

Salvinia molesta  [简体中文](#) [正體中文](#)

System: Terrestrial

Kingdom	Phylum	Class	Order	Family
Plantae	Pteridophyta	Filicopsida	Hydropteridales	Salviniaceae

Common name fougère d'eau (French, Burkina Faso), koi kandy (English), African pyle (English), aquarium watermoss (English, United States), salvinia (English), giant salvinia (English, United States), giant salvinia (English), water fern (English), water spangles (English), kariba weed (English), African payal (English)

Synonym *Salvinia auriculata*, Aubl.

Similar species *Salvinia biloba*, *Salvinia herzogii*, *Salvinia auriculata*

Summary *Salvinia molesta* is a floating aquatic fern that thrives in slow-moving, nutrient-rich, warm, freshwater. A rapidly growing competitive plant, it is dispersed long distances within a waterbody (via water currents) and between waterbodies (via animals and contaminated equipment, boats or vehicles). *Salvinia molesta* is cultivated by aquarium or pond owners and it is sometimes released by flooding, or by intentional dumping. *Salvinia molesta* may form dense vegetation mats that reduce water-flow and lower the light and oxygen levels in the water. This stagnant dark environment negatively affects the biodiversity and abundance of freshwater species, including fish and submerged aquatic plants. *Salvinia molesta* can alter wetland ecosystems and cause wetland loss and also poses a severe threat to socio-economic activities dependent on open, flowing and/or high quality waterbodies, including hydro-electricity generation, fishing and boat transport.



[view this species on IUCN Red List](#)

Species Description

Salvinia molesta is a free floating aquatic fern. It produces a horizontal rhizome (that lies below the water surface) and two types of frond (buoyant and submerged). The mature plant produces egg-shaped spore sacs containing infertile spores. It lacks true roots but its submerged fronds function as roots. Its fronds are in whorls of three (two floating and one submerged). The floating fronds are positioned in an opposite orientation to each other and are round to oblong in shape. On their upper surface they have rows of cylindrical papillae. Each papilla has four hairs at its distal end (each consisting of a single row of cells) that are joined together at their tips to form what looks like an inverted egg-beater. The cage-like structure of the end hairs is an effective air trap giving the plant buoyancy in the water. The papillae, end hairs and upper surface of the plant are water repellent in comparison to the under surface of the leaf, which attracts water. It is this difference in water attraction that maintains the correct orientation of the plant on the water surface. The fronds are light to medium green, often with brownish edges in mature plants, and with a distinctive fold in the center. The plant exhibits great morphological variation depending on the conditions of habitat (such as space and nutrient availability), and ranges from a slender floating specimen with leaves less than 1.5cm wide to one with leaves up to 6cm wide (Pieterse *et al* 2003; Kay and Hoyle 1999; Mitchell D. Pers. Comm. 2005; ARM CANZ ANZECC 2000).

Lifecycle Stages

Depending on the climate *Salvinia molesta* may be either a perennial or an annual. In non-tropical regions it may function as an annual but it will still produce significant growth during the summer period. In nutrient rich waters it may reach a density of 30 000 small plants per m² and under ideal growth conditions it can double its biomass in two days. The plant passes through three identifiable growth stages, the development of which are determined by environmental conditions. The growth of single ramets (plantlets) is known as the primary growth stage and the growth of a linear chain of ramets is known as the secondary growth stage. Finally, the formation of a compact vegetative cluster is known as the tertiary phase (ARMCANZ ANZECC 2000; ARMCANZ ANZECC 2000; WAPMS 2003; Jacono 1999). A good illustration showing the growth stages can be viewed at: [Salvinia molesta. Giant salvinia. U.S. Geological Survey.](#)

Uses

Floating aquatic weeds have been used for mulch, compost, fodder, paper making, handcrafts and bio-gas generation (Howard and Harley, 1998). Annual gains from successful biological control of salvinia worldwide have been estimated to be approximately \$US 150 million. The main impediment to the commercial use of floating aquatic weeds such as salvinia is their high water content, which is often up to 90% of the harvest wet weight. Thus a large proportion of the harvest is water, while only a small proportion is actually plant matter. The high growth rate of aquatic weeds may lead to an optimistic evaluation of their commercial use but the commercial benefits are negligible in comparison to their known wide-ranging negative socio-economic and environmental impact (Julien Center and Tipping 2002; Mitchell D. Pers. Comm. 2005).

Habitat Description

Salvinia molesta prefers tropical, sub-tropical or warm temperate areas of the world and grows best in still or slow-moving water bodies including ditches, ponds, lakes, slow rivers and canals. In standing water it forms stable floating mats. It grows optimally at a water temperature of between 20°C and 30°C. Buds are killed when exposed for more than two hours to temperatures below -3°C or above 43°C. Salvinia is able to tolerate salinity levels one tenth that of seawater, allowing the weed to adapt to a wide range of benthic environments. Its growth rate decreases by 25% at a salinity level of 0.3%. Growth is greatly stimulated by an increase in nutrient levels. As a consequence the weed is particularly fast-growing in areas where the hydrological regime has been altered by humans, encouraging an increase in nutrient levels (for example by increased runoff or fertiliser leaching) (WAPMS 2003; Mitchell D. Pers. Comm. 2005; ARMCANZ ANZECC 2000; Howard and Harley 1998).

Reproduction

Salvinia molesta produces egg-shaped, slender-tipped sporocarps that develop in elongated chains along the submersed fronds. Sporocarps contain numerous sporangia (which are usually empty or contain only a few deformed spore remnants). Because the plant is pentaploid (contains five sets of chromosomes) it can not produce viable spores (due to an unequal division of chromosomes during meiosis). As a consequence *S. molesta* is sterile and can only reproduce asexually. The plant propagates by vegetative growth and sporadic fragmentation, resulting in small vegetative propagules that are dispersed by water currents (Jacono 2003).

General Impacts

For details on impacts of this species please see [general impacts](#)

Management Info

Proliferation of aquatic weeds is often indicative of increased nutrient levels in watersheds and wetlands. This may mean several species of floating aquatic weeds may be waiting to replace *S. molesta*. Following salvinia removal continuous monitoring of infestation sites to detect aquatic plant succession is necessary. Sustainable management of the whole ecosystem, decreasing the nutrient level and improving sewage drainage and effluent treatment is likely to reduce the biomass of floating plants such as *S. molesta* (Howard and Harley 1998; Chikwenhere and Keswani 1997; Room and Fernando 1992; McFarland et al. 2003).

For details on management of this species, please see [management information](#)



GLOBAL INVASIVE SPECIES DATABASE

FULL ACCOUNT FOR: *Salvinia molesta*

Pathway

Floating aquatic weeds, including salvinia, may be spread on contaminated barges or log rafts (Howard and Harley, 1998). The attraction of *S. molesta* as an ornamental plant and as one of particular botanical interest has led to its spread to a far greater extent through intercontinental transport in aquarium and landscaping trades. Its introduction to North America, *S. molesta* is a popular aquarium plant throughout Australia (despite being banned) and continues to be kept in ponds and fish tanks in all States. It is sold through market gardens, pet shops, landscapers, with supplies coming from both wild harvest it is believed that *S. molesta* was first introduced into Sri Lanka into the Botany Department of the University of Colombo in 1943 (Williams, 1956, in Room and Fernando, 1992). Apparently a botanist at the University of Dakar (the capital of Senegal) was also responsible for encouraging the spread of the weed into the Sengal river (Pieterse *et al*, 2003).

Principal source: Room and Fernando, 1992. Weed Invasions Countered by Biological Control: *Salvinia molesta* and *Eichhornia crassipes* in Sri Lanka.

[Giant Salvinia *Salvinia molesta*, 2004. Western Aquatic Plant Management Authority](#)

Compiler: National Biological Information Infrastructure (NBII), Comité français de l'IUCN (IUCN French Committee) & IUCN SSC Invasive Species Specialist Group (ISSG)

Updates with support from the Overseas Territories Environmental Programme (OTEP) project XOT603, a joint project with the Cayman Islands Government - Department of Environment

Review: Under Revision

Dr David Mitchell Adjunct Professor School of Environmental and Information Science Charles Sturt University Australia

Publication date: 2010-10-04

ALIEN RANGE

[8] AUSTRALIA	[1] BANGLADESH
[1] BERMUDA	[1] BOTSWANA
[1] BURKINA FASO	[1] COTE D'IVOIRE
[1] CUBA	[1] FIJI
[1] FRANCE	[2] FRENCH POLYNESIA
[1] GHANA	[1] INDIA
[2] INDONESIA	[1] ITALY
[1] JAPAN	[1] KENYA
[1] MADAGASCAR	[1] MALAYSIA
[1] MAURITIUS	[1] MAYOTTE
[1] MEXICO	[1] NAMIBIA
[1] NEW CALEDONIA	[1] NEW ZEALAND
[1] PAPUA NEW GUINEA	[1] PHILIPPINES
[1] PORTUGAL	[1] REUNION
[1] SENEGAL	[1] SINGAPORE
[1] SOUTH AFRICA	[2] SRI LANKA
[1] SWAZILAND	[1] TANZANIA, UNITED REPUBLIC OF
[1] THAILAND	[1] TRINIDAD AND TOBAGO
[1] UGANDA	[12] UNITED STATES
[1] VANUATU	[1] ZAMBIA
[2] ZIMBABWE	

Red List assessed species 4: VU = 1; NT = 1; LC = 2;

[Fulica alai](#) **VU**

[Himantopus mexicanus knudseni](#) **LC**

[Mesophoyx intermedia](#) **LC**

[Oxyura maccoa](#) **NT**

BIBLIOGRAPHY

111 references found for *Salvinia molesta*

Management information

[Agriculture & Resource Management Council of Australia & New Zealand, Australian & New Zealand Environment & Conservation Council and Forestry Ministers, 2000. Weeds of National Significance *Salvinia* \(*Salvinia molesta*\) Strategic Plan. National Weeds Strategy Executive Committee, Launceston.](#)

Summary: Available from: <http://www.weeds.org.au/docs/salstrat.pdf> [Accessed 10 November 2010]

Andreu, J. and M. Vila 2010. Risk analysis of potential invasive plants in Spain. *Journal for Nature Conservation* 18(1): 34-44.

Barreto, R.; Charudattan, R.; Pomella, A.; Hanada, R. 2000. Biological control of neotropical aquatic weeds with fungi. *Crop Protection* 19(8-10): 697-703

Batianoff, G. N. and D. W. Butler 2002. Assessment of invasive naturalized plants in south-east Queensland. *Plant Protection Quarterly* 17(1): 27-34.

[Berruti, A., Baker, N., Buijs, D., Colahan, B.D., Davies, C., Dellegn, Y., Eksteen, J., Kolberg, H., Marchant, A., Mpofu, Z., Nantongo-Kalundu, P., Nnyiti, P., Pienaar, K., Shaw, K., Tyali, T., van Niekerk, J., Wheeler, M.J. and Evans, S.W. \(eds\). 2007. International Single Species Action Plan for the Conservation of the Maccoa Duck \(*Oxyura maccoa*\). AEW Technical Series No. 14. Bonn, Germany](#)

Summary: Available from: http://www.unep-aewa.org/publications/technical_series/ts_14_maccoa_duck_final.pdf [Accessed June 5 2012]

Bowcher, A. and Lee, T. 2003. *Integrated Weed Management: Salvinia* (fact sheet). CRC for Australian Weed Management.

Summary: Integrating management options into a viable management plan in Kakadu National Park.

Brunel, S.; Schrader, G.; Brundu, G.; Fried, G., 2010. Emerging invasive alien plants for the Mediterranean Basin. *Bulletin OEPP* 40(2): 219-238.

[CABI- Invasive Species Compendium, 2013. Datasheet *Salvinia molesta* Kariba weed](#)

Summary: Available from: <http://www.cabi.org/isc/?compid=5&dsid=48447&loadmodule=datasheet&page=481&site=144> [Accessed November 2012]

[Champion, P., Clayton, J. and Rowe, D. 2002. Alien Invaders Lake Managers Handbook. Ministry for the Environment.](#)

Summary: Available from: <http://www.mfe.govt.nz/publications/water/lm-alien-invaders-jun02.pdf> [Accessed 3 February 2005]

[Champion, P.D.; Clayton, J.S. 2000. Border control for potential aquatic weeds. Stage 1. Weed risk model. Science for Conservation 141.](#)

Summary: This report is the first stage in a three-stage development of a Border Control Programme for aquatic plants that have the potential to become ecological weeds in New Zealand.

Available from: <http://www.doc.govt.nz/upload/documents/science-and-technical/sfc141.pdf> [Accessed 13 June 2007]

[Champion, P.D.; Clayton, J.S. 2001. Border control for potential aquatic weeds. Stage 2. Weed risk assessment. Science for Conservation 185. 30 p.](#)

Summary: This report is the second stage in the development of a Border Control Programme for aquatic plants that have the potential to become ecological weeds in New Zealand. Importers and traders in aquatic plants were surveyed to identify the plant species known or likely to be present in New Zealand. The Aquatic Plant Weed Risk Assessment Model was used to help assess the level of risk posed by these species. The report presents evidence of the various entry pathways and considers the impact that new invasive aquatic weed species may have on vulnerable native aquatic species and communities.

Available from: <http://www.doc.govt.nz/upload/documents/science-and-technical/SFC185.pdf> [Accessed 13 June 2007]

Chikwenhere, G.P. and Keswani, C.L. 1997. Economics of Biological Control of Kariba Weed (*Salvinia molesta* Mitchell) at Tengwe in North-western Zimbabwe - a Case Study, *International Journal of Pest Management* 43(2): 109 - 112.

Summary: A summary on the use of *Cyrtobagous salviniae* as a biological control agent in heavily infested lake in Zimbabwe previously used for breeding fish (with an emphasis on cost:benefit analysis).

Coetzee, J. A.; Hill, M. P.; Byrne, M. J.; Bownes, A., 2011. A review of the biological control programmes on *Eichhornia crassipes* (C.Mart.) Solms (Pontederiaceae), *Salvinia molesta* D S Mitch. (Salviniaceae), *Pistia stratiotes* L. (Araceae), *Myriophyllum aquaticum* (Vell.) Verdc. (Haloragaceae) and *Azolla filiculoides* Lam. (Azollaceae) in South Africa. *African Entomology* 19(2, Sp. Iss. SI): 451-468.

[Collins, J.N., May M., Grosso C. 2003. Giant *Salvinia* *Salvinia molesta*. Practical Guidebook to the Control of Invasive Aquatic and Wetland Plants of the San Francisco Bay - Delta Region.](#)

Summary: Information on description, economic importance, distribution, habitat, history, growth, and impacts and management of species.

Available from: <http://legacy.sfei.org/nis/salvinia.html> [Accessed 20 May 2010].

The Guidebook is available from: <http://legacy.sfei.org/nis/index.html>

Cowie, I. D. and P. A. Werner, 1993. Alien plant species invasive in Kakadu National Park, tropical northern Australia. *Biological Conservation* 63(2): 127-135

Denslow, J. S. and M. T. Johnson., 2006. Biological control of tropical weeds: Research opportunities in plant-herbivore interactions. *Biotropica* 38(2): 139-142.

Diop, O. and M. P. Hill., 2009. Quantitative post-release evaluation of biological control of floating fern, *Salvinia molesta* DS Mitchell (Salviniaceae), with *Cyrtobagous salviniae* Calder and Sands (Coleoptera: Curculionidae) on the Senegal River and Senegal River Delta. *African Entomology* 17(1): 64-70.

Dongare, M., 2007. Phytoremediation potential of an aquatic fern: *Salvinia molesta* Mitch from Kotitirth Lake of Kolhapur city (Maharashtra). *Indian Fern Journal* 24(1-2): 71-76.

Dorahy, C. G.; Pirie, A. D.; McMaster, I.; Muirhead, L.; Pengelly, P.; Chan, K. Y.; Jackson, M.; Barchia, I. M., 2009. Environmental Risk Assessment of Compost Prepared from *Salvinia*, *Egeria densa*, and Alligator Weed. *Journal of Environmental Quality* 38(4): 1483-1492

Dye, J.M. and Heinz, K.M. Undated *Biological control of Salvinia species*. A&M University (Department of Entomology): Texas.

Summary: *Salvinia* Biocontrol poster

Emerine, Sherrie E.; Richardson, R. J.; True, S. L.; West, A. M.; Roten, R. L., 2010. Greenhouse Response of Six Aquatic Invasive Weeds to Imazamox. *Journal of Aquatic Plant Management* 48: 105-111

[European and Mediterranean Plant Protection Organisation \(EPPO\) 2012. *Salvinia molesta* \(Salviniaceae\)](#)

Summary: Available from: http://www.eppo.int/INVASIVE_PLANTS/iap_list/Salvinia_molesta.htm [Accessed November 2012]

Everitt, J. H.; Fletcher, R. S.; Elder, H. S.; Yang, C., 2008. Mapping giant salvinia with satellite imagery and image analysis. *Environmental Monitoring & Assessment* 139(1-3): 35-40.

Everitt, J. H.; Yang, C.; Helton, R. J.; Hartmann, L. H.; Davis, M. R., 2002. Remote sensing of giant salvinia in Texas waterways. *Journal of Aquatic Plant Management* 40: 11-16

Fairchild, James F.; Allert, A. L.; Riddle, J. S.; Gladwin, D. R., 2002. Efficacy of glyphosate and five surfactants for controlling giant salvinia. *Journal of Aquatic Plant Management* 40: 53-58

Fall, Ousmane; Fall, Ibrahima; Hori, Nobuyuki., 2004. Assessment of the abundance and distribution of the aquatic plants and their impacts in the Senegal River Delta: The case of Khouma and Djoudj streams. *Weed Technology* 18(Suppl. S): 1203-1209

Flores, D. and J. W. Carlson., 2006. Biological control of giant salvinia in East Texas waterways and the impact on dissolved oxygen levels. *Journal of Aquatic Plant Management* 44: 115-121

Forno, I. W., 1987. Biological Control of the Floating Fern *Salvinia molesta* in Northeastern Australia Plant-Herbivore Interactions. *Bulletin of Entomological Research* 77(1): 9-18.

Giardini, M., 2003. Notes on the biology, ecology and control of *Salvinia molesta* D.S. Mitchell (Salviniaceae), an invasive species new to Latium. *Rivista di Idrobiologia* 42(1-3): 263-282.

Giardini, M. G. M., 2004. *Salvinia molesta* D.S. Mitchell (Salviniaceae): the second record for Italy (Latium) and consideration about the control of this invasive species. *Webbia* 59(Part 2): 457-467

Glomski, L. A. M. and K. D. Getsinger., 2006. Carfentrazone-ethyl for control of giant salvinia. *Journal of Aquatic Plant Management* 44: 136-138.

Glomski, Lee Ann M.; Nelson, L. S.; Skogerboe, J. G., 2003. Clearigate(R) treatments for control of giant salvinia. *Journal of Aquatic Plant Management* 41: 127-129.

Gunaratne, A. M.; Jayakody, S.; Bambaradeniya, C. N. B., 2009. Spatial distribution of aquatic birds in Anavilundawa Ramsar wetland sanctuary in Sri Lanka. *Biological Invasions* 11(4): 951-958.

Howard, G.W. and Harley, K.L.S. 1998. How do Floating Aquatic Weeds Affect Wetland Conservation and Development? How can These Effects be Minimised?, *Wetlands Ecology and Management* 5: 215 - 225.

International Union for the Conservation of Nature (IUCN). 2002. *Note on the Control of Salvinia Molesta in Djoudj National Bird Sanctuary (Senegal)*.

Summary: Outline of the proceedings of the IUCN and associated organisations that initiated a biological control project (using *Cyrtobagous salviniae*) to manage salvinia in the Senegal River Delta area.

[IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4.](#)

Summary: The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on taxa that have been globally evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those taxa that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable). The IUCN Red List also includes information on taxa that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e. are Data Deficient); and on taxa that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation programme (i.e. are Near Threatened).

Available from: <http://www.iucnredlist.org/> [Accessed 25 May 2011]

Jacobs, T. V. 1998. Systematic and conservation status of estuarine macrophytes of South Africa. *Phyton* 63(1-2): 267-273.

Jacono, C. C. 1999. *Salvinia molesta* (Salviniaceae), new to Texas and Louisiana. *SIDA Contributions to Botany* 18(3): 927-928

Jacono, C.C. 2003. *Salvinia molesta* D.S. Mitchell. U.S. Geological Survey.

Jacono, C.C. 2004. *Sites Where Salvinia molesta (giant salvinia) Occurs in Cultivation May Serve as Sources For Introduction to Natural Systems*. U.S. Geological Survey.

[Jacono, Colette C. 1999. The Biology of Salvinia sp. Center for Environmental and Regulatory Information Systems \(CERIS\), Purdue University.](#)

Summary: Report on the description, habitat, native range, United States introduction, and expected United States range.

Available from: <http://pest.ceris.purdue.edu/searchpest.php?selectName=PEPACBC> [Accessed 20 May 2010]

Jacono, Colette C.; Davern, Tracy R.; Center, Ted D., 2001. The adventive status of *Salvinia minima* and *S. molesta* in the Southern United States and the related distribution of the weevil *Cyrtobagous salviniae*. *Castanea* 66(3): 214-226.

Jayanth, K. P. 1987., Biological Control of the Water Fern *Salvinia molesta* Infesting a Lily Pond in Bangalore India by *Cyrtobagous salviniae*. *Entomophaga* 32(2): 163-166.

Julien, M. H., A. S. Bourne, Chan, R. R., 1987. Effects of Adult and Larval *Cyrtobagous salviniae* on the Floating Weed *Salvinia molesta*. *Journal of Applied Ecology* 24(3): 935-944

[Julien, M.H., Center, T.D. and Tipping, P.W. 2002. Floating Fern \(Salvinia\). In Van Driesche, R. et al., Biological Control of Invasive Plants in the Eastern United States. USDA Forest Service Publication.](#)

Summary: Available from: <http://www.invasive.org/eastern/biocontrol/2FloatingFern.html> [Accessed 25 November]

Julien, M. H.; Scott, J. K.; Orapa, W.; Paynter, Q., 2007. History, opportunities and challenges for biological control in Australia, New Zealand and the Pacific islands. *Crop Protection* 26(3): 255-265

Kurugundla, C. N.; Bonyongo, M. C.; Serumola, O., 2010. Impact of deltamethrin aerial sprays on adult *Cyrtobagous salviniae* in Botswana. *African Journal of Aquatic Science* 35(3): 259-265

Lancer, L., Krake, K., Brabben, T., Plantey, J. and Malano, H. 2002. *Aquatic Weeds and Their Management*. Working Group on Development and Management of Irrigation Systems (WG-DMIS): International Commission on Irrigation and Drainage.

Land Protection. 2004. *Salvinia: Salvinia Species*, (facts pest series). The State of Queensland Department of Natural Resources and Mines.

Lonsdale, W. M. and A. M. Lane., 1994. Tourist vehicles as vectors of weed seeds in Kakadu National Park, northern Australia. *Biological Conservation* 69(3): 277-283.

[Mack, R. N and W. M. Lonsdale., 2002. Eradicating invasive plants: Hard-won lessons for islands. In *Turning the tide: the eradication of invasive species*: 311-318. Veitch, C.R. and Clout, M.N.\(eds\). IUCN SSC Invasive Species Specialist Group. IUCN. Gland. Switzerland and Cambridge. UK.](#)

Summary: Uses *Clidemia hirta* in Hawaii as an eradication case study. *Clidemia* is in the Melastomataceae and somewhat similar ecologically to *miconia*.

Eradication case study in *Turning the tide: the eradication of invasive species*.

Mahaulpatha, W. A. D.; Mahaulpatha, W. M. T.; Wasantha, K. A. L., 2008. Effects of water-level fluctuation and invasive water plants on pheasant-tailed jacana (*Hydrophasianus chirugus*) at the Annaiwilundawa Ramsar site of northwestern Sri Lanka. *Wetlands Ecology & Management* 16(1): 33-42.

[McFarland, D.G., Nelson, L.S. and Grodowitz, M.J., Smart, R.M. and Owens, C.S. 2004. *Salvinia molesta* D.S. Mitchell \(Giant Salvinia\) in the United States: A Review of Species Ecology and Management. Aquatic Plant Control Research Programme](#)

Summary: Available from: <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA425068&Location=U2&doc=GetTRDoc.pdf> [Accessed 20 May 2010]

McIntosh, Dennis; King, Chad; Fitzsimmons, Kevin., 2003. Tilapia for biological control of giant salvinia. *Journal of Aquatic Plant Management* 41: 28-31.

Miller, I. L. and S. E. Pickering., 1988. Eradication of *Salvinia molesta* from the Adelaide River Northern Territory Australia. *Plant Protection Quarterly* 3(2): 69-73

[National Pest Plant Accord, 2001. Biosecurity New Zealand.](#)

Summary: The National Pest Plant Accord is a cooperative agreement between regional councils and government departments with biosecurity responsibilities. Under the accord, regional councils will undertake surveillance to prevent the commercial sale and/or distribution of an agreed list of pest plants.

Available from: <http://www.biosecurity.govt.nz/pests-diseases/plants/accord.htm> [Accessed 11 August 2005]

Nelson, Linda S.; Glomski, L. M.; Gladwin, D. N., 2007. Effect of glyphosate rate and spray volume on control of giant salvinia. *Journal of Aquatic Plant Management* 45: 58-61

Nelson, Linda S. ; Skogerboe, John G.; Getsinger, Kurt D., 2001. Herbicide evaluation against giant salvinia. *Journal of Aquatic Plant Management* 39: 48-53.

NRM Facts Pest Series. *Salvinia* sp. Land Protection. Department of Natural Resources and Mines, Qld.

Oliver, J. D., 1993. A review of the biology of giant salvinia (*Salvinia molesta* Mitchell). *Journal of Aquatic Plant Management* 31(July): 227-231

Owens, Chetta S.; Smart, R. Michael; Honnell, David R.; Dick, Gary O., 2005. Effects of pH on growth of *Salvinia molesta* mitchell. *Journal of Aquatic Plant Management* 43: 34-38.

Owens, Chetta S.; Smart, R. Michael; Stewart, R. Michael., 2004. Low temperature limits of giant salvinia. *Journal of Aquatic Plant Management* 42(July): 91-94.

[PIER \(Pacific Island Ecosystems at Risk\). 2003. *Salvinia molesta*.](#)

Summary: Ecology, synonyms, common names, distributions (Pacific as well as global), management and impact information.

Available from: http://www.hear.org/pier/species/salvinia_molesta.htm [Accessed 1 October 2003]

Pieterse, A.H., Kettunen, M., Diouf, S., Ndao, I., Sarr, K., Tarvainen, A., Kloff, S. and Hellsten, S. 2003. Effective biological control of *Salvinia molesta* in the Senegal River by Means of the Weevil *Cyrtobagous salviniae*, *Ambio* 32 (7): 458 - 462.

Rayachhetry, M. B.; Center, T. R.; Center, T. D.; Tipping, P.; Pratt, P. D.; Van, T. K., 2002. First report of the pathogenicity of *Rhizoctonia solani* on *Salvinia molesta* and *S. minima* in Florida. *Plant Disease* 86(7): 813.

Rice, Barry. 2002. *Salvinia molesta* Wildland Invasive Species Team

Richardson, Robert J.; Roten, R. L.; West, A. M.; True, S. L.; Gardner, A. P., 2008. Response of Selected Aquatic Invasive Weeds to Flumioxazin and Carfentrazone-ethyl. *Journal of Aquatic Plant Management* 46: 154-158.

Riefner, R. E., Jr. and S. Boyd., 2007. New records of wetland and riparian plants in southern California, with recommendations and additions to the National List of Plant Species that Occur in Wetlands. *Journal of the Botanical Research Institute of Texas* 1(1): 719-740.

Room, P.M., 1990, *Ecology & Evolution*, 5:77. Doeleman, J.A., ♦Biological Control of *Salvinia molesta* in Sri Lanka; an assessment of costs and benefits♦, Australian Centre for International Agricultural Research, Technical Report 12.

Summary: Management information on *Salvinia molesta*.

Room, P. M. and I. V. S. Fernando., 1992. Weed Invasions Countered by Biological Control *Salvinia molesta* and *Eichhornia crassipes* in Sri Lanka. *Aquatic Botany* 42(2): 99-108.

[Royal New Zealand Institute of Horticulture \(RNZIH\), 2005. *Salvinia molesta*](#)

Summary: Available from: http://www.rnzih.org.nz/pages/nppa_078.pdf [Accessed 1 October 2005]

Sengar, R. S. and K. P. Sharma., 1993. Biological control of *Salvinia molesta* Mitchell with *Phragmites karaka* (Retz.) Trin. ex Steud. *Geobios* 20(4): 267-268.

Solangaarachchi, S. M. and R. P. K. Dushyantha., 1994. Growth and branching of damaged *Salvinia molesta*. *Journal of the National Science Council of Sri Lanka* 22(3): 271-278

Solangaarachchi, S. M. and W. M. D. S. K. Perera., 1996. Preliminary studies on changes in distribution of aquatic macrophytes in the Lunuwila tank in 1991-1993, after introduction of *Cyrtobagous salviniae* to control *Salvinia molesta*. *Journal of the National Science Council of Sri Lanka* 24(2): 81-94.

Sullivan, Paul R.; Postle, Lesley A.; Julien, Mic., 2011. Biological control of *Salvinia molesta* by *Cyrtobagous salviniae* in temperate Australia. *Biological Control* 57(3): 222-228.

Sullivan, P. R. and L. A. Postle., 2010. Low Temperature Reproduction of *Cyrtobagous salviniae*: Good News for Biological Control of *Salvinia* in a Temperate Climate. *Journal of Aquatic Plant Management* 48: 92-96

Swaziland s Alien Plants Database., Undated. *Salvinia molesta*

Summary: A database of Swaziland s alien plant species.

[Swearingen, J., Reshetiloff, K., Slattery, B. and Zwicker, S. 2002. *Plant Invaders of Mid-Atlantic Natural Areas: Giant Salvinia - Salvinia molesta*. National Park Service and U.S. Fish & Wildlife Service](#)

Summary: Online book that includes information on origin, spread, distribution, description, methods of disposal, and look-alikes.

Tipping, Philip W.; Martin, Melissa R.; Center, Ted D., 2012. Weevils Versus No Weevils: A Comparison of *Salvinia minima* Populations in Florida and Louisiana. *Florida Entomologist* 95(3): 779-782.

Tipping, Philip W.; Martin, Melissa R.; Center, Ted D.; Davern, Tracy M., 2008. Suppression of *Salvinia molesta* Mitchell in Texas and Louisiana by *Cyrtobagous salviniae* Calder and Sands. *Aquatic Botany* 88(3): 196-202

Tipping, Philip W.; Martin, Melissa R.; Bauer, Laurie; Pokorny, Eileen; Center, Ted D. 2010. Asymmetric impacts of two herbivore ecotypes on similar host plants. *Ecological Entomology* 35(4): 469-476

Tipping, P. W. and T. D. Center., 2003. *Cyrtobagous salviniae* (Coleoptera: Curculionidae) successfully overwinters in Texas and Louisiana. *Florida Entomologist* 86(1): 92-93.

Tipping, P. W. and T. D. Center., 2005. Influence of plant size and species on preference of *Cyrtobagous salviniae* adults from two populations. *Biological Control* 32(2): 263-268

Upadhyay, R. K. Upadhyay, R. K.; Panda, S. K. Panda, S. K., 2005. Salt tolerance of two aquatic macrophytes, *Pistia stratiotes* and *Salvinia molesta*. *Biologia Plantarum* (Prague). 49(1). MAR 05. 157-159.

USDA (United States Department of Agriculture) APHIS Animal and Plant Health Inspection Service. 2003. In May, M., Grosso, C. and Collins, J. (eds). *Practical Guidebook for the Identification and Control of Invasive Aquatic and Wetland Plants in the San Francisco Bay-Delta*. San Francisco Estuary Institute: Oakland (California).

Van Wilgen, B.W., Richardson, D.M., Le Maitre, D.C., Marais, C. and Magadla, D. 2001. The Economic Consequences of Alien Plant Invasions: Examples of Impacts and Approaches to Sustainable Management in South Africa, *Environment, Development and Sustainability* 3: 145 - 168.

Summary: Overview of the consequences of invasive weed species introduced into South Africa.

[Varnham, K. 2006. *Non-native species in UK Overseas Territories: a review*. JNCC Report 372. Peterborough: United Kingdom.](#)

Summary: This database compiles information on alien species from British Overseas Territories.

Available from: <http://www.jncc.gov.uk/page-3660> [Accessed 10 November 2009]

Weber, Ewald & Daniel Gut., 2004. Assessing the risk of potentially invasive plant species in central Europe. *Journal for Nature Conservation* 12 (2004) 171-179

Whiteman, J. B. and P. M. Room., 1991. Temperatures Lethal to *Salvinia molesta* Mitchell. *Aquatic Botany* 40(1): 27-36.

White, S. E.; Tipping, Philip W.; Becnel, James J., 2007. First isolation of a *Helicospiridium* sp. (Chlorophyta : Trebouxiophyceae) from the biological control agent *Cyrtobagous salviniae* (Coleoptera : Curculionidae). *Biological Control* 40(2): 243-245.

Wijeyaratne, M. J. S. and W. M. D. S. K. Perera., 2000. Studies on the feasibility of using indigenous fishes for controlling aquatic macrophytes in Sri Lanka. *Journal of Aquaculture in the Tropics* 15(3): 253-260.

General information

Adams, C. S.; Boar, R. R.; Hubble, D. S.; Gikungu, M.; Harper, D. M.; Hickey, P.; Tarras-Wahlberg, N., 2002. The dynamics and ecology of exotic tropical species in floating plant mats: Lake Naivasha, Kenya. *Hydrobiologia* 488 (15): 115-122.

Barthelat, F., pers. comm., 2007. Fabien Barthelat, Office National des Forêts, ONF Jardin d'essais 97139 Abymes, Guadeloupe.

Catarino, L. and I. Moreira, 1996. Aquatic weeds in Africa. *Revista de Ciencias Agrarias* 19(1): 81-97.

[CONABIO. 2008. Sistema de información sobre especies invasoras en México. Especies invasoras - Plantas. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. Fecha de acceso.](#)

Summary: English:

The species list sheet for the Mexican information system on invasive species currently provides information related to Scientific names, family, group and common names, as well as habitat, status of invasion in Mexico, pathways of introduction and links to other specialised websites. Some of the higher risk species already have a direct link to the alert page. It is important to notice that these lists are constantly being updated, please refer to the main page (<http://www.conabio.gob.mx/invasoras/index.php/Portada>), under the section Novedades for information on updates.

Invasive species - Plants is available from: http://www.conabio.gob.mx/invasoras/index.php/Especies_invasoras_-_Plantas [Accessed 30 July 2008]

Spanish:

La lista de especies del Sistema de información sobre especies invasoras de México cuenta actualmente con información acerca de nombre científico, familia, grupo y nombre común, así como el hábitat, estado de la invasión en México, rutas de introducción y ligas a otros sitios especializados. Algunas de las especies de mayor riesgo ya tienen una liga directa a la página de alertas. Es importante resaltar que estas listas se encuentran en constante proceso de actualización, por favor consulte la portada (<http://www.conabio.gob.mx/invasoras/index.php/Portada>), en la sección novedades, para conocer los cambios.

Especies invasoras - Plantas is available from: http://www.conabio.gob.mx/invasoras/index.php/Especies_invasoras_-_Plantas [Accessed 30 July 2008]

[Conservatoire Botanique National De Mascarin \(BOULLET V. coord.\) 2007. - *Salvinia molesta* Index de la flore vasculaire de la Réunion \(Trachophytes\) : status, menaces et protections. - Version 2007.1](#)

Summary: Base de données sur la flore de la Réunion. De nombreuses informations très utiles.

Available from: <http://flore.cbnm.org/index2.php?page=taxon&num=8aa2c95dc0a6833d2d0cb944555739cc> [Accessed March 2008]

Garbari, Fabio; Giovannini, Andrea; Marchetti, Dino., 2000. *Salvinia molesta* D.S.Mitchell (Salviniaceae) new for the Italian flora. *Archivio Geobotanico* 6(1): 73-78.

Gardner S. and Finlayson, C.M. 2002. Description of the flora and vertebrate fauna of Magela Creek, Alligator Rivers Region, northern Australia. In Gardner S., Finlayson, C.M. and Pidgeon R.W.J. (eds). *Description and literature review of the flora and vertebrate fauna of Magela Creek, Alligator Rivers Region, northern Australia*, Scientist Report 169. Supervising Scientist: Darwin NT.

Hadiuzzaman, S. S. and M. M. Khondker., 2005. *Salvinia molesta* Mitch. (Salviniaceae) - A free floating fern-allies new to Bangladesh. *Bangladesh Journal of Botany* 34(1): 37-39



GLOBAL INVASIVE SPECIES DATABASE

FULL ACCOUNT FOR: *Salvinia molesta*

Haynes, R. R. and C. C. Jacono., 2000. Status of *Salvinia* (Salviniaceae) in Alabama. *Castanea* 65(3): 225-227

Hrusa, Fred; Ertter, Barbara; Sanders, Andrew; Leppig, Gordon; Dean, Ellen., 2002. Catalogue of non-native vascular plants occurring spontaneously in California beyond those addressed in The Jepson Manual: Part I. *Madrono* 49(2): 61-98.

[Institute for Systematic Botany. 2003. *Salvinia molesta*. Atlas of Florida Vascular Plants](#)

Summary: Brief listing of scientific name, common name, synonyms, and a Florida distribution.

Available from: <http://www.plantatlas.usf.edu/main.asp?plantID=1872> [Accessed 29 September]

[ITIS \(Integrated Taxonomic Information System\). 2005. Online Database *Salvinia molesta*](#)

Summary: An online database that provides taxonomic information, common names, synonyms and geographical jurisdiction of a species. In addition links are provided to retrieve biological records and collection information from the Global Biodiversity Information Facility (GBIF) Data Portal and bioscience articles from BioOne journals.

Available from:

http://www.cbif.gc.ca/pls/itisca/taxastep?king=every&p_action=containing&taxa=Salvinia+molesta&p_format=&p_ifx=plgt&p_lang= [Accessed March 2005]

[Kay, Stratford and Hoyle, Steve 1999. *Aquatic Weed Fact Sheet*. North Carolina State University.](#)

Summary: Brief description of plant, look-alike information, and impacts.

Available from: <http://www.weedscience.ncsu.edu/aquaticweeds/facts/apfs001-99.pdf> [Accessed 1 October 2003]

Mackee, H.S. 1994. Catalogue des plantes introduites et cultivées en Nouvelle-Calédonie, 2nd edn. MNHN, Paris.

Summary: Cet ouvrage liste 1412 taxons (espèces, sous espèces et variétés) introduits en Nouvelle-Calédonie. L'auteur précise dans la majorité des cas si l'espèce est cultivée ou naturalisée.

Mansor, M., 1996. Noxious floating weeds of Malaysia. *Hydrobiologia* 340(1-3): 121-125.

Meyer, Jean-Yves & Loope, Lloyd & Sheppard, A. & Munzinger, Jérôme & Jaffré, Tanguy. (2006). Les plantes envahissantes et potentiellement envahissantes dans l'archipel néo-calédonien : première évaluation et recommandations de gestion.

Mitchell, D.S. and Thomas, P.A. 1972. Ecology of Water Weeds in the Neotropics, International Hydrological Decade, *Technical Papers in Hydrology* 12. UNESCO: Paris.

Riefner, R. E., Jr. and S. Boyd., 2005. *Salvinia molesta* D. S. Mitch. (Salviniaceae). *Madrono* 52(4): 272-273.

[USDA-NRCS \(Natural Resource Conservation Service\). 2005. *Salvinia molesta*. The PLANTS Database Version 3.5 \[Online Database\] National Plant Data Center, Baton Rouge, LA.](#)

Summary: Available from:

<http://plants.usda.gov/java/nameSearch?mode=Scientific+Name&keywordquery=Salvinia+molesta&go.x=11&go.y=10> [Accessed 29 February 2006]

Western Aquatic Plant Management Society. 2003. *Salvinia molesta*.