¹ Meinesz, A. 1999. *Killer Algae*. Translated by D. Simberloff. University of Chicago Press. 376 pp.

Aquatic Nuisance Species Handbook Available

The Michigan Department of Environmental Quality's Office of the Great Lakes has produced the Aquatic Nuisance Species Handbook for Government Officials. The purpose of the handbook is to educate local, county and state government officials about problems and solutions relating to the invasion and spread of aquatic nuisance species, such as the zebra mussel, Eurasian milfoil, purple loosestrife and round goby. The handbook identifies many aquatic nuisance species and their current distribution, and illustrates effective techniques that can be used by fishermen and boaters to prevent and control the spread of exotics into other rivers and lakes.

The handbook is available online at: www.deq.state.mi.us/ogl/an.pdf. Copies can also be obtained from the Office of the Great Lakes (517-335-4056, FAX 517-335-4053).

Killer Algae

The book *Killer Algae* by Alexandre Meinesz chronicles the story of the invasion of *Caulerpa taxifolia* in the Mediterranean Sea. The original introduction of the algae into the Mediterranean Sea is traced to tank cleaning at the Oceanographic Museum in Monaco about 15 years ago, ironically while Jacques-Yves Cousteau was the museum's director. In 1989, Meinesz, a university scientist specializing in *Caulerpa* and an avid diver, tried to bring the problem to the attention of government officials and media to no avail. The algae was not perceived as a threat to humans and therefore wasn't taken seriously, until recently.

Caulerpa now covers over 10,000 acres off the coasts of Spain, France, Italy, and Croatia. It grows everywhere, from areas swept by storms and currents, soft bottoms of sheltered bays, and on polluted muds of harbors. All attempts to eradicate it have failed, and it is continuing to spread into the Adriatic Sea.

Killer Algae is published by the University of Chicago Press.

Federal Invasive Species Council Created

It is estimated that invasive species cost our national economy \$123 billion annually, and that they are second only to habitat destruction in threatening extinction of native species. Consider these facts: Every minute 40,000 gallons of ballast water from foreign vessels are released into U.S. harbors, carrying with them organisms that could change or destroy natural marine ecosystems. One such organism is the prolific zebra mussel that often clogs water intake pipes and can shut down electrical utility facilities. In Brooklyn, New York, over 2,000 trees were destroyed in an effort to reduce the population of the Asian long-horned beetle, a non-native species that threatens maple, chestnut, poplar, willow, elm, and mulberry trees in this country. On the island of Guam, the brown tree snake has almost eradicated many of the native forest birds.

To combat this nationwide epidemic, President Clinton signed Executive Order 13112 on February 3, 1999, to create the Invasive Species Council. Co-chaired by the Secretaries of the Interior, Agriculture, and Commerce, the Council is charged with developing a comprehensive plan to minimize the economic, ecological, and human health impacts of invasive species, and to identify measures to prevent the introduction and spread of additional invasive species. The plan is due by August 2000 and

will be updated every two years. The Council will work closely with states, tribal governments, scientists, universities, shipping interests, environmental groups, and farm organizations to identify goals, objectives, and measures of success that will be used at the local, state, regional, and ecosystem-based levels. The Council is also charged with developing an internet-based information network, creating National Environmental Policy Act guidance, and identifying international recommendations. The Council held its first meeting on July 22, 1999, in Washington, DC.

Meanwhile, recent actions that have helped control the spread of invasive species include: increased inspectors at U.S. ports of entry; prohibiting the importation of untreated wood packing material from China, which is responsible for the introduction of the Asian long-horned beetle; and creation of the National Identification Digital Photo Project, which allows immediate identification of pests by inspectors. Future actions include: construction of a barrier in the Chicago Ship Canal to prevent the spread of invasive species between the Great Lakes and the Mississippi River basins; the restoration of the natural ecology of the South Florida and Everglades ecosystems; and sponsoring research to develop new technologies that will reduce foreign species discharged into U.S. waters via ballast water.

Upcoming Conferences

January 11-13, 2000—**Dredged Material Assessment and Management Seminar**, San Diego, California, sponsored by U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. The seminar focus is on assessment and testing for waters regulated under the Marine Protection, Research, and Sanctuaries Act and the Clean Water Act. Topics include: Sediment Quality Guidelines, Bioaccumulation Testing and Interpretation, Chronic Sublethal Testing and Interpretation, Dredged Material Management Models, Beneficial Uses, and Contaminated Sediment Testing and Management. See website www.wes.army.mil/el/dots and click on training. Additional information is available from: Ms. Billie Skinner (601) 634-3701, Dr. Robert Engler (601) 634-3624, and Mr. Tom Patin (601) 634-3444.

February 7-10, 2000—**Tools for Urban Water Resource Management and Protection**, Chicago, Illinois, sponsored by Chicago Botanic Garden, U.S. EPA, and the Northeastern Illinois Planning Commission. The conference is designed to facilitate the educational process and transfer state-of-the-art information to state, regional, and local urban water quality practitioners. The timing of the conference coincides well with the U.S. EPA's just-released Phase II NPDES Storm Water Program final rules. The conference will provide participants with practical, applied information on the most effective tools and technologies for

meeting these new NPDES permit requirements. Presentation topics include: public education, public involvement, detection and elimination of illicit discharges, construction site runoff control, post-construction stormwater management, and pollution prevention for municipal operations. For registration information contact the Chicago Botanic Garden's Education Registrar at (847) 835-8365. For other questions about the conference, contact Bob Kirschner at (847) 835-6837 or bkirschn@chicagobotanic.org.

March 13-17, 2000—**Fifth Marine and Estuarine Shallow Water Science and Management Conference**, Atlantic City, New Jersey, sponsored by U.S. EPA Region 3. The objective of the conference is to explore the importance of the shallow water zone as critical fish habitat and evaluate the impacts of dredging and dredged material disposal in shallow waters. Sessions will focus on communicating the current scientific understanding of critical finfish and shellfish habitat to regulatory agency personnel and on human activities affecting critical habitats in shallow waters. A series of panel discussions devoted to dredging and dredged material placement is also planned. To register or for more information, contact Ralph Spagnolo (215) 814-2718 spagnolo.ralph@epa.gov or Ed Ambrogio (215) 814-2758, ambrogio.edward@epa.gov. Also, see the conference website at www.epa.gov/region3/shallow_water.

Town Opts for Hot Water Weed Killer Over Pesticides

The town of Carrboro, NC is buying a hot water weed control machine to clear weeds along miles of fences around sports fields, on curbs and gutters, in playgrounds, and for edging around walks and buildings. The system, manufactured by Waipuna International Ltd. in Wellington, New Zealand, works by spraying weeds with a mixture of 30% steam and 70% very hot water. Chris Gerry, landscape and grounds supervisor in Carrboro, arranged for a five-week trial loan of one of the machines and found that the system performed incredibly well in many applications. Gerry could take the truck-borne machine out in all kinds of weather and watch the steam wilt weed leaves and hot water attack shallow weed roots. In addition to weed control, he found that it worked well to wash street signs, sterilize public

restrooms, and remove graffiti. The machines are already in fairly wide use in Australia and New Zealand, but are just being introduced into the U.S. market.

Carrboro is implementing this non-toxic approach for weed control as part of its Integrated Pest Management program to reduce or eliminate the use of conventional pesticides. For more information contact: Chris Gerry, Landscape and Grounds Supervisor in Carrboro, NC (919-968-7716); Martin Haver, Waipuna International Ltd. representative in Chicago, IL (773-255-8355); or Allen Spalt, Director of Agricultural Resources Center (ARC), PESTicide Education Project in Carrboro (919-967-1886). Also, see ARC's pesticide education project website at <http://metalab.unc.edu/arc/>.

Aquatic Invasive Species Treated as Biological Pollutants

One of the most common pathways for aquatic nuisance species introductions is through international shipping. Ocean-going vessels travel among ports all over the world. When a ship delivers its cargo at a port, it may pump local port water and nearby sediment into its ballast tanks. Ballast tank water is very important for maintaining a ship's proper buoyancy and balance for safe travel. Often, the water and sediment contain millions of living organisms, ranging from viruses to schools of small fish that can be transported and introduced live into other ports around the world where they can become established. Scientists believe that the zebra mussel and the Asian clam were introduced in the United States via ballast water discharges. Introductions can also occur from hull-fouling organisms transported on the exterior of ships that travel large distances.

Unfortunately, no new technologies have been implemented to treat ballast water, either on ships or onshore. The U.S. Coast Guard encourages the use of voluntary guidelines adopted by the United Nations that request ships to exchange ballast water with mid-ocean water. This method at best removes about 80-90% of the exotic organisms in the ballast tank and replaces them with mid-ocean organisms that generally do not survive in coastal waters. However, because of the inadequate removals and issues involving risk to the safety of the crew, this "open ocean exchange" method is not considered an effective long-term solution.

In California's San Francisco Bay area, exotic introductions are of great concern as local experts estimate that one new exotic species has become *established* every 14 weeks since 1961. As discovered with the Chinese mitten crab and Asian clam, the introductions represent a significant threat to many beneficial uses of the estuary. Once established, an exotic species is extremely difficult to eliminate because it reproduces and spreads

rapidly. As such, exotic introductions are being characterized and defined as biological pollutants, which can not be assimilated by natural processes and cause permanent impacts that can increase over time.

Under the California Water Code, ballast water and hullfouling that contain viable exotic organisms are defined to cause pollution and furthermore meet the Clean Water Act (CWA) definition of a point source discharge. Under the current federal regulations, however, these discharges are exempt from requiring a National Pollutant Discharge Elimination System (NPDES) permit.

The State of California decided to initiate action of its own to address the problem by getting San Francisco Bay listed as an impaired water body. In May 1999, the U.S. Environmental Protection Agency (EPA) approved the State of California's Section 303 (d) list of impaired water bodies that included a finding that San Francisco Bay and the Sacramento-San Joaquin Delta are impaired by exotic species, interpreted as a biological pollutant under the CWA. This listing has triggered a CWA requirement for the development of a total maximum daily load (TMDL) for exotic species. The San Francisco Bay Regional Water Quality Control Board (RWQCB) has proposed a TMDL of zero for exotic species. The first step in establishing the zero-TMDL will be to amend the Region's Basin Plan to prohibit the discharge of viable exotic organisms from vessels. These policies set the stage for addressing two neglected areas: (1) development of ballast water treatment technology and (2) development of port-specific plans that include baseline biological surveys and characterization of the port's shipping traffic.

For further information contact Steven Moore of the California RWQCB at (510) 622-2439 or smm@rb2.swrb.ca.gov.

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Preserving Surf – The “Latest Wave” in Mitigation Efforts?

In 1983, the Chevron Corporation requested permission from the California Coastal Commission (Commission) to construct a rock groin to protect pipelines that run between its offshore marine terminal and onshore refinery in El Segundo, CA. It sought to protect these pipelines that had become exposed during severe storms, and were granted the construction permit with the condition that it monitors surf conditions in the area. Repairs were later made to the groin, and surf conditions continued to be monitored over the years. In 1989, it was determined that “the surf quality in the project region was reduced significantly,” and Chevron was ordered by the Commission to pay \$300,000 towards constructing an artificial reef to restore “surfable waves” in the area.

A local conservation group known as the Surfrider Foundation was instrumental in bringing about the concessions awarded by the Commission. It sees this case as significant because Chevron was required not only to restore the loss of a natural resource, but compensate for the loss where it occurred, not at another site. Surfriders hopes this will send a message to future developers along the California coast that lost surfing conditions must be mitigated for at the site of impact.

Other environmental groups view this as a landmark case, in that surf may now be added to the list of nonrenewable resources that is protected by state government, similar to protection granted to wildlife habitat or fish and game.

Surfriders will begin constructing the artificial reef in the spring of 2000, 100 yards offshore in approximately 15 feet of water. Permit conditions require that no hard bottom, kelp, sea grass, or other sensitive species are present at the reef site. The reef will consist of submerged 15-ton sandbags that form a large V, which creates an obstacle that causes incoming waves to crest and break. Artificial reef construction for the purpose of creating surf is taking hold in Australia, as well, and with recent developments in mapping sea floor sites at popular surf beaches, scientists are now learning what conditions create optimal surfing waves. This latest wave to manage Mother Nature may become commonplace as coastal development and overcrowding continues, and the need to balance everyone’s interests becomes more challenging.

Sources: The Washington Post, “Dude, the Surf is Self-Serve,” June 3, 1999, A1, A12, Executive Summary for Surfrider Foundation construction application, California Coastal Commission.

North Cape Oil Spill Restoration Plan Revised

The Rhode Island Department of Environmental Management (DEM), the U.S. Department of Commerce/National Oceanic and Atmospheric Administration, and the U.S. Department of Interior/Fish and Wildlife Service released a Draft Restoration Plan on September 14, 1998, to address the environmental damage caused by the North Cape oil spill on January 19, 1996 off the coast of Rhode Island. This environmental disaster was caused when 828,000 gallons of #2 heating oil were released from the North Cape vessel during a winter storm. Eklof Marine has been charged as the party responsible for the spill. The draft plan is referred to as the Draft Restoration Plan and Environmental Assessment for the January 19, 1996, *North Cape Oil Spill*, and serves as the draft environmental assessment under the National Environmental Policy Act. The Plan provides the methodology used by the Trustees in conducting surveys to assess the harm caused by the spill, and proposes how the state’s natural resources will be restored. A 60-day comment period followed the release of the draft plan, and several changes were made to the underlying technical reports and the draft plan following this comment period. A revised draft plan was released for a second 21-day comment period after consideration was given to recommendations made during the first comment period.

Major changes to the draft document include a decrease in the estimate of loons and other marine birds that may

have been injured by the spill, and an elimination of male lobsters from the restocking project which results in overall lower costs for this project. In addition, the quahog seeding project has been replaced with an oyster seeding project that will have higher overall costs, but the oyster project is expected to have higher survival rates and will be more cost-effective. With respect to loon restoration, analytical methods were revised, a stronger emphasis on educational outreach for field biologists has been included, and estimated per-nest project costs were decreased to reflect updated land acquisition developments. Changes were also made to nest protection requirements for elders, reducing the number from 414 to 315 elder nests, with a projected decrease in cost from \$719,000 to \$631,000. A number of minor modifications were also made, and these changes will be available to the public upon release of the final plan. The final plan is completed and final settlement discussions are underway. The final plan is expected to be released by the end of the year. Once released, Eklof Marine and its underwriters will have 90 days to accept the plan in its entirety, partially accept the plan, or reject the plan in its entirety. If Eklof Marine does not accept the plan, the Trustees will seek funding under the Oil Spill Liability Trust Fund, which was established by Congress under the Oil Pollution Act of 1990. Representatives of the Fund would then seek reimbursement from Eklof Marine for restoration costs.

Drought and Record High Temperatures Take Their Toll on Fish

For many coastal states, 1999 was the driest growing season on record. Rhode Island, New Jersey, Delaware, and Maryland had their worst growing seasons in the 105 years that the National Oceanic and Atmospheric Administration's National Climatic Data Center has been keeping records. Massachusetts, Connecticut, and New York had their second worst growing seasons on record. For all of these states, all or part of the state was declared an agricultural disaster area. Drought conditions actually began in the summer of 1998 when rainfall in the Mid-Atlantic and the Northeast fell 8 to 18 inches below average. Temperatures during this same timeframe were also at record highs, which added to the severe weather conditions.

While farmers were grappling with parched crops, many fish were dying in rivers and creeks along the East Coast. Higher than normal water temperatures and reduced water flow into freshwater tributaries that feed into bays contributed to fish kills. Reduced water flow often results in higher water salinity, which is lethal to fish that are unable to escape such conditions. Low levels of dissolved oxygen in the water can also kill fish, and is

usually the result of high water temperatures, low freshwater flows and related algae blooms.

Higher water temperatures also allow bacteria to breed more effectively, and contributed to the death of thousands of white suckers and trout in the Raritan River in New Jersey this summer. As headwaters dry up, fish are subject to higher predation by other species. Even fish in enclosed water bodies are subject to higher mortality, as ponds are pumped dry to cope with water shortages by the human population.

An estimated 500,000 menhaden were lost this summer along the lower Pocomoke River in Maryland due to low dissolved oxygen in a tributary known as Bullbegger Creek. Scientists believe that the large school moved into the creek at night to feed or avoid predation and succumbed to the decreased levels of oxygen. While it is common for oxygen levels to decrease at night as algae switches from oxygen production (photosynthesis) to oxygen consumption (respiration), levels were unusually low due to drought conditions.

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