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The use of manatees for the control of aquatic weeds in Guyana

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Abstract. The West Indian Manatee (*Trichechus manatus*) has been widely suggested as a means of biological control of aquatic weeds. Despite significant research little data is available from existing manatee installations.

Manatees have been used in Guyana for weed control for over a century and are still being used today. Data was collected from a number of sites, both past and present, to establish the reliability of the manatee as a weed control agent and to formulate a series of guidelines on which to base future manatee developments.

Introduction

The West Indian Manatee (*Trichechus manatus*) or sea cow (see photo) is a herbivorous mammal which feeds on aquatic plants. It is indigenous to some 40 tropical countries and has been suggested as a means of weed control in Central and South America, the Caribbean, and West and Central Africa.



The manatee appears to have considerable advantages over other methods of weed control, yet despite this is little utilised. The object of this paper is to show that the manatee can be a practical alternative in the fight against weed infestation in irrigation and drainage channels in Guyana and other tropical countries.

Aquatic weeds in irrigation and drainage channels

Aquatic weeds have always existed but have only become a problem subsequent to mans efforts to harness natural waterways. The construction of canals and drains augmented by the enrichment of water by agricultural nutrients and fertilisers has produced an environment suitable for the proliferation of aquatic weeds. This is a worldwide problem, although prevailing climatic conditions makes the situation particularly acute in tropical countries where the rapid growth of weeds such as water hyacinth (*Eichhornia crassipes*), salvinia (*Salvinia auriculata*) and water lettuce (*Pistia stratiotes*) has occurred.

Uncontrolled aquatic weeds can infest a waterway rapidly causing a reduction in conveyance capacity, obstruction of hydraulic structures and pump stations and impeded navigation. Moreover, failure to remove the vegetation will result in a gradual build up of organic material on the bed of the channel ultimately resulting in total blockage and failure of the irrigation or drainage system.

In Guyana water hyacinth have been known to totally infest clear drainage channels in less than one year, causing a significant reduction in discharge. Engineers for the Panama Canal have estimated that without weed control the waterway would be impassable within three years. Clearly the successful operation of man made channels in the tropics and elsewhere is dependent upon the implementation of an effective weed control programme.

Weed control: the alternatives

In general terms vegetation in waterways can be controlled by three principal methods: Mechanical; Chemical; and Biological. Mechanical and Chemical control are well proven in developed countries where the cost of equipment and herbicides is acceptable. Efforts to import this technology to developing countries has not however been generally successful. Mechanical equipment and herbicides require a significant recurrent investment of foreign exchange which is not always practicable. Moreover the skills required to maintain and operate such methods of control are difficult to sustain over a period of time.

This paper is concerned with the third alternative; Biological control, in this case the conversion of vegetation into living mass using herbivorous animals such as the West Indian Manatee.

Other methods of biological control include selective organisms such as the Chrysomelid beetle (*Agasicles hygrophila*) against alligator weed, the Curculionid weevils (*Neochetina eichhorniae* and *N bruchi*) and the Stemboring Pyralid moth (*Sameodes albiguttalis*) against water hyacinth and the Curculionid weevil (*Cyrtobagous salviniae*) against *Salvinia molesta*. Non selective organisms, in addition to the manatee, include fish such as the grass carp (*Ctenopharyngodon idella*), Tilapia, Silver dollar fish (*Metynnis roosevelti* and *Mylossoma argenteum*) and the Silver Carp (*Hypophthalmichthys molitrix*). Various birds and herbivorous animals have also been used including ducks, geese, swans, capybara, nutria, donkeys, pigs, sheep and water buffalo.

The West Indian Manatee

The West Indian Manatee (*Trichechus manatus*), commonly known as the sea cow, is a large herbivorous mammal native to the tropical waters of south-eastern United States of America through the north east coast of Brazil including the Caribbean. The manatee lives in shallow coastal waters, estuaries, creeks and rivers. It is able to live in both fresh and salt water and tolerates silty as well as clear conditions.

The West Indian Manatee is one of four species of manatee which include the Dugong (*Dugongdugon*) found in the coastal waters of the Indian and Pacific Oceans, the West African Manatee (*Trichechus senegalensis*) found in the coastal waters and rivers of West Africa and the Amazonian Manatee (*Trichechus inunguis*) which is restricted to the fresh waters of the Amazon basin. All species of manatee are threatened by extinction and are listed as endangered species.

The adult manatee has an average length of about 3 metres and an average weight of 500 kg. The body is not dissimilar in shape to that of a seal with a large flat rounded tail and two forelimbs or flippers. The manatee is long lived with an estimated life expectancy in excess of forty years.

The manatee feeds exclusively on submerged, emergent and floating vegetation. It is thought that most kinds of plants are suitable for the manatee providing that they are soft enough to be torn by its flexible upper lip. In captivity manatee are commonly fed on terrestrial vegetation although aquatic vegetation is preferred, particularly the submerged variety. Manatees in irrigation canals in Guyana have been recorded feeding on: *Cabomba aquatica*, *Nelumbo speciosa*, *Paspalum repens*, *Utricularia foliosa*, *Luziola spruceana*, *Paspalum vergatum* and *Hymenachne amplexicaule*. In the irrigation and drainage sys-

tems of Guyana the most problematic weeds are *Cabomba*, *Utricularia* and *Paspalum*. Recent experience at the Georgetown Zoological Park suggests that for successful breeding a varied diet is necessary including aquatic vegetation. Manatees are commonly seen crawling partway onto banks to feed when the amount of aquatic vegetation has been depleted, this practice can cause severe bank erosion where manatees are present in sufficient numbers.

The female manatee has a gestation period of thirteen months and usually produces one calf with each pregnancy. Manatees have been successfully bred in captivity in Guyana including at least one instance of breeding in a confined irrigation trench at Three Friends.

It has been estimated that manatees consume between 4 and 9% of their body weight in wet vegetation everyday. For a typical animal this is equivalent to 20 kg to 45 kg. In captivity in Georgetown Zoological Park experience has shown that approximately 32 kg of wet feed per manatee is sufficient to maintain good health.

The use of the West Indian Manatee for weed control in Guyana

The manatee is an endangered species world wide; categorised as such it has not been practicable or acceptable to experiment on the use of the manatee for purely commercial reasons such as weed control in recent years. The lack of first hand experience makes the establishment of the controlled use of the manatee for weed control difficult. Guyana is the only country where manatees have been used specifically for weed control in irrigation and drainage systems over a prolonged period of up to four decades. The experience gained in Guyana is thus of significant interest and essential to take into account when establishing further weed control trials.

The following sections highlight the problems and the advantages encountered in three particular manatee installations in Guyana together with historical population density data.

Garden of Eden

Some fifteen years ago the Drainage and Irrigation Department installed two manatees in a section of the south irrigation/navigation canal adjacent to Guyana Defence Force land in the area known as Garden of Eden, East Bank Demerara. The Canal has a water surface width of 7 m and the manatees move freely over a 450 m length of channel. The canal varies in depth from 1 m to 2 m.

The manatees are sustained totally on the aquatic vegetation in the channel,

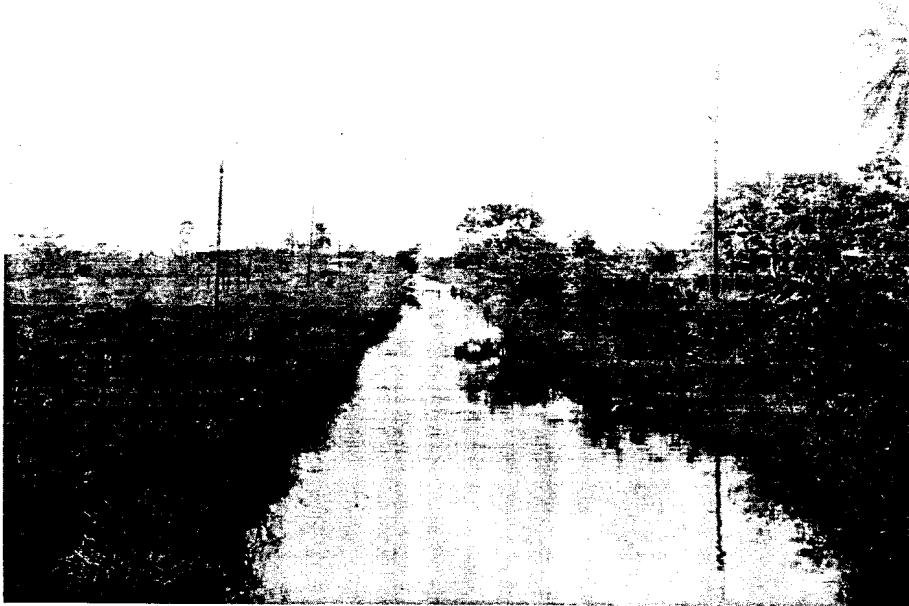


Plate 1. Canal utilising manatee for weed control (Garden of Eden, Demerara).



Plate 2. Canal with no permanent weed control agent (Garden of Eden, Demerara).

although there are some signs of bank erosion indicating that they also feed on the terrestrial vegetation on the canal banks. Comparison of separate reaches of the canal with and without manatees clearly shows that the presence of the manatees maintains the channel in a practically weed free condition in what would otherwise be a weed infested canal. See Plates 1 and 2.

Although primarily an irrigation canal the channel also serves as a source of domestic supply to the community living along the canal banks.

During the period that the manatees have been present at Garden of Eden there has been no case of poaching despite the canals proximity to the Georgetown-Timehri Highway and the lack of any security systems, including fencing. The reasons for the manatees relative safety would appear to be threefold:

- the manatees are located adjacent to land farmed by the Guyana Defence Force. As such they are clearly the responsibility of an authority respected by the local population;
- the manatees are not allowed to swim freely in a large system and are thus easily counted and checked. A five minutes visit to the canal is all that is necessary to ascertain that the manatees are still present;
- the manatees proved after a short period that they were an effective weed control agent and as such were accepted by the population. The proximity of the urban development to the canal also ensures that the manatees are guarded night and day.

Georgetown Sewarage and Water Commissioners (GSWC)

Since 1952 manatees have been used by GSWC to control the growth of weeds and algae in the secondary clarification tanks at the Shelterbelt treatment plant.

In 1951 the Georgetown Water and Sewage works constructed the secondary clarification tanks. Within a period of six weeks the tanks were seriously blocked by aquatic weeds. After several unsuccessful attempts at solving the problem four manatees were introduced into the tanks in 1952. The weeds were eradicated in four months from the 600 m long 12 m wide channel. Although the manatees kept the tanks free of weed growth and algae, sufficient aquatic vegetation was not available to sustain them, their diet is now supplemented by approximately 50 kg of terrestrial grasses per manatee per day.

By 1972 the last of the manatees had died and the weed infestation returned. A further two manatees were purchased and are still keeping the canal clear 18 years later.

Security at the GSWC Compound is provided by fencing and guards and so poaching of the manatees has not presented any problem.

Sugar Estates

In the late 1950s the Drainage and Irrigation Department and Bookers Sugar Estates introduced some 80 manatees into canals to test their weed clearing ability.

Manatees were introduced into the high level irrigation/navigation canals in several Guysuco estates from 1959 to 1962 to control the growth of aquatic weeds. The experiment was a short term success with a considerable reduction in the amount of weed growth. In the long term however the experiment failed due to the gradual decline in the manatee population. The reason for this decline was twofold: the poaching of the manatees for meat; and the death of manatees due to collision with the punts or barges used to transport sugar cane.

The problem of poaching was augmented by the character of the canal networks. The whole of the high level navigation system is interconnected within individual estates, in addition some estates are connected by central navigation canals. This system resulted in the free passage of manatees to any part of the system, many areas of which are isolated and thus present suitable conditions for poaching.

The conclusion drawn from the experiment was that manatees were not a suitable weed control agent when used in channels used for bulk motorised navigation due to the danger of collision and injury to the manatees. Moreover, until public awareness and law enforcement is increased to a level which will prevent poaching manatees should only be introduced into Canal systems which offer sufficient security against poaching.

Historical records of Manatee population density

Previous examples of the introduction of manatees into channels in Guyana and their subsequent efficiency at clearing and maintaining those channels free of aquatic weeds can be used as a basis for determining recommended manatee population densities. Listed in the following table is data obtained from nine manatee installations in Guyana both past and present.

Manatee population densities in channels in Guyana

Scheme	Water surface area (ha)	No. of manatees	No. of manatees per ha
<i>Manatees used successfully for initial clearing of channels</i>			
Ruby/Boerasirie distributary	3.1	4	1.3
Graig distributary	3.1	4	1.3
Black Bush Polder	2.2	3	1.4
<i>Manatees used unsuccessfully for initial clearing of channels</i>			
Wales/Georgia distributary	9.0	4	0.4
Garden of Eden	5.7	4	0.7
<i>Manatees requiring additional feed due to over population</i>			
Graig distributary	0.7	2	2.9
GSWC	0.7	2	2.8
<i>Manatees used successfully to maintain channels</i>			
Three Friends Canal	3.8	2	0.5
Garden of Eden	2.6	2	0.8

The results show conclusively that an effective manatee density lies between 0.5 and 1.4 manatees per ha of water surface; the lower density being suitable for maintenance and the higher suitable for initial clearing of an infested reach.

It should be noted that all the above installations contain turbid water which restricts the growth of aquatic plants to the waterway margins. The use of the water surface area as a measure of weed coverage is thus crude. Previous research has shown that in clear water manatee densities of up to 18 manatee per ha may be required. This suggests that manatees would be inefficient at controlling aquatic plants in clear water.

Conservation and legal protection

The West Indian Manatee is threatened by extinction and is one of the worlds more endangered marine mammals. However, if current populations can be preserved and restored it is feasible that the manatee may play a major role in the control of aquatic weeds in tropical countries.

In Florida, home to an estimated 1,200 West Indian Manatee, legislation has been in force from as early as 1893 to protect manatees. The Endangered Species Act now makes it a violation to 'harass, harm, pursue, hunt, shoot,

wound, kill, capture or collect endangered species'. Violations carry a fine of up to US\$ 20,000 and/or a prison sentence. Importation and Exportation is also prohibited. Conservation efforts in Florida have led to a significant increase in the understanding of the manatee and manatee husbandry methods. Such conservation leads the way to the controlled use of the manatee for weed control.

In Guyana the manatee is protected through the Convention on International Trade in Endangered Species of wild fauna and flora (CITES) and the Fisheries Act. Enforcement of legislation and a general increase in public awareness makes the controlled use of manatee for small scale weed control projects a real possibility for the future in Guyana.

Guidelines on the use of the manatee as a weed control agent

Due to the manatee being categorised as an endangered species there is only limited experience worldwide of their use as a specific weed control agent. In Guyana however the manatee has been used specifically for the purpose of weed control and the experience gained has led to the formation of the following general guidelines.

Water depth. Manatees prefer water depths of 2 to 5 m with a minimum acceptable depth of 1 m.

Water velocity. In the wild manatees avoid currents in excess of 1.4 m/s.

Navigation. Monitoring of manatee deaths in Florida and experience on sugar estates in Guyana has shown that a major cause of premature death is due to collision with boats and barges. Although the majority of deaths are caused by large boats with inboard engines small boats with outboard engines are also a danger. In addition manatees moving in confined shallow water can be crushed. It is recommended that manatees should not be placed in waterways carrying any motorised transport, this particularly includes sugar cane navigation canals in Guyana and elsewhere which are used to transport long trains of barges or punts.

Poaching. Manatees, although an endangered species, are still hunted for their meat. In recent years public awareness of their ecological value has risen but it is still strongly recommended that any use of the manatee as a weed control agent is strictly controlled and adequate security given to the animals.

Water control structures. Any water control structure is potentially hazardous

to the manatee. Care should be taken in design to ensure that the Manatee can, if required, pass through the structure without encountering higher than recommended water velocities, turbulence, and moving parts which may crush the animal. In addition it should always be remembered that the manatee is a mammal with a duration between breaths of between 30 seconds and four min.

Under no circumstances should the Manatee be allowed access to culverts or other structures which may cause drowning.

Pollution. Agricultural canals and drains contain, through run off from the fields, varying levels of pesticides and herbicides. Studies have shown that in natural waterways the residues in manatee tissue are not of pathologic significance. In canals and drains however the concentration of chemicals may be greater. It is recommended that prior to installing manatee in a man made waterway water analysis is carried out and potentially hazardous levels of chemicals identified.

Population density. The numbers of adult manatee installed in an irrigation or drainage system is of paramount importance. Too few and the channel will remain weed infested, too many and the manatees will be underfed. Moreover, manatees when hungry will seek more and more terrestrial vegetation from the channel banks. Such foraging can cause significant bank erosion which may threaten the embankment stability.

From experience in Guyana it is recommended as a first approximation to use a population density of one manatee for every two ha of water surface assuming turbid water conditions.

Population separation. It is recommended that the manatees are separated into small groups in distinct canal reaches. This process will facilitate monitoring and designate responsibility for the small groups to specific people farming or living adjacent to that canal.

Integrated weed control programmes. The population density of manatees required to maintain channels in a weed free condition has already been discussed. Initially however a channel may require a larger number of manatees or some other method of weed control to clear the infestation prior to the manatees maintaining the channel feeding purely on the regrowth.

It is recommended that chemical or mechanical methods are employed prior to introducing the manatee. Integrating the weed control methods in such a way will reduce the possibility of an overpopulation of manatees and the subsequent need to supply additional feed or transport manatees to another location.

Conclusions

The manatee is a proven method of weed control in irrigation and drainage channels in Guyana. Sufficient experience has been gained in Guyana to recommend guidelines for the use of manatees for weed control in Guyana and other tropical countries with similar prevailing conditions.

Although a proven weed control agent the manatee remains an endangered species worldwide. This status restricts the capture, captivity and subsequent use of the manatee for weed control on a large scale. However, where weed control and conservation may be achieved concurrently the use of the manatee is recommended subject to the guidelines presented in this paper.

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