

# Conference report

## Summary of a workshop on *Salvinia molesta* in Kakadu National Park, Northern Territory, Australia

C. Max Finlayson<sup>1</sup>, Mic H. Julien<sup>2</sup>, Jeremy Russell-Smith<sup>3</sup>, and Michael J. Storr<sup>4</sup>

<sup>1</sup> Workshop Chairperson, Office of the Supervising Scientist, Post Office Bag 2, Jabiru, NT 0886, Australia.

<sup>2</sup> Project Leader, CSIRO Division of Entomology, Long Pocket Laboratory, Indooroopilly, QLD 4068, Australia.

<sup>3</sup> Project Liaison, ANCA Kakadu National Park, Post Office Box 71, Jabiru, NT 0886, Australia.

<sup>4</sup> Project Officer, CSIRO Division of Entomology, c/- OSS, Post Office Bag 2, Jabiru, NT 0886, Australia.

### Introduction

A workshop to assess the status of research efforts into the effectiveness of biological control of *Salvinia molesta* (salvinia) on the Magela floodplain in Kakadu National Park was held on 23 February 1993. The workshop, convened by ANCA and CSIRO Division of Entomology, was held at the Alligator Rivers Region Research Institute in Jabiru. Representatives from a number of Northern Territory and Federal agencies involved in weed management in the Northern Territory attended.

Short talks were presented on the spread and distribution of salvinia around the world, in Australia and in Kakadu National Park in particular, on the possible ecological effects of salvinia and on biological control of the weed. CSIRO project staff presented a summary of their research on understanding the interactions between an introduced biological control agent, the weed and aspects of the Magela Creek environment. This was followed by a general discussion on the direction of, and support for, further research.

This summary of the workshop is to keep weed researchers and managers informed of recent developments, in the control of salvinia in Kakadu National Park.

### *Salvinia molesta* in Kakadu National Park

*Salvinia* was first recorded in the Kakadu region in September 1983 in a section of the Magela floodplain (Figure 1) known as the Mudginberri Corridor (Finlayson 1984). Several billabongs were fringed

with loosely packed mats of salvinia plants, generally intermixed with the native wetland vegetation. A chemical control program, utilizing the kerosene-based AF 100 and AF 101 mixtures was mooted, but quickly abandoned after more plants were found, in areas that were extremely difficult to access. Instead, the biological control agent (*Cyrtobagous salviniae*) was introduced by ANPWS (now ANCA). As this weevil had successfully controlled salvinia elsewhere (Room 1990), great hopes were held for successful control of the Magela infestations.

However, over the next 2-3 years salvinia continued to spread further downstream. All the main billabongs on the Magela floodplain were at different times at least partly, or even completely covered by floating mats of plants. Whilst salvinia continued to spread, the mats on the billabong rarely persisted for a complete annual cycle, presumably due to the joint influence of the introduced weevil and the annual floods that flushed the billabongs. Plants that remained after the Wet season flushing were the precursors of further mats, in other words, a cycle of mat development followed by dispersion (and possibly destruction by weevils) was established.

Although there was some evidence that the weed was under control, there was concern that the weevil population was not expanding and spreading as it had done elsewhere (C. Wilson personal communication). Thus, a number of further introductions were made (C. Wilson and C.M. Finlayson unpublished information). From May 1986 to December 1989

ANCA staff collected samples to estimate weevil numbers in six billabongs on the floodplain (Skeat 1990). By late 1987, the effectiveness of the weevil in controlling the weed was reduced and thick weed mats established and remained on many billabongs throughout the Wet season and into the following Dry. In previous years these mats were washed out by Wet season flood waters. The mats now appeared very stable and were rapidly colonized by other vegetation. Concern over the weed's spread became intensified when a further infestation was found in Tin Camp Creek, a tributary of the East Alligator River (Figure 1) in 1988.

In an effort to address the apparent inadequacy of the biological control agent, a research contract was established between ANCA and the CSIRO Division of Entomology. This two year program commenced in 1991. It was designed to measure and relate changes in weevil abundance in the field to temperatures and host plant nutrition, to conduct initial experiments on the effects of high temperatures on fecundity, development and survival of the weevil, and to evaluate the effects of repeated releases of the weevil at selected sites.

At the same time other control measures were implemented on the Magela floodplain. Access to the Magela billabongs was restricted and vehicles coming from Arnhem Land were inspected at the Magela Creek crossing in an attempt to prevent the spread of salvinia. However, in 1990 salvinia was found in Nourlangie Creek (Figure 1), a tributary of the South Alligator River. This infestation, approximately three hectares in area, was treated with the herbicide VELPAR in an attempt at eradication. Whilst ostensibly successful, by late 1992 two further infestations were located on the Nourlangie. In an attempt to control these infestations, 20 000 litres of AF 100 were sprayed on the floating mats and 2,4-D was used to spray plants stranded by falling water levels (salvinia plants stranded by falling water levels can survive for more than three months if the sediment remains moist, C.M. Finlayson unpublished information). However, this measure was not successful and following the 1992-93 Wet season salvinia was found to be even more widespread on the Nourlangie.

### Effectiveness of biological control on the Magela

Studies conducted on billabongs on the Magela floodplain by CSIRO project personnel demonstrated that the weevil exerted significant control of the weed during the period 1991 to early 1993. Many salvinia mats were completely destroyed over the Dry season. In some locations, biomass of salvinia was greatly reduced,

These are summarized separately below.

### *Importance of the problem*

The extent of the salvinia problem in Kakadu National Park was considered to be very serious, with urgent control measures being required. In addition to the potential for further spread within Kakadu, concern was expressed over the potential for spread to adjoining Aboriginal lands. ANCA and local Aboriginal groups are concerned about maintaining the integrity of the Kakadu landscape and protecting local food resources. The nature of ecological change that has occurred in the freshwater billabongs and creeks of Kakadu as a consequence of the salvinia infestation is not known, but was considered likely to be severe. Whilst efforts to control the weed need to be strengthened, there is also a need to obtain further information on the cultural, social, economic and ecological effect of salvinia in the Park.

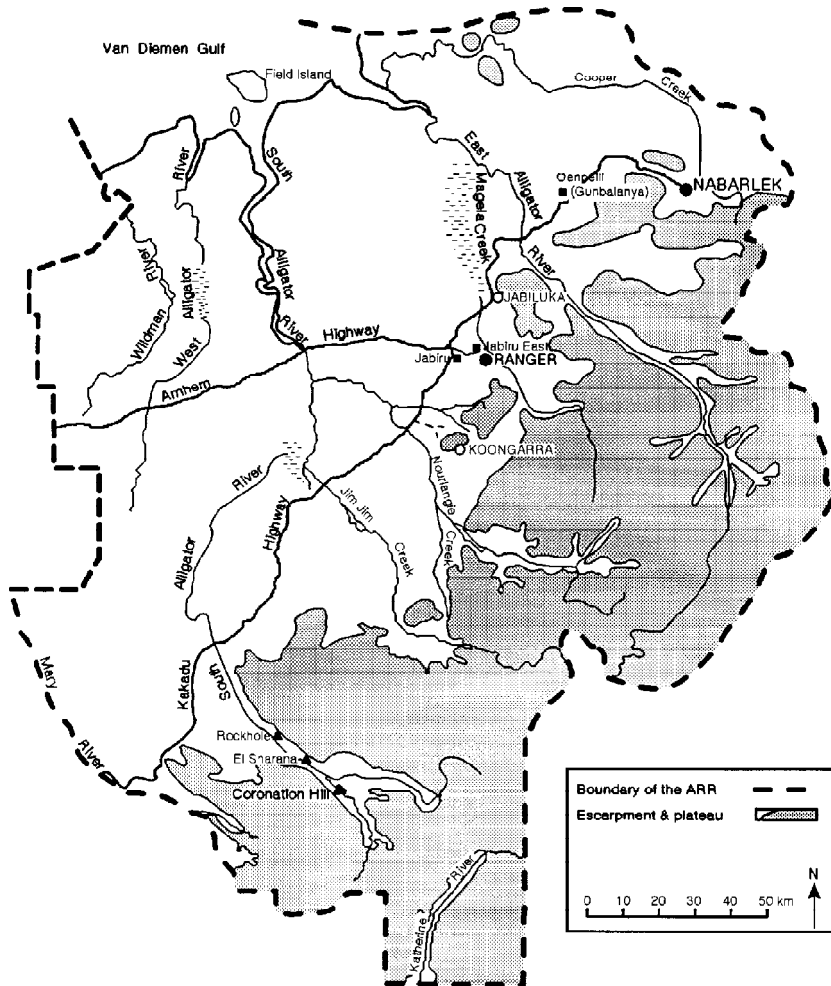
### *Level of control required*

Traditional owners within the Park are greatly concerned at the degree of control of salvinia achieved to date. Whilst CSIRO's results demonstrated that the biological control agent provided considerable control in some situations, the overall level of control was considered inadequate. To achieve a greater control, a variety of techniques may need to be utilized, either in isolation or integrated with the biological control program. It was recognized that the benefits of using chemicals would need to be balanced against the disadvantages, and deliberate choices would have to be made.

### *Further research into control and management options*

In an effort to reduce growth and limit further spread of salvinia it was recommended that the biological control agent be introduced to all infestations in the Park regardless of any further decisions that may be made. It was recognized that ongoing management of salvinia within the Park will be necessary and should include biological control. Further recommendations were:

- i. the CSIRO project to be extended for a year to begin trials with selected herbicides in conjunction with biological control,
- ii. ANCA staff be made available for training in handling the insects during the project,
- iii. emphasis on monitoring be shifted to assess the effectiveness of this broader approach and
- iv. appropriate organizations be nominated to manage the herbicidal applications and the ecotoxicological aspects of herbicidal work.



**Figure 1. Alligator Rivers Region (ARR), which includes Kakadu National Park and the eastern portion of the catchment of the East Alligator River.**

but the mats failed to sink as they were held together by other vegetation (Julien and Storrs 1993).

During the study period the broad patterns of salvinia and weevil population changes may be summarized as follows. At the height of the Wet season (January–February) weeds and weevils were widely dispersed by floodwaters. Growth of the remaining salvinia resulted in mats that partially to completely covered billabongs by September. At the same time, weevil populations that remained after the floods developed at a faster rate than they had before the floods. Over the next few months severe damage to the weed was evident, and in some billabongs the majority of the mats sank before the Wet season floods occurred (Julien 1993).

Studies on the effects of temperatures on the weevil, although not exhaustive, suggested that the high temperatures did not significantly affect the populations during the study period (Julien 1993). Nevertheless, temperatures experienced by the weevil are very high and season to season variation may result in ineffective control during some years. Tissue nutrient analysis suggested that changes in the populations of the weed were not limited

by nutrient availability. Changes in the weevil populations were most probably influenced by the availability of salvinia buds (host food plant) in the initial instance, and not by temperature. However, temperature may have been a bearing on recovery of the weevil populations. As tissue nutrient levels in the plants remained relatively high throughout the studies, this is unlikely to have limited weevil population growth (Julien 1993; Julien and Storrs 1993).

The study showed that there was no benefit to be gained by continuous and repeated introductions of the weevils into areas of the Magela floodplain where the weevil was already established. The numbers being released were insufficient to modify the level or timing of damage compared with that caused by existing field populations.

### **Recommendations for further research**

Participants discussed the status of the salvinia problem in Kakadu under three broad headings:

- i. importance of the problem,
- ii. level of control required, and
- iii. further research into control and management options.

### Acknowledgments

All participants are acknowledged for their open and constructive discussion during the workshop. There was a very obvious cooperative spirit amongst delegates that enabled the discussion to develop and keep to the subject. The Director of the Alligator Rivers Region Research Institute is thanked for making the conference facilities available.

### References

Finlayson, C.M. (1984). *Salvinia*, water hyacinth and mimosa in the Alligator Rivers Region, Northern Territory. *Australian Weeds* 3, 83.

Julien, M.H. (1993). Control of *Salvinia molesta* in Kakadu National Park. Unpublished report to Australian Nature Conservation Agency, p. 28.

Julien, M.H. and Storrs, M.J. (1993). *Salvinia molesta* in Kakadu National Park: biological control. Proceedings of the 10th Australian Weeds Conference and 14th Asian-Pacific Weed Science Conference, Brisbane 1993, pp. 220-4.

Room, P.M. (1990). Ecology of a simple plant-herbivore system; biological control of *salvinia*. *Trends in Ecology and Evolution* 5, 74-9.

Skeat, A.J. (1990). Biological control of *Salvinia molesta* on Kakadu National Park, Northern Territory. Proceedings of the 9th Australian Weeds Conference, Adelaide 1990, pp. 6-10.

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## Forthcoming conferences

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### Allelopathy in Sustainable Agriculture, Forestry and Environment

6-8 September 1994, J.N. Vyas University, Jodhpur, Rajasthan, India

Contact: Dr. S.S. Narwal, Department of Agronomy, CCS Haryana Agricultural University, Hissar-125004, Haryana, India. Tel: 91 1662 73721 Fax: 91 1662 73552

### 9th International Symposium on Aquatic Weeds

12-16 September 1994, Trinity College  
Contact: Central Fisheries Board, Trinity College, Dublin, Ireland.  
Tel: 353 1 379206 Fax: 353 1 360060

### European Society for Agronomy Third Congress

18-22 September 1994, Padova University  
Contact: ES Ag Third Congress Sistema Congressi, Via Jappelli 12, 35121 Padova, Italy. Tel: 39 49 651699 Fax: 39 49 651320

### 34th Meeting American Phytopathological Society - Caribbean Division

2-6 October 1994, Zamorano, Honduras  
Contact: Escuela Agricola Panamericana, PO Box 93, Tegucigalpa, Honduras.  
Tel: 504 76 62 40 Fax: 504 76 62 42

### Modern Agriculture and the Environment International Conference

2-6 October 1994, The Hebrew University of Jerusalem  
Contact: Prof. B. Rubin, Faculty of Agriculture, Rehovot 76100, Israel.  
Tel: 972 8 481248 Fax: 972 8 468265

### Moroccan Society of Plant Production, Protection and Breeding: Fifth Arab Congress of Plant Protection

23-29 October 1994, Morocco  
Contact: Prof. M. Besri, General Secretary, Institut Agronomique et Veterinaire Hassan II, BP 6202 Rabat-Instituts, Morocco. Fax: 77 58 38 or 77 81 10

### Weed Science Society of America

31 January-3 February 1995, Sheraton Hotel  
Contact: Robert Parker, Washington State University, Route 2, Box 2953A, Prosser, WA 99350, USA. Tel: 509 786 2226

### Gordon Research Conference in Agricultural Sciences "Chemical Biological Synergies to Reduce Inputs for Pest Control"

5-10 February 1995, Oxnard, CA

Contact: Jonathan Gressel, Plant Genetics, Weizmann Institute of Science, Rehovot, 76100 Israel. Fax: 972 8 469124

### S-234 Regional Project Meeting "Biological Control of Weeds with Plant Pathogens"

22-24 March 1995, Doubletree Hotel  
Contact: Donald Daigle, USDA/ARS, PO Box 19687, New Orleans, LA 70179, USA. Tel: 504 286 4514 Fax: 504 286 4419

### Weed and Crop Resistance to Herbicides International Symposium

3-6 April 1995, University of Cordoba  
Contact: Dr. J. Jorriin, Departamento de Bioquimica y Biologia Molecular, University of Cordoba, Cordoba, Spain. Tel: 57 218439 Fax: 57 218563

### 47th International Symposium on Crop Protection

9 May 1995, University of Gent, Belgium  
Contact: I.L. Terry, Faculty of Agricultural and Applied Biological Sciences, Coupure Links 653, B-9000 Gent, Belgium.  
Tel: 329 264 61 52 Fax: 329 264 62 39

### 13th International Plant Protection Congress

27 July 1995, The Hague, Netherlands  
Contact: Dr. Jan C. Zadoks, Dept. of Phytopathology, Binnehaven 9, Postbus 8025, 6700 EE Wageningen, The Netherlands.  
Tel: 31 8370 8 3135 Fax: 31 8370 8 3412

### 15th Asian-Pacific Weed Science Society Conference

24-28 July 1995, Tsukuba Science City  
Contact: Kenji Usui, Institute of Applied Biochemistry, University of Tsukuba, Tsukuba, Ibaraki 305, Japan.  
Tel: 81 298 53 4748 Fax: 81 298 53 4605

### Fourth International Symposium on Adjuvants for Agrochemicals

3-6 October 1995, Sheraton Hotel, Melbourne, Australia.  
Contact: Andrew Wells, Nufarm Ltd, 103-105 Pipe Road, Laverton North, Victoria 3026, Australia.  
Tel: 613 282 1000 Fax: 613 282 1001

### International Weed Science Society

25-28 June 1996, Copenhagen, Denmark  
Contact: ICS A/S, Strandvejen 171, PO Box 41, DK-2900, Hellerup, Denmark.