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Linking sustainability indicators of Indian wild caught ornamental fish industry

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ABSTRACT

The Indian ornamental fish industry is divided into two- the domestic market and the export market. 90% of the freshwater ornamental fish exported from India are wild caught indigenous species. The study formed the criteria and indicators assessing the sustainability of wild caught ornamental fish exported from India. These indicators were then analyzed for their interactions, connections, linkages and relationships using cognitive mapping. The work is first of its kind in the ornamental fisheries.

Keywords: India, ornamental fish, indigenous, sustainability indicators, cognitive mapping.

1. Introduction

Beautiful aquarium fish has always been a fancy that easily gained popularity. The popularity has evolved this hobby to an international trade affair. According to Axelrod (1973), the retail value of global ornamental fish trade including accessories was 4000 million USD. The figure has crossed more than 8 billion USD (Silas et al., 2011). The start of the millennium projected an annual global exports of USD 176 million which compounded annually at a growth rate of 6.2% and reached around 342 million USD in 2010 (Tissera, 2012).

Indian ornamental fish trade

The Indian ornamental fish industry can be divided to two- the domestic market that favors the exotic fish species and the export market that favors the indigenous fish species. India is blessed with two biodiversity hotspots – the North-east region and the Western Ghats which forms the main source of indigenous ornamental fish exported from India.

Besides enjoying the rich piscine diversity, the Indian exports are hardly 0.3% of the global exports. But, around 90% of them exported are wild caught indigenous fish (Silas et al., 2011). So, even after being in an unenviable position, the practice of capture based exports poses a sustainability threat. Table 1 shows the major exported indigenous species for the years 2005-2010.

Table 1: Indigenous Species with Major Composition in Exports (2005-2010)

SPECIES	COMPOSITION
Tetraodon travancoricus	15.51%
Dario dario	4.81%
Puntius denisonii	3.76%
Botia striata	3.69%
Carinotetraodon imitator	1.59%

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Puntius fasciatus	0.54%
Channa bleheri	0.49%
Chela dadiburjori	0.30%
Mesonoemacheilus triangularis	0.19%
Puntius terio	0.13%
Etroplus maculatus	0.12%
Puntius filamentosa	0.10%
Puntius jerdoni	0.09%
Pisodonophis boro	0.09%
Puntius narayani	0.07%
Puntius melanampyx	0.07%
Pseudosphromenus dayi	0.07%
puntius conchonius	0.05%
Barilius bakeri	0.03%
Badis assamensis	0.02%

(Source: Unpublished data from MPEDA)

The first use of the term 'sustainable' in the modern sense was by the club of Rome in 1972 in its epoch-making report on the 'Limits to Growth' (Grober, 2007). Ever since the first definition of sustainable development during the Brundtland Commission, (WWF report, 2008) sustainability had different notions and conceptions all pertaining to sustenance.

Sustainability has been linked to fisheries through numerous approaches for example private standards and certification for food safety and quality in fisheries and aquaculture (Washington et al., 2011) or general principles involving criterion and indicators that could be used for the assessment of the plight of fisheries (Adrianto et al., 2005; Link et al., 2010; Shin et al., 2010; Ommani et al., 2012)The usefulness of indicators in detecting ecosystem change depends on three main criteria: the availability of data to estimate the indicator (measurability), the ability to detect change in an ecosystem (sensitivity), and the ability to link the said change in an indicator as a response to a known intervention or pressure (specificity) (Link, 2010).

The study aims to list out the suitable sustainability criteria and indicators for the wild caught indigenous ornamental fish exported from India. The indicators were then analyzed for their interactions, connections, linkages and relationships. Although individual indicators appear to be good, sustainability may be compromised due to cross-criterion or cross-indicator interactions. These interactions may not be apparent if criteria or indicators are assessed without examining their interrelationships between and among each other (Mendoza and Prabhu, 2002). The study would be the first of its kind as far as the ornamental fish industry is concerned.

2. Material and methods

The sustainability indicators were formed according to the steps followed in IOC Manual (2006). Then a qualitative method called cognitive mapping (Eden and Akermann, 1998) was used to find the interactions between the criteria and the indicators. The method is well suited for complex problems where many aspects and dimensions of the problems are difficult to comprehend adequately (Mendoza and Prabhu, 2002). Two primary analytical constructs based on cognitive mapping were used. They are domain and centrality.

Domain indicates the 'density' or number of indicators directly linked to a particular indicator regardless of direction. Thus higher domain values reflect a larger number of indicators directly affecting or affected by the indicator. Centrality reflects downstream effect combining both direct and indirect effects which in turn reflect the strategic significance indicating the cumulative impact of an indicator beyond the direct impact.

Centrality was identified after finding the central score which is defined as

$$C_i = {}^{S_j}\!/_{j} + \ldots\ldots\ldots + {}^{S_n}\!/_{n}$$

where,

j= 1, 2,……….n

i= indicator

Ci= central score of indicator ‘i ‘considering ‘j’ levels of interactions (Eden and Akermann, 1998)

The central scores of three levels were found using Decision explorer.

3. Result and conclusion

The sustainability indicators were formed for the wild caught indigenous ornamental fish exported from India. Four criteria were formed namely ecological with 11 indicators, governance with 4 indicators, socio-economic with 9 indicators and technical with three indicators as shown in Table 2.

Table 2: Criteria and indicators formed for wild caught indigenous ornamental fish species

Criteria	Variable	Indicators
Ecological	A1	Distribution
	A2	Stock Assessment
	A3	Species Biology
	A4	Reproduction Biology
	A5	Spawning
	A6	Exploitation rate
	A7	Impact of ecosystem factors relevant to target species
	A8	Interaction with other species
	A9	Use and impacts of gear
	A10	Fishing grounds
	A11	Risk factors known and understood
Governance	B1	Specific fisheries management objectives
	B2	Measures to discourage destructive fishing practices
	B3	Economic instruments for management policies like certification
	B4	International recommendations or guidelines influencing the industry
Socio-economic	C1	Value of catch
	C2	Quantity of catch

	C3	Quality of catch
	C4	Income at each stage
	C5	Fishery contribution (domestic, exports)
	C6	Total employment
	C7	Fisher demographics
	C8	Management by local and indigenous communities
	C9	Manifestation of traditional knowledge
Technical	D1	Measures to reduce transport stress and mortality
	D2	Optimum physical and chemical properties of water suitable for the target species
	D3	Captive breeding technology

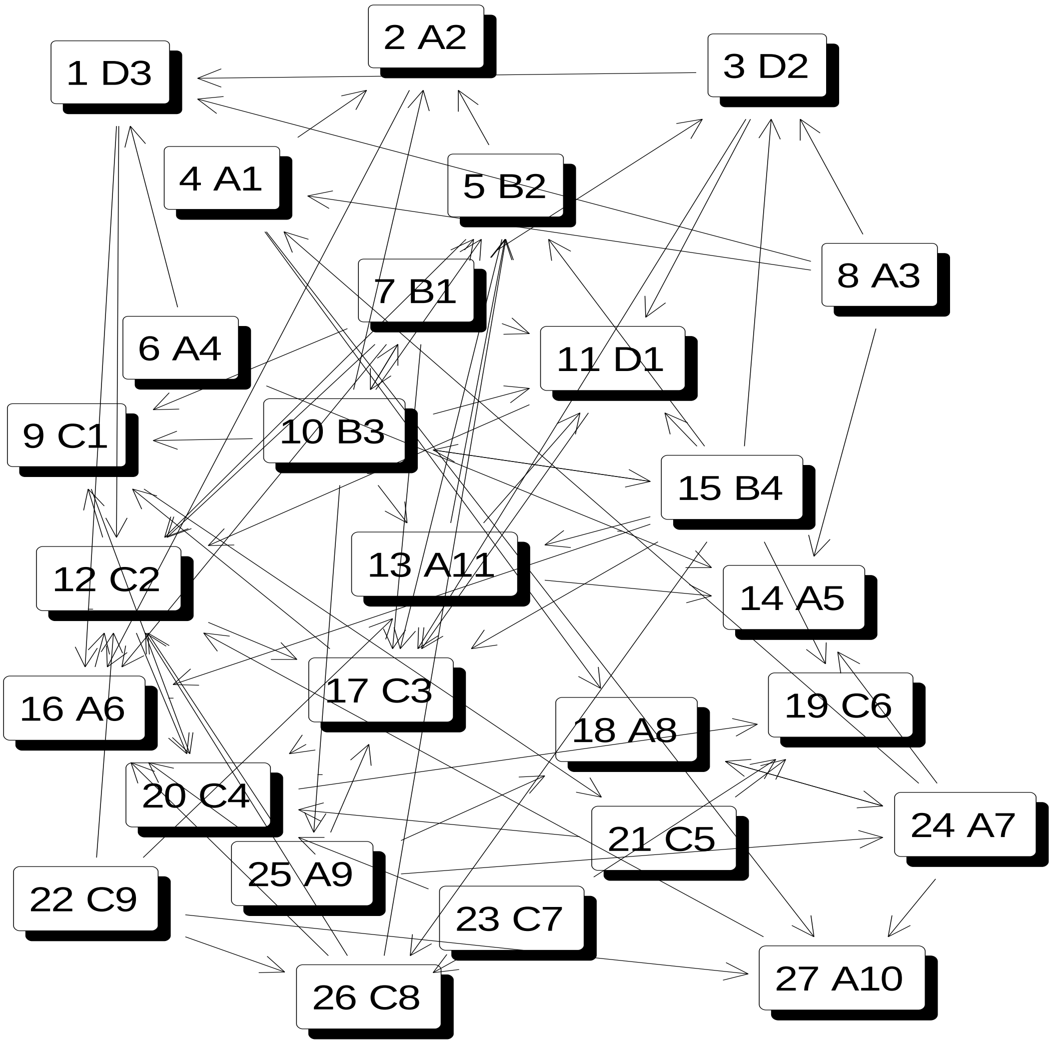

Figure 1: Causality map of the indicators

For the holistic assessment of the relationships between the indicators, using cognitive mapping, a causality map was generated (Figure 1.) Table 3 gives the important information regarding the domain and centrality of indicators.

Table 3: Domain and central scores for the indicators.

Criteria	Variable	Indicators	Domain	Central Score
Ecological	A1	Distribution	5	12
	A2	Stock Assessment	4	13
	A3	Species Biology	4	12
	A4	Reproduction Biology	2	10
	A5	Spawning	4	11
	A6	Exploitation rate	7	15
	A7	Impact of ecosystem factors relevant to target species	6	12
	A8	Interaction with other species	4	11
	A9	Use and impacts of gear	6	14
	A10	Fishing grounds	4	13
	A11	Risk factors known and understood	6	15
Governance	B1	Specific fisheries management objectives	9	15
	B2	Measures to discourage destructive fishing practices	8	15
	B3	Economic instruments for management policies like certification	10	15
	B4	International recommendations/guidelines influencing industry	10	16
Socio-economic	C1	Value of catch	6	15
	C2	Quantity of catch	12	18
	C3	Quality of catch	9	17
	C4	Income at each stage	6	14
	C5	Fishery contribution (domestic, exports)	3	9
	C6	Total employment	4	11
	C7	Fisher demographics	3	10
	C8	Management by local and indigenous communities	6	14
	C9	Manifestation of traditional knowledge	4	13
Technical	D1	Reduce transport stress and mortality	7	15
	D2	Optimum physical and chemical properties of water suitable for the target species	6	14
	D3	Captive breeding technology	5	14

In terms of domain 15 out of 27 indicators have at least a density of six. Among this 15, five are from socio-economic criteria, four each from governance and ecological and two from technical. C2 (quantity of catch) under the socio-economic criteria has the highest domain and the central score. So arguably this indicator, that is quantity of catch would be the central of sustainability issues for the wild caught indigenous ornamental fish exported from India.

As far as exports of ornamental fish is considered there are no clear data on the quantity exported and the only data recorded are the weight of the boxes in which the live fish are moved and the value of these shipments in US$ (http://www.ornamental-fish-int.org/files/files/volume-of-the-trade.pdf) Higher DOA has been found to be one of the weaknesses of the indigenous species exported during the SWOT analysis (Sekharan, 2006). Olivier (2001) has mentioned mortalities of 25-40% in every step of the transport chain, resulted in a total mortality of up to 73% for the total transport chain.

Rubec (2005) has highlighted certain reasons for the mortality of marine ornamental fish during shipment which includes capture with cyanide which caused 50% of the acute mortality, and 30% mortality on average at each step of the chain of custody. To compensate the DOA higher quantity of fish are being caught which threatens the sustainability of the resources.

It is easier for India to adopt approaches to maintain sustainability as India is in an infant stage as far as ornamental fish exports are concerned. Market based incentives like ecolabelling and certification is gaining importance in fisheries. They foster the provision of increased protection to biodiversity and enhancement of its quality (Brauer et al., 2006). Marine Products Export Development Authority, India has come up with a certification scheme called Green certification, which is the first of its kind in the freshwater ornamental fish sector (Ramachandran, 2012). Green certification helps to maintain the environmental and socio-economic sustainability. The approach stresses on reducing the dependence on wild stocks and ensuring that the fish collection is managed according to the principles of ecosystem management (Silas et. al, 2010).

Integrating the supply chain fully will also provide the best opportunity to control supply quality, ensure optimal resource allocation to invest in the necessary condition (Amos et al., 2009). Substantial subsidies for basic infrastructure development should be promoted (Nair, 2002). Certification can be successful only if they generate tangible contributions to the stakeholders in the entire chain including the consumers (Anon, 2002). Regulations should not be a disguised measure to protect the domestic industry and should not operate as barriers to market access (Deere, 1999).

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