Innovative approaches to transferring information on the use of biological control for noxious and nuisance plant management

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Abstract. The capability to access pertinent and up-to-date information on plant management procedures is an important and time-consuming component of any noxious- and nuisance-plant management programme. This accounts for the large investiture of time and money in the development of efficient technology transfer activities associated with any major research endeavour. Traditional technology transfer activities including the use of formal and informal publications, oral and poster demonstrations, as well as the production of video tapes have proven to be highly successful. Some of the approaches to technology transfer in aquatic weed management in the United States of America include the development of a short course on the use of biocontrol for the management of aquatic plants, a soon-to-be-published field guide and manual to serve as a primer on the use of biocontrol for aquatic plant control, personal communication with operational personnel via cooperative extension activities, and, finally, the development of computer-based information/expert-systems.

Introduction

More than 2000 exotic species of plants have been accidentally or purposely introduced to the United States of America (U.S. Congress, Office of Technology Assessment 1993). While the majority of introductions have been highly beneficial, in numerous situations such introductions have had disastrous consequences. Economically important weeds include terrestrial plants such as knapweed, leafy spurge and various thistles, and aquatic and wetland plants such as waterhyacinth, waterlettuce, hydrla, Eurasian watermilfoil and purple loosestrife. The United States Office of Technology Assessment (1993) estimates annual losses of over four billion dollars from such harmful plant introductions.

As can be expected, a tremendous wealth of information is needed to utilize and implement plant management strategies. For example, the use of chemical technology requires detailed information on herbicide-adjvant combinations. With hundreds of effective herbicides on the market, choosing the appropriate combination requires definitive information on herbicide-use restrictions, environmental conditions which influence control, state-specific restrictions and equipment needs. Since changes in labelling and re-registrations occur frequently such information is hard to keep current.

Similarly, mechanical control procedures also require much detailed and current information. For example, the effective use of mechanical control technology necessitates having access to information on removal and cutting equipment, operation costs, and transportation.

The knowledge needed to use biocontrol technology effectively requires a broad background of underlying concepts on population biology, intra- and inter-specific competitive effects, sampling procedures, release techniques and of the integration of biocontrol with existing plant management procedures. Of utmost importance is the ability to recognize each introduced biocontrol agent and its associated host plant. In addition, it is vitally important to be able to recognize the agent's feeding damage and ultimate impact. This requires an in-depth knowledge of the insects' feeding patterns, as well as plant growth characteristics and physiology. To make matters more difficult, there is usually a large assemblage of native organisms that feed on and damage these same noxious and nuisance plant species. The native organisms and their associated damage are easily confused with that of the introduced biocontrol agents. In addition, new
agents are being approved for release each year, which increases the complexity.

Because of the large and complex nature of developing effective noxious-and nuisance-plant management strategies, several approaches to technology transfer have been, or are in the process of being, developed. In the context of biological control of aquatic weeds in the USA, these approaches include: (i) the development of a short course that details general and specific concepts on the use of biocontrol for aquatic plant management; (ii) formal publication of a United States Department of Agriculture, Agricultural Research Service (USDA, ARS) and Florida Department of Natural Resources (FDNR) manual to serve as a primer on the use of biocontrol for aquatic plant management; (iii) organization of cooperative extension-like activities on the use of biocontrol for operational personnel at the federal, state and local levels; and (iv) the development of a variety of highly interactive, computer-based information/expert systems that allow for efficient and rapid access of information on a variety of different plant management options.

**Short course**

Beginning in 1992, biocontrol researchers from the USDA, ARS (T. Center and G. Buckingham), U.S. Army Engineer Waterways Experiment Station (WES) (M. Grodowitz and A. Cofrancesco), and Nicholls State University (W. Johnson) developed a short course which includes a wide range of information on the correct and efficient use of biocontrol for aquatic plant management. Subjects covered in the short course include a brief background on ecological theory and population biology, historical aspects on the use of biocontrol, the process of biocontrol, advantages and disadvantages of biocontrol, biocontrol in existing aquatic-plant management programmes and information on the introduced agents and commonly encountered native herbivores of four species of nuisance aquatic plants. Plants species covered in the course include alligatorweed (*Alternanthera philoxeroides*), waterhyacinth (*Eichhornia crassipes*), waterlettuce (*Pistia stratiotes*), and hydrilla (*Hydrilla verticillata*).

**Biocontrol manual**

We are in the process of producing a field guide and manual to the insect herbivores of aquatic plants (i.e., biocontrol agents) which will serve as a primer to the use of insect biocontrol for aquatic plant management and which will be published in 1996 or 1997. The guide will contain an introduction on the use of biocontrol, which is based on the information presented in the short course, plus pictures and descriptions of many of the commonly encountered native and introduced herbivores.

**Cooperative extension activities**

Close communication and cooperation between researchers in the biocontrol field and personnel at the operational level allow for rapid and efficient application of newly-developed products and, or, ideas directly to in-field problems. While cooperative extension activities have been on-going since the inception of aquatic-weed-biocontrol programmes in the USA, they have recently taken on a more organized and expanded approach. For example, biocontrol researchers have been working closely and formally with operational personnel in Texas since 1990 on specific aquatic plant problems requiring the use of biocontrol. With such a personal approach, the active use of biocontrol technology has increased in many areas of aquatic plant control in Texas, thereby strengthening and expanding the role of biocontrol in existing plant management programmes.

**Computer-based information/expert systems**

Since 1989, we have been developing computer-based programs for the transfer of information to operational personnel on the management of various noxious- and nuisance-plants. We have found that the use of information/expert systems for technology transfer allows for rapid and efficient information access, processing, and retrieval. These highly interactive programs utilize a variety of formats for information presentation including hyper-linked textual information, photographic quality images, and numerous illustrations. The systems also include computer algorithms which use expert-system-type programming that simulates the human decision process. Such algorithms enable users to identify important noxious plant species and to select the most appropriate control technology based on user-provided site-specific input.

To date, we have, or are in the process of developing, five different information/expert systems.
These systems are concerned with various aspects of noxious- and nuisance-plant management, including the use of biocontrol technology. Three systems deal specifically with the identification and use of insect biocontrol agents of aquatic and wetland plants including the identification of specific damage types. Another system is concerned with the identification of 50 to 60 commonly encountered aquatic and wetland plant species, and one system combines noxious plant identification with the selection of appropriate chemical, mechanical, and biological control methodologies. The systems were developed for PC-based machines running under Windows 3.1® or higher. Using the Windows® environment allows for a high degree of portability to machines utilizing vastly different hardware configurations. The majority of the systems were developed using the C++ programming language with minimal use of Microsoft’s® Visual Basic.

The overall plant management system utilizes much of the computer expertise built into the previous systems with expansions in the areas of plant identification as well as herbicide and mechanical control selection.

Until recently, the development of such multifaceted computer-based information systems was made difficult because of a lack of appropriate software and the difficulty of displaying high resolution computer images. With recent advances in video display capabilities, most computers purchased within the last several years are able to display images of at least 256 colours simultaneously in 640x480 pixel resolution while running in the Windows® environment. This video mode provides the capability of displaying near-photographic quality images. However, the software used for information retrieval and decision processing (i.e., development software) is still not widely available or is so difficult to learn that developing even a simple system for identification purposes is typically a long and tedious process which requires specialized training.

Acknowledging this limitation, researchers (C. Smith, S. Graham, and M. Grodowitz) developed software which easily creates the identification portion of the system. This program or identification shell, named ‘ID-Expert’, is the core of the information systems. It allows for the decision process used for identifications, displays character screens and final screens of the identified items, and accesses Windows® hyper-text files containing textual information on specific characters and descriptions of each item to be identified. The shell operates or is driven by an external text file (in ASCII format) which includes information on characters and character states, a numerical description of each item to be identified, name and location in the Windows help file (i.e. text file) of the required text, and information on the appropriate images to be displayed. Using an external file to drive the system allows for maximum flexibility in designing information/expert systems for a variety of purposes.

The only additional item that is included in the information/expert systems that have been designed to date is a graphical ‘front end’ or information manager. As the name implies it is used for easily accessing various portions of the system including, among others, the identification sections, overviews on the subject matter, plant species included in the system and various management options. The textual portions of the system are contained in hyper-linked text files and are developed using any one of the Windows® help file authoring programs. Until recently, the development of these hyper-linked text files was extremely difficult but, advances in off-the-shelf software, e.g. Blue Sky’s RoboHelp®, has made this task relatively easy.

The use of computers for identification of various organisms was proposed in the early 1970s by Pankhurst (1970) and Morse (1974). Several programs are available that allow for the development of identification systems. One system that is gaining wide acceptance by various taxonomists is DELTA or Description Language for Taxonomy (Dallwitz et al. 1993; Dallwitz and Paine 1986; Partridge et al. 1988, 1993). Our systems are similar in design and approach, utilizing an external file to drive and guide the program.

References

