REVIEW OF CLEARCAST™ (IMAZAMOX) PROPERTIES FOR AQUATIC WEED CONTROL AND RESULTS OF 2005 EUP APPLICATIONS.

Dan Beran; Ph.D. Technical Specialist, Professional Vegetation Management
BASF Corporation, 1422 57th Place, Des Moines, IA 50311.
e-mail: berand@basf.com

Clearcast™ (imazamox) is under review and testing by BASF Corporation for use in aquatic weed control. Imazamox is an imidazolinone herbicide that inhibits the AHAS enzyme that is essential for the synthesis of three branched chain amino acids. This enzyme system is unique to plants and studies indicate that imazamox is nontoxic to fish, aquatic invertebrates, birds, mammals, earthworms, and honeybees. Based on numerous laboratory tests on the toxicology of imazamox, the U.S. Environmental Protection Agency (EPA) has determined that imazamox is exempt from the requirement for a residue tolerance on all food commodities. In aquatic environments, photolytic degradation is the primary source of dissipation. Based on laboratory tests and field trials, the half-life of imazamox in water ranges from 5 to 15 days with the length dependent upon water clarity, depth, and available sunlight. Imazamox was evaluated under an EPA-granted Experimental Use Permit beginning in spring 2005 in several states including Florida, Texas, Louisiana, and Indiana. Results from these trials indicate that imazamox has activity on submersed, floating, and emergent vegetation. Submersed species that exhibited sensitivity to imazamox included hydrilla, coontail, southern naiad, curlyleaf pondweed and sago pondweed. The free-floating species water hyacinth was controlled by imazamox, whereas activity on common duckweed appeared limited. A wide range of emergent species was sensitive to imazamox. Cattail, alligatorweed, pennywort, fragrant water lily, and willow were sensitive to foliar applications of imazamox. In contrast, water injected treatments of imazamox resulted in little to no activity on the majority of these emergent species.

CYGNET PLUS, EFFICACY AND FISH TOXICITY STUDIES FOR CALIFORNIA AND WASHINGTON STATE REGISTRATIONS, Stephen Brewer;
Brewer International, Inc., PO Box 690037, Vero Beach, Fl. 32969,
e-mail: Steve@brewerint.com

Efficacy trials were done by Clean Lakes in 2003 under authorization number 308027. Trials evaluated efficacy of Cygnet Plus in California waters. Trial was conducted at Rio Vista Golf Course in California and completed on November 5, 2003. Seven plots were involved in the study. Results showed that herbicide efficacy was enhanced significantly through the addition of Cygnet plus spray adjuvant to aquatic herbicides Reward and Aquathol K. Pacific EcoRisk did a fish toxicity study for the registration in the state of Washington. Toxicity studies were conducted on *Ceriodaphnia Dubia*, 96-hr. EC50= 5.5 mg/L; *Rainbow Trout*, 96-hr. EC50= 55 mg/L; and *Fathead Minnows*, 96-hr. EC50= 20.6 mg/L.

Both efficacy and fish toxicity studies resulted in California and Washington registrations for Cygnet plus.

TOP FIVE EMERGENT WEEDS IN NEW ZEALAND. Paul Champion; Principal Scientist, National Institute of Water & Atmospheric Research (NIWA), PO Box 11-115, Hamilton, New Zealand.
e-mail: p.champion@niwa.co.nz

New Zealand's worst emergent aquatic weeds are assessed to be *Phragmites australis* (common reed), *Zizania latifolia* (Manchurian wild rice), *Lythrum salicaria* (purple loosestrife), *Iris pseudacorus* (paleyellow iris or yellow flag) and several *Sagittaria* (arrowhead) species (*S. platyphylla* and *S. montevidensis* subsp. *montevidensis* being the worse of these). Only paleyellow iris and to a lesser extent Manchurian wild rice are widely distributed in New Zealand and all these species have extreme impacts in the areas they have naturalized. Introduction to New Zealand was most likely to have been through the ornamental pond/aquarium trade, with the exception of Manchurian wild rice being introduced as a contaminant of solid ship ballast. Overseas weed history and weed risk assessment of these species has led to them all being banned from propagation, sale and distribution with eradication programs carried out on all populations of those species with restricted distribution and outlier populations of paleyellow iris and Manchurian wild rice. Most control is herbicidal with selective control achieved with metsulfuron used to treat paleyellow iris and *Sagittaria* spp., triclopyr on purple loosestrife and haloxyfop on Manchurian wild rice. Glyphosate has been used to control all species but is of limited effectiveness on most of these species. Imazapyr has been successfully used to eradicate common reed from most North Island sites.

A RISK MANAGEMENT APPROACH TO AQUATIC WEED CONTROL. Paul Champion; Principal Scientist, National Institute of Water & Atmospheric Research (NIWA), PO Box 11-115, Hamilton, New Zealand.
e-mail: p.champion@niwa.co.nz

The water bodies of New Zealand, like the Western USA and almost all other inhabited countries, is already highly impacted by a range of alien invasive plants, but there are areas still free of most of our worst weed species and effective preventative management is still attainable. There are several factors regarding aquatic weeds and habitats that work in New Zealand's favor in this endeavor. There is a massive distance between overseas freshwater habitats and those in New Zealand making accidental importation outside of the aquarium/pond trade very unlikely. Most problem species do not reproduce sexually so natural (non-human) vectors are limited. Catchments are essentially islands in a sea of land. Therefore the majority of aquatic weed introductions are human mediated. Risk management of aquatic weeds include pre-border, border and post-border steps. These include:

- Identification of potential weeds not known to be in New Zealand (e.g. *Myriophyllum spicatum*) and giving those assessed to pose a threat to our water bodies "Unwanted Organism" status
- Intercept plant importations at the border (e.g. soft x-rays) and PEQ

- Identify weed threats present in New Zealand but not naturalized (e.g. Weed Risk Assessment Model, competition trials) and ban from propagation, sale and distribution (National Pest Plant Accord)
- Regional and national assessment of low incidence/high impact naturalized species (e.g. *Phragmites australis*) with eradication programs
- Identification of weed-free sites/regions, predicted impacts of weed species, nearest weed sources and high probability vector pathways
- Manage weed sources and vectors and instigate targeted surveillance programs in unimpacted high value water bodies

This proactive approach is only effective provided that incursions are reported at an early stage allowing for an effective incursion response (e.g. the Lake Waikaremoana *Lagarosiphon major* eradication program).

WHAT IS AT STAKE: AN OVERVIEW OF NATIVE FRESHWATER MACROPHYTE COMMUNITIES IN NEW ZEALAND. John Clayton; Science Leader, NIWA, P.O. Box 11-115, Hamilton, New Zealand.
e-mail: j.clayton@niwa.co.nz

Why have aquatic weeds have been so successful at invading New Zealand? An island nation, New Zealand has an abundance of lakes, wetlands and flowing waterways set within a maritime-temperate climate. Evolved within this isolated setting was a native aquatic flora of diverse emergent plants in wetlands and at lake margins, and species-rich turf communities in lakes and alpine tarns. Internationally outstanding examples of deep-water charophytes and bryophytes are still present. However, there were no specialized native river plants, no water lilies or large floating plants and relatively few species of tall-growing submerged plants. Superimpose on this scene, a short but intense human colonization over the last 150 years, a dependence on agricultural production and hydro-electric power generation, growing water allocation issues and a tourism trade based on our wild and scenic places. Lastly, add over fifty alien aquatic plants that have successfully naturalized within New Zealand. Some weed invasions have been spectacularly successful, at the cost of native biodiversity, as well as public utility and economic production. This account sets the scene for the invasion of New Zealand's waterways, introduces some of the special features of New Zealand's native aquatic flora, and considers why they have been so vulnerable to invasion.

FUTURE DIRECTIONS. John Clayton; Leader, National Institute of Water & Atmospheric Research (NIWA), PO Box 11-115, Hamilton, New Zealand.
e-mail: j.clayton@ihug.co.nz

Escalating trend lines for invasive species confirm we live in changing times. A fatalistic attitude might be understandable in view of threats from globalization, increasing trade and tourism, limited funding, fragmented management responsibilities, bureaucratic inertia, philosophical challenges against the war on 'alien' species, uncontrollable climatic events, and incorrigible human behavior. Despite these many challenges it is in our nature and sense of justice to help protect indigenous species diversity, and where possible to prevent establishment of further invasive species. Although these sentiments may not be shared by poverty stricken & war torn countries, we are in a privileged position of having the opportunity to seek solutions. Collaboration in recent years between USA and NZ aquatic weed colleagues has led to several worthwhile exchanges under our Visiting Scientist Program. International conferences, web pages' and email have also proven to be a valuable means of sharing ideas. This conference is the first time we have attempted to have an international session where we can focus as a group on three key areas of mutual concern and interest. The Western USA states of Washington, Oregon & California lie on the same Pacific Rim as NZ and we share almost identical latitudes of c. 33 – 48 degrees North to 34 – 47 degrees South. Understandably we have many similar concerns over aquatic invasive species and can share many worthwhile experiences in our search for suitable solutions in the future. Hopefully this public forum on Future Directions will generate a better understanding of the challenges we face and provide us all with more ideas and a stronger network of contacts and ongoing support in our war on weeds.

THE WEST COAST BALLAST OUTREACH PROJECT. Holly Crosson; Coordinator, West Coast Ballast Outreach Project, University of California Sea Grant Extension. Department of Environmental Science and Policy, One Shields Avenue, Davis, CA 95616
e-mail: hacrosson@ucdavis.edu

Ballast water is a major transport mechanism for introducing non-native aquatic species to coastal waters. It is estimated that on any one day more than 5,000 species of freshwater, brackish and marine organisms may be transported in the ballast water of ocean-going vessels around the world. Every hour, an average of over 2 million gallons of ballast water is released into U.S. waters. A variety of aquatic invasive species (fish, invertebrates, algae, vascular plants, and pathogens) have been known to be transported via ballast water or vessel hull fouling. Established populations of these invaders have in some cases caused significant economic and environmental impacts. Researchers, regulators, resource managers, and many in the maritime industry are investigating and/or implementing measures to prevent new invasions. The West Coast Ballast Outreach Project (WCBOP) helps coordinate ballast water and hull fouling information exchange for the west coast. This is accomplished through distribution of outreach materials (posters and brochures), a biannual newsletter Ballast Exchange, seminars and workshops focused on specific audiences, and a project website (http://ballast-outreach-ucsgep.ucdavis.edu). Our outreach efforts are guided by a 50-member Advisory Committee with representation from ports, commercial shipping interests, US Coast Guard, California Maritime Academy, the ballast water treatment technology industry, university researchers, and state and federal regulatory and resource agencies, among others.

DON'T RELEASE AQUATIC INVASIVE SPECIES INTO THE SAN FRANCISCO BAY/ SACRAMENTO-SAN JOAQUIN RIVER DELTA: A RIDNIS PROJECT OUTREACH POSTER. Holly Crosson; RIDNIS Project Outreach Coordinator, University of California, Davis, Department of Environmental Science and Policy, One Shields Avenue, Davis, CA 95616
e-mail: hacrosson@ucdavis.edu

The San Francisco Bay-Delta is the most invaded aquatic ecosystem in North America with over 250 introduced species. Developing and delivering clear educational messages about aquatic invasive species (AIS) to target audiences can help prevent their spread. One of the goals of the RIDNIS Project (Reducing the Introduction and Distribution of Non-native Aquatic Invasive Species through Outreach and Education) was to produce a colorful illustrated poster in English and Chinese (Mandarin) about preventing the spread of AIS. The water-resistant 18" x 24" poster focuses on non-ballast water pathways by which these species can be released (live bait and seafood, recreational boating and angling, and aquarium and water gardening hobbies). The poster illustrates these pathways and suggests ways in which people of all ages and cultures can help reduce the number of new invasions in the Bay-Delta. AIS depicted in the poster include: European green crab (Carcinus maenas); Caulerpa (Caulerpa taxifolia); zebra mussel (Dreissena polymorpha); water hyacinth (Eichhornia crassipes); Chinese mitten crab (Eriocheir sinensis); and New Zealand mudsnail (Potamopyrgus antipodarum).

DO JUVENILE SALMON AVOID COMMONLY USED AQUATIC HERBICIDES?

CATHERINE A. CURRAN[1], JAMES M. GRASSLEY[2], CHRISTIAN E. GRUE[3]; [1]MS CANDIDATE, [2]RESEARCH COORDINATOR, [3]ASSOCIATE PROFESSOR AND LEADER, WASHINGTON COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT, SCHOOL OF AQUATIC AND FISHERY SCIENCES, BOX 355020, UNIVERSITY OF WASHINGTON, SEATTLE, WA 98195.
e-mail: ccurran@u.washington.edu

Herbicides are frequently used to control exotic or nuisance aquatic plants. However, their use has been hampered by concerns directed at the non-target toxicity. Unfortunately, adequate data on the non-target toxicity of aquatic herbicides are lacking, threatening the permitting process. Recent declines in several species/stocks of salmon and an emphasis to restore these populations heighten concerns in the Pacific Northwest. Behavioral responses such as avoidance can alter the exposure of fish to pesticides and such behavior has been suggested as important in mitigating the hazards aquatic herbicides pose to juvenile salmonids provided suitable uncontaminated habitat is accessible. The aquatic herbicides we selected to study, Sonar®PR (fluridone), REWARD® (diquat dibromide), and RENOVATE® 3 (triclopyr), are permitted for use in Washington State. Our objective was to determine if juvenile Chinook salmon (*Oncorhynchus tshawytscha*) avoid these herbicides. The maximum application rate and ten times the maximum application rate were tested as well as positive controls. We used five replicate uni-directional flow chambers adapted for juvenile Chinook and photographed the position of fish (n=10/chamber) for 15 min (1-min intervals) before chemical exposure, during chemical exposure, and after clean water was re-introduced into the chambers. One water sample from each concentration tested was chemically analyzed. Responses were quantified using a novel method comparing mean position and slopes of lines generated by mean position in the test chambers over time. Juvenile chinook were neither attracted to or avoided the maximum label rates of the herbicides, but were attracted to 10x the maximum label rates of RENOVATE® and REWARD®.

EGERIA DENSA DEVASTATING WILD SALMON WATERS. Doug Freeland; Aquatic Consulting and Evaluation Eurasian Watermilfoil Task Force Idaho State, ACE Diving, P.O. Box 840, Spirit Lake, ID 83869.
e-mail: acediving@hotmail.com

One of the few wild salmon rivers on the west cost is the Chehalis. It extends from the Pacific Ocean over 70 miles upstream without man-made dams interfering with the salmon runs. The ever-expanding *egeria densa* infestation in the river is beginning to show signs of interfering with the river flow and the salmon run. The Thurston County Weed Agency in conjunction with US Fish and Wildlife has implemented a plan to gain control of the spread and reclaim the devastated river bottom. We will discuss the plan, keying on the control method being used. The Agency interest and their input. The results of the two years control work, the future expectations and implications of success or failure.

ADVOCACY, THE MEDIA, LITIGATION, PUBLIC PERCEPTIONS AND THE FUTURE OF SCIENCE IN NATURAL RESOURCE MANAGEMENT. Christian E. Grue; Associate Professor and Leader, Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, Box 355020, University of Washington, Seattle, WA 98195.
e-mail: cgrue@u.washington.edu

As scientists, we hope that natural resource management decisions will be based on the best available science and that, through adaptive management, decisions and policies will evolve concurrently with advancements in understanding. Increasingly, however, it appears that advocacy, the media, and litigation are driving natural resource management decisions and, as a result, public perceptions of the value of science have been diminished. Additionally, this comes at a time when the political views on a number of social and environmental issues are highly polarized and when a number of legislative acts dealing with the environmental protections are due for reauthorization. To what extent have we, as scientists, contributed to this situation? Or, does it reflect the increasing complexities of science and natural resource management at a time of diminishing natural resources, increasing human population, increasing concerns over private property rights, and advances in communication and information transfer? These issues will be discussed within the context of the use of pesticides, particularly aquatic herbicides.

EURASIAN WATERMILFOIL MANAGEMENT IN CAPITOL LAKE USING TRICLOPYR. Kathy Hamel[1], Jenifer Parsons[2]; [1]Aquatic Plant Specialist, Washington Department of Ecology, P.O. Box 47600, Olympia, WA 98504-7600, [2]Aquatic Botanist, Washington Department of Ecology, 15 West Yakima Avenue, Suite 200, Yakima, WA 98902-3452.
e-mail: kham461@ecy.wa.gov

Capitol Lake is a shallow freshwater impoundment just north of the Washington State Capitol Campus near downtown Olympia, Washington. The lake was once part of lower Puget Sound, but in 1951 the state constructed a dam that blocked the tidal flow. This changed the estuary/mudflat into a 260-acre freshwater reservoir that acts as a reflecting pool for the state capitol building. The lake used to be drawn down each summer and flushed with salt water to control native freshwater plants. This practice was discontinued in 1997 to establish a native freshwater community. The invasive freshwater weed, Eurasian watermilfoil (*Myriophyllum spicatum*) was discovered in Capitol Lake in 2001. After an extensive planning effort and failed manual management attempts, Capitol Lake was treated with the aquatic herbicide triclopyr in July 2004, in a split-application scenario. Triclopyr was used because it is a selective, systemic herbicide that only needs a short contact time. Because it is a reservoir, Capitol Lake has a very short water residence time. Pre- and post-treatment monitoring included the following parameters: Dissolved oxygen and pH, triclopyr residues in lake and marine water, groundwater and lake sediments; frequency of occurrence sampling and biomass sampling of the aquatic plant community. The triclopyr treatment caused little change in pH or dissolved oxygen and triclopyr water residues declined approximately ten-fold within two weeks after treatment. Both the frequency of occurrence and the biomass of Eurasian watermilfoil were significantly reduced both three months and one year after treatment compared with pretreatment levels.

DETECTING WATER QUALITY AND TROPHIC TRANSITIONS IN THE SACRAMENTO-SAN JOAQUIN RIVER DELTA USING HYPERSPECTRAL IMAGERY. Erin L. Hestir[1, 3], Sepalika S. Rajapakse [1], Shruti Khanna [1, 2], Margaret E. Andrews [1,2], Maria Santos [1, 4], Mui Lay [1], and Susan L. Ustin [1,2]; [1]CalSpace Center of Excellence, University of California, Davis, One Shields Ave., Davis, CA 95616, [2]Department of Land, Air, and Water Resources, University of California, Davis, One Shields Ave., Davis, CA 95616, [3] Graduate Group in Geography, University of California, Davis, One Shields Ave, Davis, CA 95616, [4]Department of Wildlife, Fish and Conservation Biology, University of California, Davis, One Shields Ave., Davis, CA 95616. email: elhestir@ucdavis.edu

Water hyacinth (*Eichornia crassipes*) is considered one of the most invasive and problematic aquatic weed species worldwide. Native to South America, it is now globally ubiquitous and has been documented in more than 50 countries. Hyacinth invades eutrophic water bodies, tolerates high levels of toxicity, impedes waterways for transportation, provides habitat for mosquitoes, reduces sunlight exposure below water, increases sedimentation, and reduces dissolved oxygen content. Currently the University of California, Davis, Center for Space Technologies and Remote Sensing, in cooperation with the California Departments of Boating and Waterways and Food & Agriculture, is working to accurately map the extent of invasive plant species, including water hyacinth, in the Sacramento-San Joaquin River Delta. HyMap imagery acquired in October 2005 to map aquatic weeds was analyzed in an initial attempt to map the trophic state of the Delta. Secchi depth transparency and chlorophyll-*a* concentration were determined from the hyperspectral images. The secchi depth map may provide trophic transition zones in the Delta, revealing spatial patterns of organic and inorganic particulate and dissolved matter order. Chlorophyll-*a* concentrations predict blue-green algal blooms, and can be used in the Delta to measure bioproductivity by helping map nutrient availability. The goal of this study is to explore the potential of using hyperspectral imagery to detect trophic gradients in the Delta and to better predict eutrophic situations in which hyacinth is likely to occur.

CHEMICAL CONTROL OF *EGERIA DENSA* IN CLIFTON COURT FOREBAY.

Jay Kasheta; Operations Manager, Clean Lakes, Inc., P.O. Box 3186, Martinez, CA 94553.
e-mail: jkasheta@cleanlake.com

Clifton Court Forebay is located in the southern portion of the Sacramento-San Joaquin Delta and is a regulated reservoir at the head of the State Water Project's (SWP) California Aqueduct. It is operated by the Department of Water Resources (DWR). The water collected in the forebay is sent south, via various pumping station, to supply the Central Valley and Southern California. *Egeria Densa* (Brazilian Elodea), a non-native, invasive, submerged aquatic plant grows to nuisance proportions in Clifton Court Forebay. It creates slow moving water, clogs fish collection screens at the JE Skinner processing plant and impedes and or stops pumps at the Banks Pumping Station from sending delta water to south. Historically, attempts to control the Egeria in the forebay have included mechanical harvesting and aerial herbicide applications. These methods were not providing the desired control. As a result, a subsurface injection application method was implemented. The two treatments consisted of 10,000 gallons each of the cooper based herbicide Komeen applied in one day via highly specialized boat mounted equipment. This treatment method provided the desired control while conforming to the numerous constraints imposed by DWR's water delivery schedule.

HYDRILLA ERADICATION EFFORTS IN THE CHOWCHILLA RIVER AND EASTMAN RESERVOIR IN CENTRAL CALIFORNIA; A SUCCESS STORY.

Florence C. Maly; Agricultural Pest Control Supervisor, CA Department of Food and Agriculture, 2889 N. Larkin, Ste. 106, Fresno, CA 93727
email: fmaly@cdfa.ca.gov

Discovery of hydrilla (*Hydrilla verticillata*) in Eastman Reservoir and twenty-six miles of the Chowchilla River in Madera and Mariposa Counties in Central California presented a daunting task to the CA Department of Food and Agriculture. Hydrilla is a noxious, invasive aquatic weed that poses a serious threat to the State's water resources and the CDFA is mandated by legislation to eradicate hydrilla "where feasible". The infestation in the Chowchilla River presented challenges that had not been faced before, and only by initiating an integrated pest management approach, using every available tool in the toolbox, has the CDFA been able to eliminate hydrilla from Eastman Reservoir and the Chowchilla River. The most recent plants were detected and removed in 2002, and the CDFA is cautiously optimistic that eradication can be declared following three more years of negative plant finds.

PERMITTING AQUATIC PLANT MANAGEMENT ACTIVITIES IN WASHINGTON STATE: A NEW APPROACH. Kelly McLain; Aquatic Pesticide Specialist/Permit Writer, Washington State Department of Ecology, P.O. Box 47600, Olympia, WA 98504-7600.
e-mail: kelm461@ecy.we.gov

Washington State allows the chemical control of aquatic plants only after obtaining a permit from the Department of Ecology. Since the 2001 *Talent* decision, Ecology has been issuing permit coverages under National Pollutant Discharge Elimination System (NPDES) permits for aquatic plant control activities. Originally, there were two different permits governing these activities: one that covered the removal of noxious weeds, and one that permitted the control of native plants and algae. These permits are reissued every five years, and as a result of a lawsuit settlement against the noxious weed permit earlier this year, the timeline was pushed up to rewrite both the nuisance weed and noxious weed permit. Because of this settlement, an EPA rulemaking, Ecology workload issues, and the recent *Fairhurst vs. Hagener* decision by the U.S. 9th Circuit Court of Appeals, Washington State will be issuing a state permit in 2006 that covers both the attempted eradication of noxious weeds, as well as the control of noxious weeds, native plants, and algae. By employing a new philosophy towards the control of aquatic plants and algae, Ecology is restructuring how these plants are viewed in Washington's aquatic environment.

LUDWIGIA CONTROL IN THE LAGUNA DE SANTA ROSA, CALIFORNIA.
Thomas J. McNabb[1], Julian Meisler[2]; [1]Clean Lakes, Inc. P. O. Box 3186, Martinez, CA 94553, [2]Laguna de Santa Rosa Foundation, 50 Old Courthouse Square, Suite 609, Santa Rosa, CA 95404.
e-mail: tmcnabb@aquatics.com

The Laguna de Santa Rosa Foundation (Laguna Foundation) spearheaded a three-year control effort aimed at reducing the area and density of the non-native invasive weed *Ludwigia spp.* (species unknown as of 11/17/05) within selected areas of the Laguna de Santa Rosa (Laguna) watershed in 2005. The infestation harbors mosquito vectors of West Nile Virus (WNV) that poses a health threat to humans and wildlife; out-competes native wetland species, severely degrading habitat; and is believed to impair both the water quality and the flood-control functions of the Laguna. The 2005 control efforts began on July 18th following receipt of the required approval documents (NPDES Permits, CDF&G Approvals), and continued through October 21st. Control occurred at two sites within the Laguna (California Department of Fish and Game Property, Sonoma County Water Agency Property) and included three principle elements: herbicide treatment, harvesting of dead biomass, and hauling of biomass to agricultural hayfields. The 2005 effort was the first step in the larger process of restoring the Laguna. The Foundation does not expect that control efforts will remove 100% of *Ludwigia* from the Laguna. Rather, it is expected that the control effort will reduce the population of Ludwigia to a point where restoration of natural ecosystem processes and vegetation can maintain it as a minor rather than dominant component of the natural community. The presentation will cover the results of the 2005 control efforts, as well as plans for Year Two control efforts.

LOW TEMPERATURE AND PH EFFECTS ON GROWTH AND POTENTIAL DISTRIBUTION OF SALVINIA MOLESTA MITCHELL. Chetta S. Owens[1], R. Michael Smart[1], Michael J. Grodowitz[2]; [1]Plant Ecologist, Lewisville Aquatic Ecosystem Research Facility, 201 E. Jones Street, Lewisville, TX 75057, [2]Corps of Engineers-

Environmental Research and Development Center, 3909 Halls Ferry Road, Vicksburg, MS 39180.
e-mail: chetta@laerf.org

Giant salvinia (*Salvinia molesta*), an invasive, free-floating fern native to Brazil, is invading the US. In order to predict its ultimate distribution and to identify environmental factors that may affect the susceptibility of aquatic ecosystems to invasion, a series of studies were conducted to determine the effects of low temperatures and water pH on the growth of giant salvinia. Results from acute low temperature exposure in a controlled study demonstrated that formation of ice results in a decrease in percent survival of giant salvinia. All giant salvinia plants exposed to air temperatures of –16C (48hr) were killed while those exposed to –3C (48hr) survived due to incomplete ice formation in the surface water of the container. Additionally, growth of giant salvinia under different pH regimes was examined. Giant salvinia grew to completely cover a research pond over a 15-week period when pH was less than 7.5. Growth was reduced in a second pond maintained at higher pH (greater than 8 units). Tank studies found that significantly greater giant salvinia biomass was produced at lower pH and that water chemistry of tanks changed when completely covered by the resultant mat. Four outdoor research ponds are being used to mass-rear the weevil (*Cyrtobagous salviniae*), a promising biocontrol agent for giant salvinia. Different nutrient regimes were employed to determine optimum conditions to grow maximum numbers of weevils. Giant salvinia plants, infested with large numbers of weevils in all life-stages, have been distributed to several salvinia-infested lakes in Texas.

PARROTFEATHER MILFOIL *(MYRIOPHYLLUM AQUATICUM)* AND WATER PRIMROSE *(LUDWIGIA HEXAPETALA)* CONTROL WITH HERBICIDES. Kim Patten, Chase Metzger; Washington State University Long Beach Research and Extension Unit, 2907 Pioneer Road, Long Beach, WA 98631.
e-mail: pattenk@wsu.edu

Research was conducted in 2004 and 2005 at numerous sites in southwest Washington in drainage canals clogged with Parrotfeather Milfoil (PM) and Water Primrose (WP). Herbicides, herbicide rates, timings, application methods and herbicide combinations were evaluated for one and/or two years of treatment. Herbicide treatments included imazapyr (Habitat), imazamox (Raptor), triclopyr (Renovate), glyphosate (Aquamaster), 2,4-D (Weedar 64), diquat (Reward). For PM, no foliar applied herbicide provided 100% control with one application. For the single application treatments however, Habitat (6 pt/ac) was the most effective herbicide, consistently providing >85% control 12 months after treatment (MAT). Renovate treatments required multiple applications, regardless of rate, to achieve a reasonable level of control (>80%). There were no differences in efficacy between combinations of herbicides, Renovate + Habitat or Aquamaster + Habitat, compared to Habitat alone. The efficacy of foliar applied herbicides was directly related to the amount of exposed PM canopy. PM in drainage canals with low water levels, with the bulk of canopy exposed at application, was controlled (>95%) by all of the foliar applied herbicide treatments. PM with < 10-20 cm of exposed canopy required multiple treatments per year of Habitat or Renovate for two years to control (>99%). Due to the thick canopy mat and slow flow, experimentation with sub-surface applications of herbicide for PM control was problematic. Under these conditions, Raptor at 20 ppb was not effective, while short-term control (20 DAT) for Renovate at 0.5 to 1 ppm, Reward at 375 ppb, and Weedar 64 at 2 gal/ac was 25, 86 and 98%, respectively. For short-term control of WP (2 MAT), one application of Habitat 3pt/a, Habitat 6pt/a, Raptor 24 oz/ac and Renovate 2 qt/a resulted in 100%, 80 to 93%, 56 to 88%, and 98% control respectively. Long-term control of WP (12 MAT) with Habitat (4 pt/a) or Renovate (3 qt/a) was 75% and 15%, respectively.

THE USE OF SPIKEWHEEL™ INJECTION SYSTEM FOR UNDERWATER SUBSOIL HERBICIDE PLACEMENT IN AQUATIC WEED CONTROL. Kim Patten, Chase Metzger; Washington State University Long Beach Research and Extension Unit, 2907 Pioneer Road, Long Beach, WA 98631.
e-mail: pattenk@wsu.edu

The direct placement of residual based herbicides below the benthic surface could be a useful method for providing long-term control of very problematic aquatic weed species. Under aquatic conditions, however, shanking or injecting a product below the sediment surface requires more horsepower than can delivered by most amphibious equipment. A simple boat- based low-horsepower system to directly place herbicide 5 to 20 cm below the sediment using a series of Spikewheel™ injectors will be discussed.

FACTORS AFFECTING THE ESTABLISHMENT AND CONDITION OF *EGERIA DENSA* FRAGMENTS. Toni G. Pennington, Mark D. Sytsma; Center for Lakes and Reservoirs, Portland State University, PO Box 751-ESR, Portland, OR 97207.
e-mail: toni@pdx.edu

Egeria densa Planch. (Brazilian elodea) in the U.S. spreads exclusively by fragments of staminate (male) plants. Even in its native range of South America, pistillate (female) flowers are extremely rare. Branches, roots and flowers are formed in specialized regions, referred to as double nodes, comprising two closely spaced leaf nodes. We investigated factors that influence the establishment success and condition of *E. densa* fragments. Two stems lengths (8 to 12 cm or 17 to 23 cm) were incubated in one of two nutrient levels (0x or 25x Hoagland's solution). After incubation, half the stems were planted in sediment filled pots and half were floated 30 cm above a sediment filled pot. Dry weight and nitrogen concentration of *E. densa* subsamples were determined prior to planting. Dry and fresh weight, stem and root length, and nitrogen and carbohydrate concentration were measured after 11 weeks. Stems floated in high nutrient media produced significantly longer roots; however, roots of planted stems produced more dry weight per cm of root material. Establishment was considered successful if roots were embedded in the sediment, which was the case for 50 percent of the floating stems. Where establishment was observed, stems rarely sank to the sediment surface; instead, they continued to float and send roots down toward the sediment. These data emphasize the importance of removing *E. densa* fragments from waterways following mechanical control.

CHANGE DETECTION OF WATER HYACINTH (*Eichhornia crassipes*) INVASIVE WEED SPECIES IN SACRAMENTO SAN-JOAQUIN RIVER DELTA

USING HYMAP IMAGERY. Sepalika S. Rajapakse[1], Shruti Khanna[1, 2], Margaret E. Andrews[1, 2], Erin Hestir[1, 3], Susan L. Ustin[1, 2], Maria Santos[1, 4] and Mui Lay[1]; [1]CalSpace center of Excellence, University of California Davis, The Barn, One Shields Avenue, Davis, CA 95616, [2]Department of Land, Air, and Water Resources, University of California, One Shields Avenue, Davis, CA 95616, [3] Department of Geography, University of California, One Shields Avenue, Davis, CA 95616, [4] Department of Wildlife, Fish and Conservation Biology, University of California, One Shields Avenue, Davis, CA 95616.
e-mail: srajapakse@ucdavis.edu

In recent years, the impact of aquatic invasive species on biodiversity has become a major global concern. In the Sacramento-San Joaquin Delta region in the central valley of California, USA, heavy infestations of the invasive aquatic emergent weed, hyacinth (*Eichhornia crassipes*) has the ability to change the structure and function of entire ecosystem. Hyacinth was introduced from South America in the 1880s and these plants escaped from gardens and ponds where they were kept as decorative plants. Hyacinth is one of the fastest growing plants. One of the challenges of controlling these plant invasions is detecting them. The plants can be spread with the river's flow. The processing and analyzing remote sensing imagery provide a useful method for assessing large-scale weed detection over time. Two sets of HyMap imagery acquired over Sacramento San- Joaquin River Delta during June 2005 and October 2005 were used for this study. Classification was performed on eleven flightlines acquired over the study site using a decision tree. The hyacinth infested area was detected with significant accuracy (κ value > 0.7). The resulting invasive weed maps in Delta region should allow aquatic weed managers to track and thus manage the outbreak of these destructive weeds. Change detection technique is the process of identifying changes over time. This technique helps to assess the effectiveness of current invasive weed control methods. Change Vector Analysis method was applied to June and October post classification image data sets to detect the change hyacinth infested pixels. It was investigated that hyacinth infestation was reduced after the chemical application which was performed by the Department of Boating and waterways in summer 2005.

RENOVATE® PRODUCT DEVELOPMENT UPDATE: REVIEW OF THREE YEARS OF FIELD RESULTS WITH A NEW SELECTIVE AQUATIC HERBICIDE. Scott Shuler[1], Mark Mongin[2]; [1]SePRO Corporation, 1780 Creekside Drive, #922, Folsom, CA 95630, [2]SePRO Corporation, 11550 N Meridian Street, #600, Carmel, IN 46032.
e-mail: scotts@sepro.com

Renovate is a highly selective broadleaf herbicide that can be used to systemically control a variety of nuisance and exotic aquatic plant species. In addition to controlling unwanted exotics, Renovate allows many native monocots and less susceptible dicots to thrive following treatment. Therefore, this product can be used as an ecosystem restoration tool in lakes, ponds, reservoirs and wetlands. Field development work conducted by the Army Corps of Engineers in the 1990's, SePRO's Experimental Use Permit evaluations from 1997 to 2000 and aquatic applicator evaluations during the 2003

-2005 management seasons have documented control of many nuisance and exotic broadleaf species while having minimal impact on many desirable monocots. This unique selective herbicide activity continues to be developed on a variety of emergent, floating and submersed aquatic weed species. A review of this new herbicide technology will be provided with results and discussion of the data from recent trials and field development work.

CONTROL OF JAPANESE KNOTWEED AND SAGO PONDWEED IN RIPARIAN ZONES AND IRRIGATION CANALS. Joseph Vollmer; Sr. Market Development Specialist, BASF Corporation, 2166 North 15th Street, Laramie, WY 82072.
e-mail: vollmejg@basf.com

Japanese knotweed (*Polygonum cuspidatum*) infests waterways and riparian zones, crowding out native vegetation. Glyphosate stem injection, used in the past, was labor intensive and resulted in large amounts of active ingredient used per acre. Imazapyr, a new aquatic herbicide, sprayed as a low volume foliar treatment, significantly increased efficacy and reduced active ingredient load to the environment. Results showed that treating knotweed with a stem density of 700 stems per 100 square feet used 2175 pounds of glyphosate acid equivalent compared to 0.4 pounds of imazapyr acid equivalent per acre. Efficacy evaluation on stem counts revealed imazapyr to provide 95% control with one application and glyphosate efficacy ranging from 0 to 80% depending on site. Sago pondweed (Stuckenia pectinatus) restricts water flow in irrigation canals in the western U.S. Current treatments provide a chemical mowing effect and are applied periodically throughout the irrigation season. Imazapyr was applied in the fall after water draw down, providing control of sago pondweed throughout the entire next season.

Hand Removal of Invasive Aquatic Weeds in Lake Tahoe.

Valerie Van Way; Senior Staff Environmental Scientist, California State Lands Commission, 100 Howe Avenue, Suite 100-South, Sacramento, CA 95825
e-mail: vanway@slc.ca.gov

Eurasian watermilfoil (*Myriophyllum spicatum*), a devastating invasive weed in North American waterways, has been steadily expanding within Lake Tahoe in over a dozen documented sites. In 2005, in an effort to initiate a control effort on an incipient infestation in Emerald Bay, a site of high resource value, the State Lands Commission of California sought permissions from the three regulating agencies to conduct a pilot diver survey and hand removal effort on the infestation in Emerald Bay, Lake Tahoe. In May and November, 2005 an SLC-contracted diver removed 65 and 250 pounds of milfoil plants, respectively, from three infested acres in Emerald Bay. Concerned Lake Tahoe Diver Conservancy volunteers, trained in the identification of aquatic plants, Lake Tahoe Resource Conservation District staff, and resource managers and regulators have vowed support and drafted a Memorandum of Understanding to streamline the permit process, and to help towards the development of a strategic plan for managing this weed in the entire Lake. The outcomes of these initial efforts, and key points of the resultant draft Memorandum of Understanding, will be presented.

AQUATIC WEED CONTROL TECHNIQUES IN NEW ZEALAND AND HOW THEY COMPARE WITH THE U.S. Rohan Wells; Scientist, NIWA, P.O. Box 11-115, Hamilton, New Zealand.
e-mail: r.wells@niwa.co.nz

New Zealand has a long history of aquatic weed control spanning back to the 1880's when *Nasturtium* spp. (water cresses) was controlled, some 20 years after their deliberate introduction as food plants. Research on aquatic weed control began in the 1950's and has continued to the present, managing problem species to prevent their further spread (including eradication programs), protecting indigenous biodiversity and amenity control for recreation, hydro-electric generation, irrigation and flood control. A decision support system has been developed with steps to; define the weed problem; identify the problem species and predict impacts; look at available control options; design a site-specific management plan and monitor success with modifications to the management plan if necessary. There are fewer aquatic weed control options compared to the US on account of a small population base, restricted market for mechanical or herbicide solutions, and legislation restricting the ability to experiment with new herbicides or biocontrol agents. This has led to 'kiwi ingenuity', customizing and optimizing techniques including suction dredging, opaque covers, diploid grass carp and weed management at sites of impact. The toolbox for controlling weeds is expanding, with the Aquatic Plant Group trailing a range of options currently used or under development in the USA and other countries, for New Zealand situations. Endothall has recently been registered for aquatic use in New Zealand and in the near future triclopyr amine is likely to join it.

TOP FIVE SPRAWLING EMERGENT AND FLOATING WEEDS IN NEW ZEALAND. Rohan Wells; Scientist, NIWA, P.O. Box 11-115, Hamilton, New Zealand.
e-mail: r.wells@niwa.co.nz

The top five sprawling emergent and floating weeds of New Zealand's freshwater habitats are *Alternanthera philoxeroides* (alligatorweed), *Salvinia molesta* (giant salvinia), *Gymnocoronis spilanthoides* (Senegal tea), *Myriophyllum aquaticum* (parrotfeather) and *Glyceria maxima* (reed mannagrass). These life forms were under-represented amongst the natural flora of New Zealand, and have invaded existing and modified habitats. Their distribution, impacts and current control methods are outlined. An introduction via ships ballast, alligatorweed is widely established within northern North Island but few other sites. It is spreading via the movement of contaminated machinery and soil. Once present, it can rarely be eradicated from aquatic sites despite the use of biocontrol agents (*Agasicles hygrophila*, *Arcola malloi*) or herbicides (glyphosate). Recent control trials with metsulfuron, triclopyr and imazapyr hold some promise, with metsulfuron used at some field sites. A national campaign for eradication of salvinia has reduced this weed to a handful of active sites by the use of herbicide and mechanical clearance. Senegal tea escaped from an ornamental pond stockist in 1989, but is now in scattered locations in the North Island and top of the South Island. Control and local eradication has been obtained with a combination of glyphosate and metsulfuron. Parrotfeather and reed mannagrass are widely spread. Parrotfeather has been difficult to completely control, but the herbicide triclopyr appears to give excellent control. Reed mannagrass is controlled mechanically or with the herbicide glyphosate.

DON'T LET ALGAE RUIN YOUR DAY. Paul Westcott[1], James C. Schmidt,
[1]Southwest Regional Manager, Applied Biochemists, 15420 N 29th Ave, Phoenix, AZ 85053
e-mail: paulwestcott@appliedbiochemists.com

From farm ponds to drinking water reservoirs, algae and cyanobacteria plague our aquatic ecosystems with an array of problems ranging from aesthetics to use impairment. While those of us in the lake and pond management business realize their importance in the overall aquatic ecology of these sites, control efforts are often needed to balance the ecosystem, improve appearance, restore functional water use, bring water quality into acceptable regulatory compliance or alleviate public concerns and complaints. A strong focus on research and monitoring of toxic and taste & odor (T & O) producing algal species continues to mount with their increased nationwide occurrence. Recent studies on interrelationships between exotics such as Zebra Mussels, phytoplankton and nutrient budgets have shown some interesting shifts in dominant species. Toxic epiphytic and T & O producing benthic species have been recently discovered. Further work has gone into classifying algal toxins based upon their sources and physiological impacts. A database is in process of being compiled from laboratory studies on different species and biomasses utilizing varying algaecide rates and formulations. Work is on-gong in expanding this "Targeted Algal Management" approach. Observations and data gathered following large-scale operational algaecide treatments conflict with assumptions related to "leaky" cells and "spilling" of these cellular materials post-application. New studies are underway to determine impacts from commonly used algaecide products at the cellular level with respect to production and potential release of toxins / T & O compounds.

TOP FIVE SUBMERGED WEEDS IN NEW ZEALAND. Mary de Winton; Scientist, NIWA, P.O. Box 11-115, Hamilton, New Zealand.
e-mail: m.dewinton@niwa.co.nz

The top five weed species of New Zealand's submerged freshwater habitats are *Hydrilla verticillata* (hydrilla), *Ceratophyllum demersum* (coontail), *Egeria densa* (egeria), *Lagarosiphon major* (lagarosiphon) and *Utricularia gibba* (bladderwort). This presentation outlines their typical habitat and distribution within the country, why we are concerned, and what is currently being done to control or contain these weeds. Hydrilla has a restricted distribution, with a management emphasis on containment while the feasibility of eradication from New Zealand is explored. Coontail and egeria are widespread in the North Island, with relatively few incursions to the South Island. They are widely controlled, with containment or eradication being a goal only where new incursions lead to an advanced risk of spread. Lagarosiphon is widely distributed, but there remain lakes where lagarosiphon has a limited establishment and the focus of control is containment to invaded areas of the water body. The spread and establishment of bladderwort in the northern North Island has escalated in the last five years. The extent of bladderwort impacts, or pathways and vectors for spread are as yet poorly documented and control options are yet to be tested. Control options currently in use in New Zealand against submerged weeds include the herbicides diquat and endothall, suction dredging, bottom lining and diploid grass carp. The effectiveness of these options for different species management goals is briefly considered.

AQUATIC PLANT RESEARCH & SERVICES IN NEW ZEALAND. Mary de Winton; Scientist, NIWA, P.O. Box 11-115, Hamilton, New Zealand.
e-mail: m.dewinton@niwa.co.nz

The Aquatic Plant Group provides research, services and solutions spanning the spectrum of freshwater plant problems in New Zealand. Our organization, NIWA, is New Zealand's leading provider of atmospheric and aquatic science and services and has a wide range of commercial clients, as well as funding by contestable government sources. Web-Pages (http://www.niwa.co.nz/rc/prog/aquaticplants/) outline the range of activities, relevant articles and recent publications by the Aquatic Plant Group. In the area of '*Resource survey and information systems*' we design survey techniques to delineate aquatic vegetation and to assess water body condition, as well as reporting data via web-accessible data storage and retrieval systems. For '*Biodiversity services*' we apply molecular taxonomic techniques to recognize unique flora aspects, identify the habitat requirements for native vegetation and advance strategies to protect populations of rare aquatic plants. Within '*Biosecurity services*' we assesses risks posed by aquatic weeds within New Zealand and at our borders, and prioritize species for bio-security management. A major goal is to expand the toolbox of solutions for the control or eradication of aquatic weeds. Under '*Outreach*' activities we provide educational and training resources on freshwater issues, plant identification and supply advice for managers towards identifying issues and options in managing freshwater vegetation, or to guide policy makers. We seek to network with colleagues around the world for knowledge exchange, collaborative opportunities and alliances.

BOATER-MEDIATED DISPERSAL OF AN INVASIVE AQUATIC MACROPHYTE, EURASIAN WATERMILFOIL (*MYRIOPHYLLUM SPICATUM* L.), IN AND AROUND THE LAKE TAHOE BASIN, CALIFORNIA & NEVADA, USA. Marion Wittmann; Graduate Student, Donald Bren School of Environmental Science & Management, University of California Santa Barbara, CA 93106
e-mail: mwittmann@bren.ucsb.edu

Eurasian watermilfoil (*Myriophyllum spicatum* L.) is a submersed, invasive aquatic macrophyte that has naturalized in and around Lake Tahoe for over 30 years. It has spread extensively along the South shore of the lake and into the Truckee River. Lake Tahoe and surrounding water bodies are heavily utilized for recreational boating and fishing activities. The transport of aquatic plants on boats and boating equipment is believed to play a key role in the dispersal and contamination of new water bodies (Johnstone et al. 1985, Howard-Williams 1993). Under current conditions, there are no vehicle inspection programs regarding the removal of potentially viable plant fragments from boats and trailers exiting the lake. I conducted surveys at seven Lake Tahoe boat launches gathering information on boater movements both within the lake and to surrounding water bodies. I also collected information on boat cleaning habits and awareness of invasive aquatic plants, and performed visual inspections of outboards, propellers and trailers. I found that 22% of boats removed from Lake Tahoe carry plant fragments, and that 83% of these either return to Lake Tahoe or travel to other water bodies within seven days, posing a potential threat to uninfested sites nearby. Current infestations of Eurasian watermilfoil and boater pathways within Lake Tahoe suggest that within-lake dispersal is strongly influenced by recreational boating. Here I use a spatially explicit model to outline propagule pressure within this system, and to show relative risks of introduction of Eurasian watermilfoil to uninfested sites via recreational boaters.