Journal of Aquatic Biology and Fisheries Vol. 2/2014/ pp. 600 to 606

IMPACTS OF MACROPHYTES DIVERSITY AND WEED RISK MODEL IN MAJOR FRESH WATER BODIES IN CUDDALORE DISTRICT, TAMILNADU

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Received on: 10 October 2013, accepted on: 12 December 2013

Abstract: Freshwater ecosystems are important natural resources for the survivability of all the living organisms of the biosphere. Aquatic plants are a relatively small group of species within a wide number of families, but most have a similar range of adaptive characteristics to enable them to survive in the aquatic environment. Impacts of aquatic weeds are well known, with obstruction of waterbodies and displacement of desirable species often the most cited impacts arising from these plants. Within the context of risk management, water plants have a number of notable differences from their terrestrial counterparts. The potential for new species to further impact on indigenous freshwater biodiversity is limited in comparison to that which has already arisen from historical introduction of weed species. Furthermore, the spread of already naturalised weed species represents the most immediate threat to the ecological values and biodiversity of the remaining non-impacted or minimally impacted habitats. Nevertheless, there is still further potential for new species to modify the nature and extent of existing impacts. Conservation of fresh water is an absolute necessity today, hence the present research planned to assess the changes on water quality and ecosystem changes of by the occurrence of aquatic floral diversity in the three major fresh water bodies of Cuddalore District, Tamil Nadu. Point intercept method was used to measure the diversity, species richness, frequency etc. and the data were recorded and the weed risk model used for the six species, viz. *Limnophyton obtusifolium, Ottelia alsimoides, Ipomoea aquatica, Ceratophyllum demersum, Typha latifolia* and *Myriophyllum spicatum*. From the present work, it is clear, firstly, each potential adverse impact factor, such as those listed above, could be considered in isolation to identify whether there are any new species that might qualify as a risk for that factor. The alternative approach, which is emphasized in this work, is to focus on each new species and to consider what combination of cumulative adverse impacts might be based on all possible factors, so that the species itself can be ranked for risk.

Key words: Macrophyte diversity, Cuddalore District, Weed risk model

INTRODUCTION

The inland fresh water ecosystem, both lentic and lotic contributes a greater fraction towards the available water resource on the planet which, is now being increasingly subjected to greater stress from various human activities. The alarming rate of deterioration of water quality of fresh water resources like lakes, ponds, rivers etc. is now a global problem. Freshwater ecosystems are considered as one of the most important natural resources for the survivability of all the living organisms of the biosphere. Fresh water habitats are of much importance to mankind but they occupy a relatively small portion of the earth's surface as compared to the marine and terrestrial habitats (Santra, 2001). The fresh water ecosystem cover only 0.2% of the earth's surface with a volume of 2.04×105 km3 (Lieth, 1975). It is the availability of water which determines the nature, composition and abundance of terrestrial life. Over-exploitation, misuse and pollution of water are responsible for making it scarce and unfit for consumption (Sharma, 1999).

Aquatic plants are a relatively small group of species within a wide number of families, but most have a similar range of adaptive characteristics to enable them to survive in the aquatic environment. These include an ability to rapidly spread through a water body, often by asexual means, and a general lack of lignified structural tissue, with support being provided by the surrounding water. The spread of introduced aquatic species is often constrained by a lack of natural dispersal vectors from one water body to another. They are reliant on human activities for distribution, either accidental or deliberate. Impacts of aquatic weeds are well known, with obstruction of water bodies and displacement of desirable species often the most cited impacts arising from these plants. Within the context of risk management, water plants have a number of notable differences from their terrestrial counterparts, and in this respect they need to be addressed separately (Champion, 1994).

Aquatic macrophytes play important roles in the structures and functions of aquatic ecosystems (Wetzel, 2001). They act physically on the environment by hampering wave action and water flow and stabilizing sediment (Brix, 1997; Madsen *et al.,* 2001) in addition to strongly affecting nutrient cycling and the physico-chemical characteristics of both water and sediment (Wigand *et al*., 1997; Havens, *et al*., 2004). Aquatic vegetation also interacts closely with other members of aquatic communities, supplying food, shelter, and refuge for a diversity of organisms such as fishes, invertebrates, and waterfowl (Pelicice *et al.,* 2005; Rybicki and Landwehr, 2007).

Impact of aquatic flora on water quality has been studied periodically by number of researchers in India (Sharma and Solomon *et al.,* 2005; Das, 2008; and Sushilkumar, 2011). Biota of a water body is basically responsible for its natural renewal of purity. The capacity of a system to purify waters is an important issue to be investigated in the context of water resources management. The study of biota holds the basic clue to this. Conservation of fresh water, therefore, is an absolute necessity today (WHO, 1992). Hence the present research proposal planned to assess the changes on water quality and ecosystem changes of by the occurrence of aquatic floral diversity in the three major water reservoir of Cuddalore District, Tamil Nadu.

MATERIALS AND METHODS

Study area (Fig. 1)

1. Perumal lake

The Perumal Lake is oldest and largest Lakes of Tamilnadu. This lake is situated (Lat. 11°35'N; Long. 79°40'E) in the Cuddalore District in the state. The lake is being used mainly for irrigation and fish catching. The length of the lake is 17 km North-South and width of 3 km East-West. The depth is nearly5.44 m and water holding capacity is 574 M. cft.

2. Veeranam lake

Veeranam tank is one of the biggest fresh water reservoir. The Veeranam lake (Lat. 11° 17'N); Long. 79° 32'E) is located 14 km SSW of Chidambaram in Cuddalore District of Tamil Nadu and is located 235km from Chennai. The length of tank in North to South is 16 km, and in East to West it is 5 km. The full tank level is 45.50 feet and water catchment area is 165 sq. miles.

3. Wellington Lake

Wellington Reservoir is situated in Tittagudi Taluk of Cuddalore District at a distance of 240 Km in the South West of Madras. The Reservoir is located in Vellar Basin across a tributary stream Periya Odai of Vellar River. It receives Regulated Supply diverted from Vellar River at Tholdur Regulator and an additional catchment area of 129 Sq. Km., of its own during North East Mansoon. The Reservoir was constructed during 1913-1923 and irrigates an Ayacut of 11,200 Hectare.

In the present study, a survey was conducted during January 2012 to May 2013 using point intercept survey.

Assessment of macrophytes in Cuddalore district using MAF weed assessment model (Phelong, 1996). This model is based on adaptations of the systems used in Esler *et al*. (1993) and Champion (1995). Attributes of the plants ecology, biology and weediness are assessed based on observations of their behaviour in Cuddalore district and/or information from other states of India. The attributes of greatest importance are ranked on a scale of 0-10, of intermediate importance 0-5 and 0-3 and of minor importance 0-1. These attributes are briefly discussed below and are fully outlined in Table 1.

1. Versatility (2-10)

This relates to the tolerance of plant species to a range of environmental variables such as low temperature, salinity, water depth/exposure, trophic status and water clarity.

2. Competitive ability (0-10)

This compares the competitive ability of the plant to displace other species within the same life-class

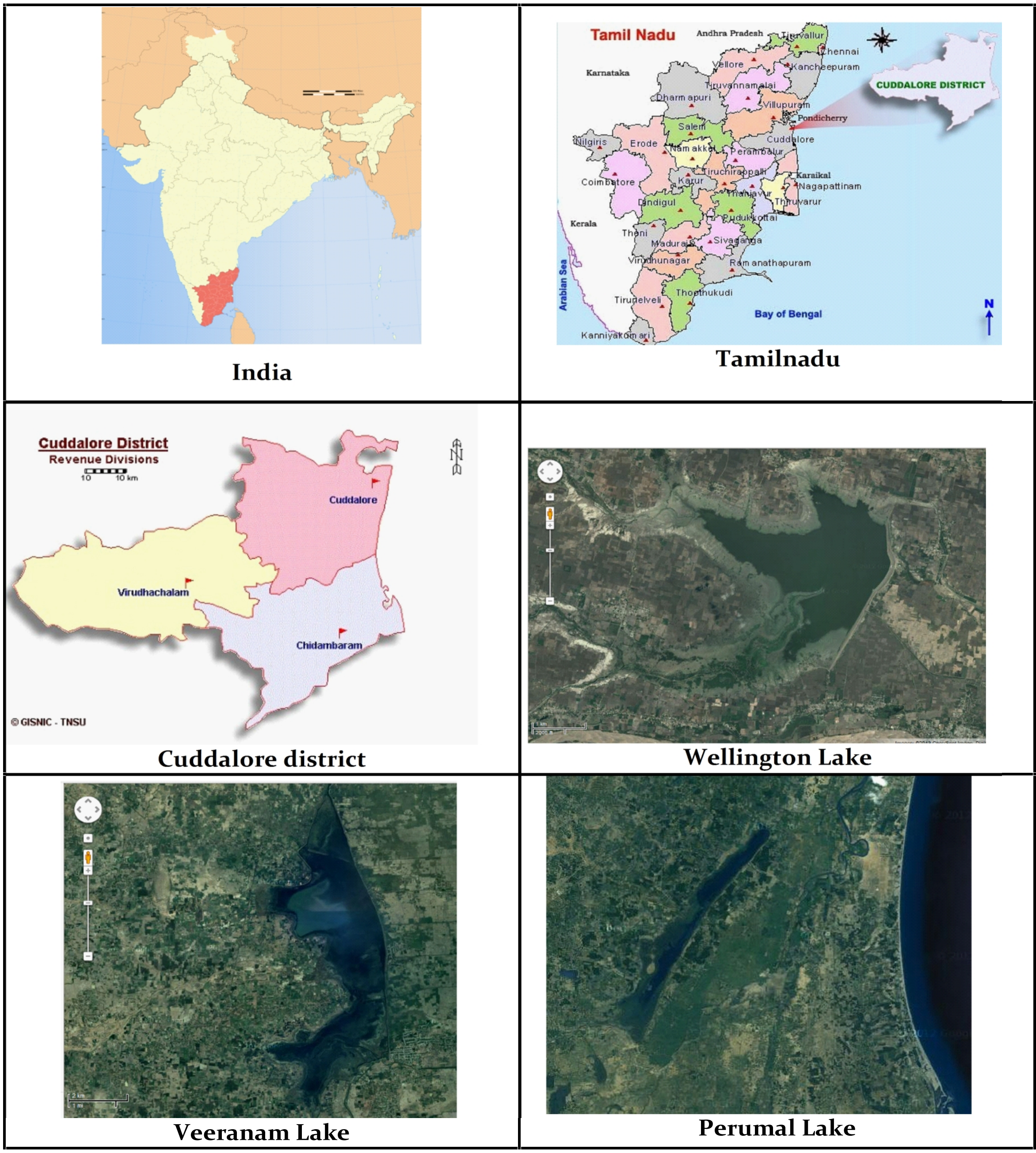

Fig. 1. Study area

(e.g. submerged, floating, emergent) and between life classes. This competitiveness is determined from field observations and/or inter-species competitive trials, e.g. Hofstra *et al.* (1999).

3. Propagule dispersal (0-10)

This relates to the range and effectiveness of dispersal mechanisms into new catchments including natural agents (birds or wind), human activity (accidental or deliberate), and the ability to spread within a catchment via seed or plant fragments.

4. Degree of obstruction (0-10)

This relates to potential obstruction problems caused by the plant affecting recreational water use, access to waterbodies, hydro-electric power generation, irrigation, flood control and aesthetic qualities (visual and olfactory).

Table 1. Weed risk model of the aquatic plants studied

	Limnophyton obtusifolium	*Ottelia alismoides*	*Ipomoea aquatica*	*Ceratophyllum demersum*	*Typha latifolia*	*Myriophyllum spicatum*
Versatility	**7**	**5**	**7**	**4**	**7**	**7**
temperature	2	1	1	1	1	3
salinity	0	0	1	0	1	0
Habitat	2	2	3	1	2	2
Water substrate	2	1	1	1	2	2
clarity	1	1	1	1	1	0
Habitat	**7**	**5**	**4**	**4**	**4**	**5**
lentic	2	2	1	2	0	2
Lotic	3	3	1	2	3	3
Wetland	2	0	3	0	1	0
Competition	**6**	**10**	**10**	**4**	**5**	**7**
Within	6	8	8	4	5	7
Between	0	2	2	0	0	0
Dispersal	**4**	**4**	**4**	**4**	**6**	**4**
Bird/wind	0	0	1	0	5	0
Accidental	2	2	2	2	1	2
Deliberate	1	1	0	1	0	1
Within	1	1	1	1	0	1
Maturation	**3**	**3**	**3**	**1**	**1**	**3**
Seeding	**3**	**5**	**3**	**2**	**4**	**6**
Quantity	1	3	2	1	3	0
Viability	2	2	1	1	1	0
Cloning	**4**	**4**	**4**	**3**	**3**	**5**
Biological Success	34	36	35	22	30	37
Obstruction	**8**	**5**	**8**	**2**	**4**	**9**
Water use	2	1	1	1	1	2
Access	0	1	2	0	1	1
Flow	2	0	2	0	0	2
Irrigation	2	2	2	0	1	2
Aesthetic	2	1	1	1	1	2
Natural Areas	**5**	**5**	**5**	**2**	**6**	**9**
Biodiversity	4	4	4	1	5	5
Water quality	0	0	1	0	1	3
Physical	1	1	0	1	0	1
Other	**0**	**0**	**0**	**0**	**0**	**1**
health	0	0	0	0	0	1
Weed	0	0	1	0	0	0
Habitat	**8/8**	**5/5**	**4/4**	**1/1**	**10/10**	**10/10**
Resistant to management	**6**	**3**	**3**	**0**	**1**	**5**
Implementation	1	1	1	0	1	1
Recognition	1	0	0	0	0	1
Scope	1	0	0	0	0	0
Suitability	1	1	0	0	0	1
Effectiveness	1	0	1	0	0	1
Duration	1	1	1	0	1	1
Other countries	**5**	**5**	**5**	**0**	**1**	**1**
WEEDINESS	32	23	25	5	22	35
Total Score	66	59	60	27	52	72

5. Damage to natural ecosystems (0-10)

This relates to ecosystem values such as reduction in biodiversity (Adair and Groves 1998), reduction in water quality (especially deoxygenation) and negative impacts on physical processes (e.g. substrate stability, increased/ decreased flooding)

6. Extent of suitable habitat not occupied within Cuddalore district (0-10)

This evaluates the current distribution of the plant in New Zealand and its potential distribution. The score relates to available habitat not presently occupied by the plant.

7. Resistance to management (0-10)

This combines various aspects of weed control, including ease of recognizing a weed problem, accessibility, scope of control methods, suitability of control methods, and the effectiveness and duration of control.

8. Weed history in different habitats (1-9)

This combines the potential degree of weediness of the species in lentic (flowing), lotic (static) waters, and wetland habitats.

9. Seeding ability (0-5)

This evaluates the potential maximum seed (or other perennating structures) production, its viability and persistence.

10. Cloning ability (0-5)

This relates to the ability of the plant to spread by fragmentation, rhizome, or stolon extension.

11. Behaviour in other countries (0-5)

This evaluates the weediness of the plant in other temperate or tropical countries and its history of naturalisation into other countries.

12. Maturation rate (1-3)

This evaluates the time taken to produce dispersive propagules.

13. Other undesirable traits (0-3)

This relates to other features not accounted for under the other attributes and includes aspects of health impairment (drowning risk, toxicity, wounding and mosquito breeding habitat) and weediness in terrestrial systems.

RESULTS AND DISCUSSION

From the present observation, it is clear that there are two approaches to the undertaking of a risk assessment. Firstly, each potential adverse impact factor, such as those listed above, could be considered in isolation to identify whether there are any new species that might qualify as a risk for that factor. The alternative approach, which is emphasized in this report, is to focus on each new species and to consider what combination of cumulative adverse impacts might be based on all possible factors, so that the species itself can be ranked for risk. Such adverse impacts need to be assessed for their potential scale or extent. They also need to be placed in the context of the range of positive and negative potential impacts posed by each species, so that their final risk ranking will be based on a cumulative index of all factors.

Comparing to three fresh water lakes, the maximum score observed in *Myriophyllum spicatum* followed by *Limnophyton obtusifolium*. The minimum score recorded in *Ceratophyllum demersum* followed by *Typha angustata* and both occupied near the edges of the lake. Among the weeds in individual lake concern *Limnophyton obtusifolium* is dominant in Perumal lake, *Myriophyllum spicatum* is dominant in Wellington lake and *Ceratophyllum demersum* is dominant in Veeranam lake.

It is correlated with earlier report in various parts of India viz. *Ottelia alismoides* and *Ceratophyllum demersum* are the most problematic weeds in Ansupha lake of Orissa. *Typha* is a big problem in reservoirs and pond of Punjab (Sharma and Chandi, 1996). *Ipomoea aquatica* is in the first order among water weeds causing menace in Tamilnadu (Sushilkumar, 2011). Aquatic weeds blocked the drainage canals of the colonies and irrigations canals badly due to its profuse growth (Sushilkumar *et al.,* 2009). On the other hand, the flow of water in canals is reduced drastically, 40 to 90% by submersed weeds such as pond weeds (*Potamogeton* spp.). Vast swampy areas, ditch banks, drainage channels and flood-control channels are infested with cattails (*Typha* spp.) throughout India which are often designated as India's worst weed (Gupta, 2001; Varshney *et al.* 2008).

Negative effects can range from a shift in the aquatic plants toward predominantly ûoating and emergent species (Egertson *et al.,* 2004) to a complete collapse of the macrophyte community (Philips *et al.,* 1978; Rasmussen and Anderson, 2005). Aquatic macrophytes in these communities have unique ways of occupying the different environments, with diversiued life-and growth-forms and distinct distribution patterns in the pool space (Pott *et al.,* 1989) over time. Since a plant life-form is considered a survival strategy (Grime *et al.,* 1988), the proportion of each life-form present in a community – i.e., its biological spectrum – indicates not only how adapted the species are to the prevailing climatic conditions but also how strong the possible stressors are and how they impact the community (Nikolic *et al.,* 2011).

In summary, the two major difficulties in developing a meaningful Weed Risk Assessment for aquatic plants have been **i**nadequate tools (i.e. models for determining potential weediness) and unreliable data (i.e. identity of potential ecological weeds already in India and and volume of traffic entering the border by illegal means). This stage of the report (Weed Risk Model) has focused on resolving the first problem by developing a specific risk assessment model for aquatic plants, while Stage two of the Border Control Programme (Weed Risk Assessment) will correct the data on aquatic species in this country and volume of traffic entering by the various pathways.

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