AQUATIC WEED MANAGEMENT IN URBAN AND AGRICULTURAL CANALS USING TRIPLOID GRASS CARP

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Background

Freshwater canals present a significant challenge to the aquatic plant manager. In most situations, canals are closely associated with some form of agriculture and are usually constructed for water conveyance to facilitate crop irrigation or flood control. Canals in Florida are relatively shallow and water movement is either static or sluggish, generally less than one meter per second, often providing a suitable environment for submersed macrophytes and in some situations, mosquito production.

In Florida, a considerable network of canals is associated with urban coastal areas. Over 1000 miles of urban canals were created primarily as a source of fill dirt in just a three county area of southwest Florida. These urban canals also provide a source of water for lawn irrigation and recreational activities such as fishing and boating. The citrus industry in Florida is responsible for creating many thousands of acres of irrigation canals which have been invaded by the exotic macrophyte Hydrilla verticillata. Hydrilla is also a problem in a huge network of irrigation canals that provide water for agricultural activities in the desert southwest, primarily in parts of Arizona and the Imperial Valley in southern California.

There are several obstacles to effective aquatic plant management in canals with the traditional approach of herbicide applications. Moving water presents problems concerning the necessary exposure time for contact as well as systemic herbicides. Many canals are often associated with some type of agricultural irrigation project where herbicide residues might cause damage to the crops being irrigated. For these reasons, biological control of aquatic vegetation is a logical method for many canal situations. Triploid grass carp are now being used to control or even eradicate aquatic vegetation in many canal systems. The objective of this paper is to review the use of grass carp for aquatic weed management in both urban and agricultural canals and to provide a guide for their continued use in these types of systems.

Use of Triploid Grass Carp in Urban Canals

Aquatic plant management objectives for urban canals are similar to those for ponds and lakes that have high visibility and extensive recreational use. Urban canals in south Florida rarely exceed eight feet in depth and receive stormwater runoff from a highly developed watershed. The combination of shallow water, moderate to excessive nutrient concentrations and a sub-tropical climate provide an ideal environment for submersed

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macrophytes. In general, residents living on urban canals desire high water transparency, very little submersed vegetation and a productive fishery. These conditions rarely exist in unison and resource managers should attempt to manipulate submersed vegetation density to bring about a compromise in the objectives for the intended use of the resource. A gradual long-term reduction in submersed vegetation density can be achieved using grass carp. Grass carp can have negative effects on water quality if overstocked and should be used with caution (Leslie et al. 1987). An ongoing study designed to evaluate triploid grass carp as a primary control option in a 112 acre urban canal system has shown that it may be possible to substantially reduce submersed vegetation density without eliminating it (Cassani et al. 1988). A stocking rate of 3-5 (10-12 inch) fish per metric ton (1000 kg) of vegetation at this site resulted in little vegetation control the first year but was substantially reduced the second year without complete elimination (Fig. 1). Results for most of the third year indicate seasonal fluctuations similar to pre-stock conditions but at a greatly reduced density. Because of this relatively gradual change, there has been no significant negative impact on various water quality parameters. Analysis of the resident fishery indicated improving trends in sport-fish size structure, condition and population density. A recent study dealing with retention of phosphorus in grass carp body tissue indicated that grass carp may be retaining more phosphorus than previously thought and substantiates the findings of several studies that on-site nutrient concentrations have not increased greatly as a result of vegetation reduction in a number of situations where grass carp were used (Swanson and Bergersen 1989). The key determinant here is that vegetation decline was relatively gradual compared to what would be expected for herbicide treatments, allowing other nutrient buffering factors such as emergent vegetation and decreased water residency times etc. to have an impact. Stocking rates as high as 7 or 8 fish per metric ton on several weed species have resulted in a gradual decline of vegetation biomass but elimination generally resulted sometime after the first year.

In order to bring about a gradual decline in vegetation with grass carp, it is necessary to quantitatively determine the vegetation biomass. A drop and cut style biomass sampler similar to one described by Osborne and Sassic (1979) and Kilgore and Payne (1984) was used to determine biomass density in the study mentioned previously. Using this methodology, we were able to determine a stocking rate range of 3-5 fish/metric ton of vegetation (fresh weight) that approaches a threshold rate allowing for the majority of the reduction during the second or third year. Obviously, many variables such as climate, target weed species and grass carp survival will have an impact on this stocking rate. Many of these variables are now being studied with respect to grass carp stocking rates and should be available in the near future on computer software that would simulate the effects of various stocking rates under different site conditions. A stocking rate model has just been recently described for coldwater lakes where grass carp use has been minimal but is increasing rapidly with the availability of sterile triploid grass carp (Swanson and Bergersen 1989).

Other methods of quantifying vegetation biomass such as recording fathometry and aerial imaging may be more practical for larger systems (Maceina and Shireman 1980; Martyn et al. 1986). If submersed vegetation cannot be quantified, then we suggest a very low initial rate of 4 or 5 (10 to 12 inch fish) per surface acre or 7-8 fish per vegetated acre. Areas having cooler and longer winters such as those north of latitude 32 or 33 N should consider increasing these recommendations somewhat and should refer to Swanson and Bergersen (1989).

Another important factor for successfully using grass carp is retention. Fish must not be able to escape the target areas and the construction of fish barriers is necessary to maintain the intended grass carp density. It is impractical to comprehensively review barrier design considerations here, however, horizontal bars with 1.5-2.0 inch spacing has proven to be the best design in our studies with respect to minimal debris accumulation in urban canals. Vandalism unfortunately is often a consideration and heavy duty materials such as 3/4 inch smooth steel bar has been quite durable.

Analysis of grass carp movement behavior in urban canals, determined by radio telemetry methods, indicated that grass carp movement was relatively high, 12-16 weeks after release. This initial high activity pattern emphasizes the need to have barriers in place and well maintained. Further analysis of movement behavior demonstrated that some individuals establish a home range usually within the first year after release, while others are characteristically free ranging. We were also able to determine that narrower and shallower canals were avoided until the majority of submersed vegetation had been reduced elsewhere. This avoidance resulted in more time to achieve control of the weed infestation and may require some chemical control during the first year at the low stocking rates described above.

AGRICULTURAL CANALS AND DITCHES

Introduction

For several years, work has been conducted with grass carp, hybrid grass carp, and triploid grass carp in various agricultural canals and ditches. Presently, the State of Florida, through the Florida Game and Fresh Water Fish Commission, issues permits for the use of triploid grass carp. Triploid grass carp are currently being used in Florida, under this permit system, for weed control in agricultural areas in Florida.

The major target weed of the grass carp biological control program in agricultural canals and ditches is Hydrilla [*Hydrilla verticillata* (L.f.) Royle]. The next most important single weed in these types of waters is torpedograss (*Panicum repens* L.).

Hydrilla Growth

Hydrilla control is particularly difficult in the small agricultural ditches for several reasons. One, by having to make herbicide applications in flowing water, the degree of control by the herbicides is reduced, many times below acceptable levels. Second, because many of the ditches are shallow, hydrilla regrowth following mechanical cleaning operations is very rapid. The hydrilla may regrow to reach the surface of the ditch in two to three weeks. Third, the continual need to retreat the hydrilla infestations in these ditches make the control costs unacceptable to the growers. Therefore, using the grass carp to control hydrilla regrowth is an attractive alternative for the growers.

Use of Grass Carp

Initial hydrilla control can be achieved with herbicides, or with mechanical equipment. Either method can be used to remove the initial standing crop of weeds prior to the introduction of the grass carp. Then the grass carp can be stocked to control the hydrilla regrowth.

Mechanical equipment such as a back-hoe or a dragline, can be used for hydrilla removal. Also, some water managers use a weighted object such as a cable, chain, or structural steel drag, which is pulled through the ditch or canal to break the shoots from the hydrosoil. The floating shoots are then allowed to drift in the ditch with the water flow until they collect at a water control structure where they can be removed with a back-hoe or dragline.

The grass carp can also be used for initial weed control, however this will require a different approach to the use of the fish. If ditches are filled completely with hydrilla and other weeds, some partial cleaning will be required to prepare an area for stocking. The cleaning is necessary so there will be a reservoir area in the canal or ditch with sufficiently good water quality to support the fish until they can begin to remove the weeds from the remainder of the ditch. Dissolved oxygen may be critically low in ditches and canals which are filled with hydrilla, especially when water temperatures are high.

Using the grass carp for initial weed control will also require relatively higher stocking rates of fish. The higher rates are required to give acceptable weed control in reasonable amounts of time.

Stocking Rates of Grass Carp

The number of grass carp required per acre of water vary greatly depending on a number of factors such as: 1) type of weeds present; 2) growth rate of weeds; 3) shape and depth of water body; 4) size of fish stocked; 5) amount of weeds present at stocking; 6) water quality as it affects fish survival; 7) amount of predation on stocked grass carp; 8) amount of weed control required; and 9) rate of weed control required.

For example, three large grass carp carp per acre may be all that are required to control hydrilla regrowth in a pond or small lake if these fish are stocked into a situation in which the infestation is under excellent control. The stocking rates required can then range to in excess of 200 fish per acre when small (seven to nine inch) fish are used in areas where a heavy standing crop of hydrilla is present.

Summary - Agricultural Canals and Ditches

1. It appears that to get effective weed control using the grass carp in the small lateral ditches, the fish must be isolated into the laterals with barriers. Over the long term the fish may spread over an entire field and give control in the larger lateral ditches, however, in the short term, the

fish seem to migrate into the larger water supply ditches. These ditches generally have more water and better water quality. In addition, the water flows more often in these larger ditches.

2. The fish can be forced from one section of the ditch to another using lowered water levels. The fish will move from low water levels to higher water levels. This can be used to move fish into areas where additional weed control is desired.

3. Removal of ditch bank grasses and weeds on the margins of the water course can aid in moving the fish from one ditch section to another. The fish seem to remain in an area following removal of hydrilla while continuing to feed on shoreline grasses, rather than move to feed on hydrilla in sections of the ditches in which the hydrilla has not yet been controlled.

4. Water managers have used low rates of selected herbicides integrated with the grass carp to help achieve initial control in the smaller, lateral ditches. It is in these ditches that hydrilla grows to the water surface very rapidly. Two of the herbicides used are Aquathol K and Sonar. Sonar pellets were metered into slowly flowing ditches and gave good control over a period of several weeks.

5. Barrier cleaning and maintenance is critical during periods of high water flow. Barriers with a "pointed V" frontal area seem to be somewhat easier to maintain free of debris in periods of high water flow.

HYGROPHILA CONTROL IN URBAN CANALS

Introduction

Two 250-acre water management districts were stocked recently with triploid grass carp to evaluate their effectiveness in controlling hygrophila [Hygrophila polysperma (Roxb.) T.Anderson]. Both areas also had stands of hydrilla growing in association with the hygrophila. However in both districts the hydrilla was at a low level of infestation as a result of the herbicide control programs.

Fish Barriers

In the Old Plantation Water Control District, two fish barrier designs were evaluated. The most promising design is a hinged, steel frame with vertical bars to contain the fish. The frame hangs on a 45-degree angle, with the direction of the water flow. It is hinged on its supporting shaft. If trash collects on the barrier and frame, it is designed to rotate and lift to allow the flowing water to remove the debris from the structure. It is mounted to protect against fish escaping when water is discharged through a water control structure. No additional barriers, other than the trash guards, are installed on the discharge pumps.

In the Sunshine Drainage District, there is no water discharge except through the pumps. As in the other district, no additional barriers, other than the trash guards, are installed on the discharge pumps.

Stocking Rates

In the Sunshine Drainage District, a stocking rate of approximately 100 fish per acre were used. Fish size at stocking was approximately in the "nine to eleven inch" range.

In the Old Plantation Water Control District, a stocking rate of 25 fish per acre was used. Fish size at stocking was also approximately in the "nine to eleven inch" range.

Urban Canal Hygrophila Control Results

Fish were stocked in the Sunshine Drainage District during the January to April 1988 period. By July, much of the hygrophila had been controlled. Hygrophila was removed prior to mature stands of Chara. Numerous schools of grass carp can be observed in the system.

A fall 1988 stocking in the Old Plantation Water Control District has not yet resulted in significant hygrophila control. Recently, fish in the "three to five pound" range have been observed in the system. Plans are being formulated to increase the stocking rate in this area.

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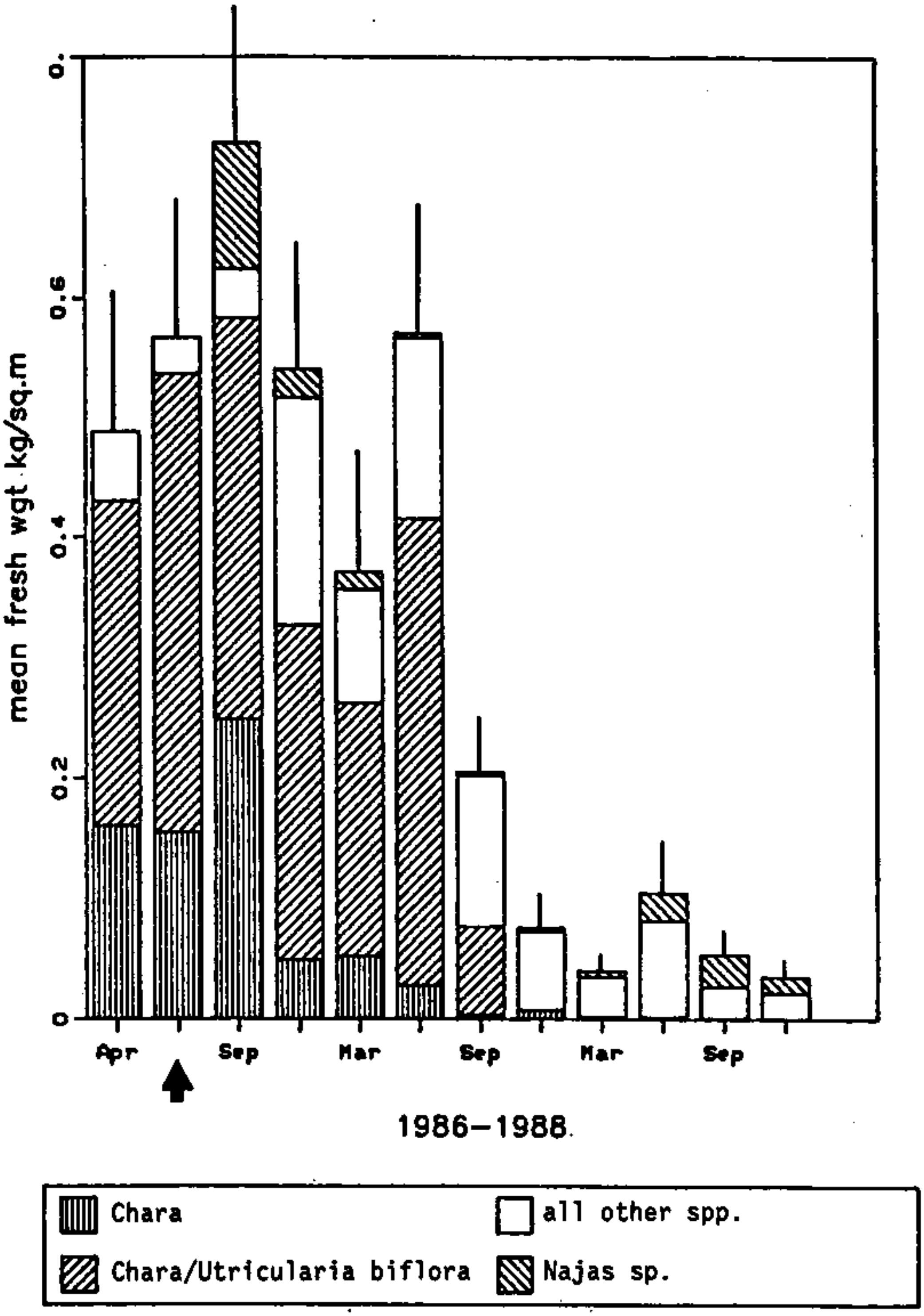

Fig. 1. Aquatic macrophyte biomass changes in an urban canal stocked with triploid grass carp at a rate of three 10-12 inch fish per metric ton. Dark arrow indicates time of stocking.