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Assessing the Stakeholder Delphi for Facilitating Interactive Participation and Consensus Building for Sustainable Aquaculture Development

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Calls for participation in development projects are reviewed, meanings of participation discussed, and constraints to good participation considered. The stakeholder Delphi, drawing on knowledge and experience of participants, is assessed in facilitating interactive participation and consensus building. Stakeholder Delphi outcomes from a study concerning strategies to limit negative aquaculture wastewater impacts are presented. Round 1 participants ($n = 24$) identified 18 strategies within institutional, managerial, socioeconomic, and technological subcategories. Friedman's test indicated rank patterns ($p < .001$, two-tailed) in participant responses after round 2. Following round 3, Kendall's coefficient of concordance (W) indicated agreement ranging from "strong–unusually strong" for technological strategies to "moderate–strong" for socioeconomic strategies; managerial and institutional strategies were rated highest. Acknowledging possible limitations reviewed here and advocating mitigating measures discussed, the stakeholder Delphi could facilitate interactive participation and consensus building among disparate, hierarchical, and possibly antagonistic groups that may require representation when assessing other aspects of sustainable aquaculture development.

Keywords aquaculture development, consensus building, global, participation, stakeholder Delphi

Stakeholder participation in development projects is a recognized prerequisite for success: engendering stakeholder ownership of process and outcomes; ensuring an efficient, effective and socially sensitive approach; prompting transparency and accountability; empowering the poor and powerless; promoting understanding,

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social cohesion, and accumulation of social capital; and enhancing the ability of people and communities to learn, plan, and innovate (Pretty 1995). Principle 10 of the Rio Declaration (UN 1992) underlines the commitment of the signatories to promoting participation, noting that the "participation of all concerned citizens" is most effective in addressing environmental issues and that individuals should have appropriate access to environmental information and "the opportunity to participate in decision-making processes," concluding that "States shall facilitate and encourage public awareness and participation." Addressing aquaculture development specifically, Article 9 of the Code of Conduct for Responsible Fisheries prepared by the United Nations' Food and Agriculture Organization (FAO 1995) calls on states to "promote active participation of fishfarmers and their communities in the development of responsible aquaculture management practices." Unfortunately, and despite numerous other institutions advocating stakeholder participation in research, decision making, and policy formulation, significant barriers to participation and problems with implementing participatory approaches persist.

The first hurdle is unpicking what participation means. Pretty (1995) presented a seven-stage typology of participation in development programs and projects. Participation ranged from type one, "manipulative participation," and type two, "passive participation": telling people what has already been decided or enacted, to type seven, "self-mobilization" where people take the initiative, develop external contacts, and retain control over resources. Types one to four are regarded as disingenuous and unlikely to produce lasting benefits. Well-conceived development initiatives probably strive for "interactive participation" (type six), where according to Pretty (1995, 1252), "People participate in joint analysis, development of action plans and formation or strengthening of local institutions. Participation is seen as a right"; however, various constraints have been identified that limit the effectiveness of such endeavors and that result in more "functional" participatory approaches (type five) where predefined project goals take precedence.

Multiple perspectives, joint analysis, and group decision making are central to effective interactive participation, but as summarized in Table 1, social context and norms constitute inherent flaws. People experience different problems and have different perspectives, priorities, and agendas; some are more powerful than others and their perspective and priorities often gain greater attention, through enhanced opportunities for articulation and the deference of others; in group situations, minority views and those of the powerless are often missed or subjugated.

These limitations to decision making and consensus building have been noted in business, technology forecasting, social policy, and natural resources management contexts, and in response the Delphi technique has been invoked widely (Gupta and Clarke 1996). However, in presenting a critical review, possible limitations of a Delphi-based approach must be acknowledged; McKenna (1994) discussed concerns surrounding the use of experts, poor response rates, accountability, and scientific respectability. The Delphi technique has been used to develop sustainability indicators for aquaculture in the southeastern United States (Caffey 1998) and to assess prospects for horizontally integrated aquaculture development (Bunting 2008). Prospects for enhanced policy making for aquaculture service provision to poor people in India were assessed using a Delphi-based approach (Haylor et al. 2003, 2). The authors noted that "Delphi is particularly appropriate when decision-making is required in a political or emotional environment, or when the decisions affect strong factions with opposing preferences." In assessing future

Table 1. Constraints to interactive participation and possible mitigation strategies

Issue	Constraint	Mitigation strategy
Development program or project organization and implementation	Sectoral organization (education, health, water and sanitation, natural resources, etc.)	Support cross-sectoral and multidisciplinary activities that can respond to poor people's most pressing needs. Conduct a comprehensive needs analysis with communities and use resources targeted by sector to address issues prioritized by selected poor stakeholders.
	Predefined focus, agenda, objectives, or targets	Ensure activities are demand led and focused on identifiable groups of the poor or target institutions. Incorporate a consultative inception phase to define local needs and explain focus and limitations of studies or projects, thus avoiding false expectations.
	Authorities fear interactive participation will slow planning and implementation, resulting in token participation that undermines the process and engenders greater distrust and alienation	Reassure authorities that interactive participation constitutes a more effective approach than more manipulative types; promote transparency and accountability; ensure strong facilitation and full representation (see below); test trustworthiness of findings through, e.g., extended interaction, critical observation, triangulation, and participant checking.

Representation and engagement	People unable to attend meetings due to logistical and social constraints	Select conveniently situated, politically and institutionally neutral, and socially accessible venues or meeting places. Schedule activities at convenient times and give sufficient advance warning.
	Stakeholders inadvertently missed in the process	Conduct preliminary stakeholder analysis to ensure process is as inclusive as possible; encourage newly identified stakeholders to engage with ongoing process on equal terms.
	Views and opinions of poor, powerless, and marginal groups subjugated, ignored, or not finding expression	Seek out views of poor, vulnerable, and socially excluded or politically marginalized groups using appropriate participatory tools; avoid situations where participants are unduly influenced by social pressures, peers, or the powerful.
Barriers to participation	Stakeholders barred from participation due to intrahousehold and social norms or tacit exclusion	Adopt methods that negate such barriers, e.g., focus groups, household interviews, ensure transparency, and strive for full representation (see above).
	Prospective participants unwilling to engage due to a lack of trust, fear of conflict or losing control, scepticism, or an alternative personal or political agenda	Establish constructive dialogue, raise awareness of process and objectives, provide reassurance, safeguard anonymity, ensure findings are trustworthy and promote transparency and accountability.

prospects for aquaculture globally, Brugere and Ridler (2004, 34) concluded that "Planning will therefore be key to the sustainable development of aquaculture" and recommended adoption of a planning framework underpinned by application of the Delphi method. This article addresses this proposition, describing the methodology and interpretation of results from such a study, but also highlighting limitations and suggesting how to overcome them.

Conventional Delphi investigations capitalize on the judgment, analytical ability, and predictive powers of experts in a specific subject area to explore consensus about possible future events (Linstone and Turoff 1975). Unlike group decision making and discussion methods for reaching consensus, the Delphi technique is conducted through an iterative series of questionnaires presented to individual participants or panelists. The Delphi technique was founded on four key assumptions: expert opinion is a valid input to inexact research areas; consensus among experts is more valid than the opinion of an individual; joint meetings of experts induce a follow-the-leader bias; ensuring the anonymity of participants compensates for inherent opinion biases (Caffey 1998). Considering the limitations just identified with group decision-making and consensus-building approaches, it was decided to test the apparent strengths of the Delphi technique, assessing with stakeholders potential strategies to ameliorate impacts of aquaculture development and evaluating the technique in facilitating interactive participation in natural resources management.

Many contemporary strategic or policy studies dealing with aquaculture begin by explaining the growing importance of aquaculture globally and that landings from marine capture fisheries are static. The proportion of crustaceans, fish, mollusc, and other aquatic animals from aquaculture to global supplies increased from 3.9% in 1970 to 32.4% in 2004; aquaculture output grew at a rate of 8.8% per year from 1970 to 2004, as compared with 1.2% for capture fisheries and 2.8% for terrestrial farmed meat production; global per capita production from aquaculture increased from 0.7 kg in 1970 to 7.1 kg on 2004 (FAO 2007). It must be remembered, however, that farming marine finfish accounts for a small proportion, less than 5% in 2000, of that consumed by humans; aquatic foods do not necessarily readily substitute for meat and livestock products; farming marine fish and shrimp can constitute a net protein consumer (FAO 2002a, b; Naylor et al. 2000). Aquaculture depends upon the sustained supply of environmental goods and services, including space, water and feed inputs, waste nutrient and carbon assimilation, and in several cases the supply of wild seed, juveniles, or broodstock (Beveridge et al. 1997; Kautsky et al. 1997; Folke et al. 1998; Naylor et al. 2000; Bunting 2001a). Where the environmental carrying capacity to sustain such goods and services is exceeded, this causes adverse impacts. Physical and chemical environmental parameters may be affected, eutrophication can occur, species assemblages can be altered, and biodiversity can be lost. Escapees from aquaculture can compete directly with native species for habitat and food and predate on wild stocks; aquaculture has been implicated in causing disease and genetic degradation in native populations.

Appropriate aquaculture development can generate broad positive socioeconomic benefits: enhancing poor livelihoods in rural, coastal, and peri-urban situations; contributing to food security, livelihoods, and income diversification; increasing employment; suppressing food prices; facilitating more efficient water and nutrient management at the household or community level (ODI 1999). However, at a community or regional level, aquaculture development is frequently contentious, sometimes resulting in open conflict. Disruption to traditional or

informal access rights often precipitates such conflict; the emergence of offshore aquaculture has been highlighted as a particular area for concern (Skladany et al. 2007). Shrimp aquaculture in Bangladesh, Honduras, and Thailand (Dewalt et al. 1996; Deb 1998; Flaherty et al. 1999) and cage culture of salmon in British Columbia, Canada (Ridler 1997; Marshall 2001; Gerwing and McDaniels 2006), and southern Chile (Barrett et al. 2002) reportedly caused social conflict.

Against a backdrop of rapid and continuing expansion of the sector and much-publicized cases of negative environmental and social impacts associated with inappropriate and poorly planned developments, the debate over the future of aquaculture can become distorted by stakeholder groups with markedly different agendas. As Boyd (1999, 10) noted, "There is a great diversity in the way different people perceive the proper use of natural ecosystems and resources, and their deep-seated feeling [*sic*] often overrule objectivity. . . . Thus, environmental issues are volatile because they are tempered by both strong feelings and opinions." To prevent such distortions, he advocated a rational appraisal of the environmental impacts associated with different production systems, including development and implementation of better environmental management procedures.

Here the potential of the Delphi technique is assessed in conducting such an appraisal, in facilitating the interactive participation of varied and conceivably hierarchical and antagonistic stakeholder groups, and in capitalizing on their knowledge and opinions as a valid input to research in an inexact research area. Strategies to ameliorate negative impacts of waste discharges from aquaculture were elicited from stakeholders, the relative importance ascribed to alternative strategies was investigated, and iterative rounds of the Delphi were used to build consensus. Outcomes of the study were assessed with respect to the potential and degree of agreement on the waste management strategies identified and utility of a Delphi-based approach, as described here, in facilitating interactive participation when assessing aquaculture development or natural resources management among multiple stakeholder groups.

Method

Alternative strategies for limiting negative impacts associated with aquaculture wastewater discharges were elicited from a stakeholder panel; the panel then considered their relative importance, assigning rates to each. At the outset a research question was posed to guide the investigation: "Which alternative strategies do the panel believe could limit negative impacts associated with aquaculture wastewater?" A hypothesis was then formulated to assist in analyzing responses from the stakeholder panel; it was expected that improved treatment technologies would represent the most promising strategy. Questionnaires for the study, summaries provided to participants, and a more extensive description of the analysis are presented elsewhere (Bunting 2001b).

Questionnaire Formulation

The first-round questionnaire was written specifically to address the aims of the investigation. Prior to distribution to the panel, a small number of colleagues were asked to provide feedback on content and presentation. This demonstrated that asking for alternative wastewater management strategies elicited broad responses

such as "better management" and "appropriate controls"; therefore, four subcategory headings: institutional, managerial, socioeconomic, and technological, were incorporated to elicit more specific responses. These subcategory headings were used as they adequately described responses from the pilot study.

Participant Selection and Instruction

The piloted first-round questionnaire and research aims were presented to prospective panel members, allowing them to assess their competence to participate. Prospective participants were selected based on authorship of peer reviewed publications dealing with aquaculture development; working in an aquaculture-related regulatory, consultancy, or research capacity; and production system management. Approximately 40 individuals were contacted directly and a total of 24 individuals responded in the first round. Of the initial respondents, 71% were researchers, 13% managed production facilities, 8% worked for regulatory bodies, and 8% were consultants. Considering geographical distribution, seven were from the United States, six from Scotland, and two from Brazil, with single representatives from Australia, Canada, Chile, Korea, Malaysia, New Zealand, Nicaragua, Singapore, and Taiwan. Although the statistical tests selected to assess outcomes of this Delphi investigation require a minimum of three paired samples, that is, three panel members, previous studies employing this approach commonly elicited the opinion of panels with 15–60 members (Hasson et al. 2000). It was anticipated that a similar number of participants would respond to this study. To avoid leader bias, the identity of those responding was concealed from other panel members. Three rounds were found necessary to elicit strong agreement among the participants.

Round 1

Panel members were requested to suggest alternative strategies for limiting negative impacts associated with aquaculture wastewater discharges. Strategies suggested were grouped under representative headings, where possible retaining wording used by participants. In previous studies, factors suggested by less than a specified proportion of the panel members were discarded (Caffey 1998). However, in this study no responses elicited during the first round were rejected. This approach was adopted to avoid biasing the study toward majority-held beliefs and opinions and permitted individual participants to express unique points of view for evaluation by other panel members during subsequent rounds.

Round 2

The second-round questionnaire, summarizing alternative strategies suggested by participants, was sent to all respondents from the first round. Alternative strategies were listed under the respective subcategory headings with the frequency with which they occurred. Participants were asked to rate the importance of each strategy between 1 and 10, with higher values signifying greater importance. Responses for the second round were collated and mean values and interquartile ranges for rates were calculated. During the second round 19 replies were received, a response rate of 79%.

Round 3

Second-round responses were summarized in tables and sent to panelists who replied during round 2. Mean rates and interquartile ranges were given for the alternative strategies, together with the original narrative description. Participants were requested to either accept the mean or suggest an alternative rate based on their own perception. Where participants wished to assign a rate outside the interquartile range, they were asked to provide a statement justifying their decision. During the third round the response rate was again 79%, with replies from 15 participants.

Analysis

Although the nonrandom selection of participants might be expected to result in responses demonstrating nonnormal distribution, this should be tested prior to selecting a nonparametric test. The normality of responses from participants in round 2 was assessed using the Kolmogorov–Smirnov test and for four of the strategies was found to be non-normally distributed ($p < .05$). Transformation to attain a normal distribution was not possible; it was decided not to exclude outliers from the analysis, as in the context of the study even extreme views were treated equally. Consequently, the nonparametric Friedman's test was selected for the analysis. Friedman (1937, 675) described the rationale and application of this test and noted that "the normal distribution is likely to be the exception rather than the rule" when dealing with social and economic data, and that "This difficulty can be obviated, however, by arranging each set of values of the variate in order of size, numbering them 1, 2, and so forth, and using these ranks instead of the original quantitative values.... In this way no assumption whatsoever need be made as to the distribution of the original variate."

Friedman's null hypothesis (H_0) assumes that each ranking of random variables within a block is equally likely. However, the nature of the Friedman's test statistic means that the null hypothesis tends to be rejected in the presence of slight rank correlation, and the test provides no indication of the degree of agreement between ranks (Caffey 1998). Confidence in the degree of agreement within identified rank patterns was therefore elicited using Kendall's coefficient of concordance (W). Schmidt (1997) recommended this measure of rank convergence, or agreement, ranging from 0 to 1, for interpreting data generated by Delphi investigations to provide information on the degree of consensus or agreement achieved and level of confidence with which mean ordinal ranks may be considered. Accordingly, a Kendall's W of 0.1 is indicative of "very weak" agreement and confidence levels in ranks of "none," values of 0.3 and 0.5 indicate "weak" and "moderate" agreement, respectively, with confidence levels of "low" and "fair," respectively, while values of Kendall's W of 0.7 and 0.9 correspond to "strong" and "unusually strong" agreement, respectively, with confidence levels of "high" and "very high," respectively (Schmidt 1997).

Although it provides an indication of the degree of convergence observed in Delphi survey data, and a level of confidence with which ranks may be regarded, Kendall's W fails to provide any indication of the relative importance that participants ascribe to alternative strategies. Caffey (1998) employed a distance function approach to assess the actual consensus order of ranked preferences and indicators. However, his comparison with mean ranks calculated from cardinal weights of individual indicators showed only slight differences; therefore, it was considered acceptable to use mean ranks to describe the relative importance attached to alternative strategies by participants.

Table 2. Strategies proposed by participants to reduce negative impacts associated with aquaculture wastewater, the frequency of occurrence in round 1 (n) and both mean rate (x) and mean ordinal rank following round 3

Factor	n	x	Rank
Managerial			
Management procedures that improve water quality, e.g., careful feed management, de-sludging lagoons, aeration, and harvesting strategies that minimize discharges	5	8.1	1.5
Good planning prior to developing aquaculture facilities and improved site selection	3	8.1	1.5
Adoption of a more holistic/systematic paradigm for aquaculture	2	6.7	12
Adopt extensive as opposed to intensive management practices	1	3.8	18
Institutional			
Encourage collaboration between researchers and commercial enterprises	3	7.9	3
Better education of farmers regarding water quality and environmental management	3	7.1	6
Provide information and direction to government regarding opportunities for the innovative management of aquaculture wastewater	2	7.1	7
Increase and enforce discharge standards for wastewater or implement a pollution tax	3	6.9	10
Open some commercial operations for public tours	1	6.1	15
Technological			
Increase research and development into improved treatment technologies	7	7.5	4
Improved feed quality and lower feed conversion ratios	5	7.3	5
Develop systems for water reuse	6	6.6	13
Develop new vaccines and improve disease control	3	5.2	17
Socioeconomic			
Improve evaluation of benefits associated with management practices that reduce environmental impact	2	7.0	8
The need to portray a positive image will necessitate improved waste management	1	6.9	9
Look at the energy costs of typical intensive production systems	1	6.6	11
Educate the public and managers regarding recycling systems	1	6.5	14
Government funding, e.g., subsidies, grants, and tax relief, to encourage research and development	2	6.1	16

Results

Results summarized here include the nature and distribution of alternative wastewater management strategies submitted in round 1, mean rates assigned to alternative strategies following round 3, and associated mean ranks. Patterns in the ranked distribution of rates assigned by participants were identified and the degrees of convergence in responses following rounds 2 and 3 were evaluated.

Alternative Strategies for Aquaculture Wastewater Management

First round participants responded with 51 short statements describing alternative strategies for limiting negative impacts associated with aquaculture wastewater. These alternative strategies were aggregated under 18 distinct headings, summarized in Table 2. Five were mentioned by single panel members, while two proposed in the technological category, "increased research and development into improved treatment technologies" and "develop systems for water reuse," were mentioned by seven and six participants, respectively. Distribution of responses among subcategories showed that four alternative strategies were submitted in both the managerial and technological subcategories, while five were submitted in both the institutional and socioeconomic subcategories.

Mean rates assigned to the alternative strategies after round 3 ranged from 3.8 to 8.1. The lowest mean rate was associated with "adoption of extensive as opposed to intensive management practices," and the highest with two strategies submitted in the management category: "management procedures that improve water quality e.g., careful feed management, de-sludging lagoons, aeration and harvesting strategies that minimize discharges" and "good planning prior to developing aquaculture facilities and improved site selection." Two management strategies with mean rates of 8.1 received an overall rank of 1.5, indicating their equal importance to participants. The most important strategies in the institutional, technological, and socioeconomic subcategories received mean ranks of 3, 4, and 8, respectively, and were "encourage collaboration between researchers and commercial enterprises," "increased research and development into improved treatment technologies," and "improved evaluation of benefits associated with management practices that reduce environmental impact."

Confidence and Convergence in Rank Patterns After Round 2

Application of Friedman's test in assessing the distribution of rates assigned by each participant identified similar rank patterns for alternative strategies following round 2 of the investigation ($p < .001$, two-tailed) (Table 3). However, despite the presence of rank patterns, Kendall's W calculated for ranks assigned to alternative

Table 3. Values for Friedman's χ^2_F at probability levels (p) indicated and Kendall's W for rates assigned to alternative strategies in rounds 2 and 3

Round	Friedman's χ^2_F	(p)	Kendall's W	Agreement	Confidence
2	59.2	<.001	0.205	Weak–very weak	Low–none
3	174.4	<.001	0.733	Strong	High

Table 4. Friedman's χ^2_F at probability levels (p) indicated and Kendall's W for rank patterns in rates assigned to alternative strategies following round 3

Subcategory for alternative strategies	Friedman's χ^2_F	(p)	Kendall's W	Agreement	Confidence
Technological	33	<.001	0.786	Strong–unusually strong	High–very high
Managerial	32.1	<.001	0.765	Strong	High
Institutional	39.1	<.001	0.697	Strong	High
Socioeconomic	32.4	<.001	0.579	Moderate–strong	Fair–high

strategies was 0.205, indicating that agreement was "weak" to "very weak" and that confidence in defining rank patterns was "low" to "none."

Confidence and Convergence in Rank Patterns After Round 3

Friedman's test on the distribution of rates following round 3 indicated the presence of rank patterns ($p < .001$, two-tailed). Application of Kendall's W indicated that the level of agreement in rank patterns was greater than in round 2, and that the level of confidence in ranking had increased (Table 3). At 0.733 Kendall's W for alternative strategies implied "strong" agreement among participants and a "high" level of confidence.

Rank Patterns and Consensus Within Subcategories

Analyses of rates assigned in each subcategory employing Friedman's test indicated the presence of similar rank patterns for responses from individual participants in all categories ($p < .001$, two-tailed). Rank patterns observed in the institutional and managerial categories resulted in values for Kendall's W of 0.697 and 0.765, respectively, indicating "strong" agreement among participants and a "high" level of confidence (Table 4). Kendall's W for rank patterns in the technological category was 0.786, indicating "strong" to "unusually strong" agreement and signifying "high" to "very high" confidence. A value for Kendall's W of 0.579 for rank patterns in the socioeconomic category indicated "moderate" to "strong" agreement with "fair" to "high" confidence.

Discussion

Attrition constitutes a potential constraint to the stakeholder Delphi; participants contributing value-laden statements and rates in initial rounds may decide not to contribute in subsequent rounds. To avoid this problem several representatives from each stakeholder group should be encouraged to participate, reducing dependence on any one individual. Efforts should also be made to ensure that as few participants retire as possible; this may require additional time and resources being allocated to following up queries and unreturned questionnaires. Sumsion (1998) suggested a response rate of 70% is desirable in each round to ensure the rigor of the investigation, a criterion met in this investigation. However, it is important to consider why some people failed

to respond. In a development context these people might hold the key to success; they may have become disenchanted and frustrated at their inability to influence the majority view but ultimately they might be responsible for passing the law, formulating the policy, or calling for the boycott.

Commitment of participants is a critical factor governing response rates in Delphi investigations, and Hasson et al. (2000) related this to their interest and involvement with the question under investigation. A notable attribute of the stakeholder Delphi described here is the selection of wastewater management strategies for investigation by participants; open questions employed initially provided participants with an opportunity to respond based on their personal knowledge and experience; and encouraging participants to propose strategies for consideration by the panel helps engender ownership of the process. This contrasts with situations where the research agenda is predefined or in group discussions where opinionated or powerful individuals may exploit such a forum to impose their ideas on others, or the views and feelings of less powerful or vocal groups are missed or ignored. Here, where all strategies proposed in the first round were included in the second, all perspectives were given equal consideration; the wide range and scope of strategies submitted by participants also ensured that the study was comprehensive. Moreover, the four highest ranked strategies were distributed across managerial, institutional, and technological subcategories, supporting the need to consider aquaculture development from a systems-based perspective (Muir 1996).

It was hypothesized that improved treatment technologies would represent the most promising strategy for reducing negative impacts associated with aquaculture wastewater. This was rejected, with the greatest importance being associated with management strategies, namely, adoption of management procedures that improve water quality and good planning and site selection prior to development. Refined management practices to improve water quality include improved feed management and delivery; enhanced disease management; improved animal welfare; and modified harvesting regimes (Muir 2005; Bunting 2007). Implementation of enhanced management regimes can represent an efficient and cost-effective approach to waste reduction and improved resource-use efficiency.

Good planning and appropriate site selection for aquaculture development constitute widely acknowledged prerequisites for sustainable aquaculture development, reiterated in the findings of this study. Brugere and Ridler (2004) highlighted the need for enhanced planning for aquaculture development, advocating inclusion of the Delphi methodology to improve the quality of future plans; the case study and critical review of the stakeholder Delphi presented here constitute an important resource in this regard. Participatory planning approaches that engage with the broadest array of stakeholders possible and aim to achieve interactive participation have been developed and tested for fisheries and aquaculture development in floodplain, wetland, and peri-urban areas (Sultana and Thompson 2004; Bunting 2006). Good site selection is increasingly being guided by the application of geographic information systems (GIS) where multiple layers of information can be considered simultaneously. Salam et al. (2003) employed a GIS framework to assess prospects for crab and shrimp farming in Bangladesh; support for similar assessments could be critical for sustainable aquaculture development. However, as access to better sites for aquaculture declines and returns from improved management strategies diminish, other strategies may gain in importance, implying the need for continued reassessment.

Employing the Delphi method to develop sustainability indicators for aquaculture in the southeastern United States, Caffey (1998) reported strong to unusually strong agreement among the panel after round 3. Considering the global perspective of the current study, with participants from 12 countries, it is noteworthy that strong agreement on managerial, institutional and technological strategies was achieved after round 3. Findings presented here have the potential to guide planning, funding, and policy initiatives concerning the amelioration of negative environmental impacts of aquaculture development. Priorities identified by participants could be included in national and regional aquaculture development plans; where such plans are absent, their development should be a priority. Furthermore, findings could conceivably guide national and regional federations and societies, producer associations, and development agencies in formulating guidelines, codes of conduct, and best practices. Development funding should also be targeted at promoting uptake of good management practices and supporting good planning and site selection, as well as sponsoring collaborative demand lead research; potential areas for investigation appear to be ''improved treatment technologies'' (ranked fourth) and ''improved feed quality and lower feed conversion ratios'' (ranked fifth). Enhanced wastewater management constitutes one aspect of moving toward more sustainable aquaculture development. The stakeholder Delphi approach could be invoked to explore consensus on other aspects or indicators of sustainable aquaculture development, including issues of economic viability, resource use, health management and welfare, environmental standards, human resources and livelihoods, biodiversity, post-harvest operations, sector issues, public perception, and social justice.

Agreement reached concerning prospects for socioeconomic strategies was only ''moderate–strong'' after round 3. Possibly reflecting different social settings and economic realities encountered by participants, further analysis of the socioeconomic strategies proposed and their influence on aquaculture development in different countries and regions seems warranted. However, because of inherent differences in socioeconomic status and expectations among stakeholders it may be that strong or unusually strong agreement is an unrealistic goal. Areas of ambiguity and, more significantly, disagreement highlighted during a stakeholder Delphi demand further investigation. Tools for achieving greater depth of understanding might include alternative participatory approaches, key informant and household interviews, focus groups, or a more focused stakeholder Delphi, but limitations outlined in Table 1 will apply.

The stakeholder Delphi presented here marks an important departure from the traditional Delphi approach where experts would constitute the panel. Previous studies have emphasized the importance of selecting a panel of experts for Delphi investigations. Hasson et al. (2000) discussed the validity of the term ''expert'' as applied to participants in Delphi investigations and instead referred to ''a panel of informed individuals,'' a term McKenna (1994, 1221) invoked to describe participants in a Delphi investigation regarding nursing practices. As this study was aimed at identifying and assessing alternative and innovative wastewater management strategies, it was considered important to include people with a range of backgrounds, with knowledge and experience of policymaking, regulation, environmental protection and advocacy, commercial aquaculture production, and research and development. Additionally, concerning aquaculture development, stakeholders not regarded as experts can nevertheless be highly influential, or can have an agenda that may constrain or enhance prospects for development. This widened the debate,

elicited a broad range of strategies for consideration, and tested the Delphi methodology in generating consensus among diverse multidisciplinary stakeholder groups.

In a development context the pitfalls of taking the opinion of experts as the truth is widely recognized. This constitutes a fundamental difference between the traditional Delphi approach and the stakeholder Delphi described here. Participants in a stakeholder Delphi by definition have a vested interest, but may well possess different degrees and types of knowledge; the stakeholder Delphi is one means of structuring joint analysis and learning, building dialogue, and forming the basis of action planning or resource allocation. There are limitations to the participation of poor and vulnerable groups directly in a stakeholder Delphi structured in the manner presented here; however, with appropriate facilitation and development of participatory approaches these hurdles can be overcome. Focus groups during each round of a stakeholder Delphi with poor and vulnerable groups, especially women, children, and the elderly, could provide feedback, and, using appropriate visualization and scoring activities, ensure their views are given equal weight in the process. Punch et al. (2002) employed focus groups with women and children to explore livelihood strategies and coping mechanisms to ensure that their perspectives were included in action plans for enhanced water management in peri-urban East Kolkata Wetlands. Furthermore, assessing risk perceptions associated with aquaculture development in Australia, Mazur and Curtis (2006) highlighted the need to consult with both key stakeholders and the "wider public" to guide aquaculture planning and management; focus groups could be employed to integrate perceptions of the wider public into stakeholder Delphi studies.

Considering the diverse backgrounds and knowledge of participants in this study, prospects for reaching consensus may have been considered poor. However, following the third round, rank patterns had emerged in all subcategories demonstrating at least "moderate–strong" agreement and "fair–high" confidence. The focus of this Delphi investigation, with respect to both research area and participant selection, has implications for interpreting the results. It could be argued that selecting participants from a particular geographical region or having experience with a certain culture system may have resulted in stronger consensus.

As investigations become more focused, the demands and expectations of participants could become more personal and value-laden. For example, if one or more participants displayed a disregard for environmental protection or an ideological objection toward aquaculture, then prospects for even "moderate" agreement might have been limited here. The current study could be criticized for not including such people and for not having representatives from user groups who may be negatively affected by aquaculture wastewater discharges, or nongovernmental organizations (NGOs), environmental groups, and consumers organizations. Participation of such groups might have led to the proposition of more varied management strategies and resulted in different mean ratings and rankings. Future studies should strive to engage the widest selection of stakeholders possible. The stakeholder Delphi process would then make the views of different groups explicit, with participants having to justify their position, and the implications of this could then be addressed.

A criticism of traditional consensus-building methods, which the Delphi methodology was designed to avoid, is that open debates regarding emotive issues become distorted by the opinions of participants with markedly different agendas. Discussions involving stakeholders with differing agendas may cause concerns and

grievances to become explicit, leading to conflict. Discussing her experiences in a stakeholder workshop Punch (2001, 20) noted that "Some also saw the workshop as an opportunity to express previous grievances . . . within the first half an hour a heated argument broke out." The Delphi technique aims to avoid conflict as the quasi-anonymity of participants is ensured and emotive language tempered through the formal submission of statements in the first round, although value-laden statements are not excluded. Eliminating conflict using the stakeholder Delphi and avoiding confounding influences such as leader bias could help develop constructive dialogue among participants with differing perspectives and could assist in formulating mutually acceptable outcomes and reaching consensus. However, having guaranteed anonymity, the need for a transparent and trustworthy process that avoids accusations of bias, unfairness, or cheating becomes paramount; the standing of the facilitator or coordinating organization will be critical. Additional measures: adequately reporting the data and methods invoked to permit replication; peer review; clear description of the panel to permit an assessment of the relevance, reliability, and composition of respondents should be taken to further ensure confidence in findings. Haylor et al. (2003) included a list of participants who evaluated aquaculture service provision in India, enabling assessment of representation, engagement, and relevance.

Consensus is a widely used but often problematic term. On closer inspection, consensus often translates into the absence of dissenting voices or broad, possibly grudging acceptance; seldom is the strength of consensus assessed, it is assumed to be absolute. Consensus often reflects the majority-held belief or perspective, but without considering those that are not in agreement, or may have been excluded, openly or tacitly, there is a danger that development will fail, not gaining the required institutional support that would have enabled success, or not benefiting the poor and vulnerable groups it was supposed to help.

Participants in this study gained an insight to the perceptions of others regarding alternative ways to reduce negative impacts of aquaculture development. Where they disagreed with the majority-held view there was a chance to explain their position to the other panel members, contributing to shared learning and mutual understanding. However, fundamental to the previous discussion is the degree of representation or engagement achieved. According to DFID (2001, section 5.4), "Involving those who stand to win or lose from policy or institutional reform, or who may influence the reform process, helps to make the interests of key stakeholders transparent and to build ownership of the reform process." If communities, interest groups, or stakeholders are not represented, the process is flawed from the outset; only by including all groups and ensuring their voices are heard will shared learning and understanding be achievable. Participation by stakeholders in planning and decision making should be seen as a right; consequently, future application of the stakeholder Delphi should include a preliminary stakeholder analysis to ensure the process is fully representative. The CATWOE approach elaborated by Checkland and Scholes (1999) could help facilitate such a process.

Considering the diverse situations in which aquaculture development occurs, and the varied management systems employed, the stakeholder Delphi is proposed as a potentially useful tool for joint analysis and building consensus among the diverse stakeholder groups that those proposing or implementing such development must engage. The stakeholder Delphi could contribute to more refined joint analysis and consensus building for enhanced natural resources management in other often

complex social and institutional settings, for example, formulating integrated coastal zone management plans for areas, including mangroves and bays, where the multiple demands of stakeholders must be reconciled; planning co-management strategies where different values, interests, and concerns must be recognised (Borrini-Feyerabend et al. 2000); or developing participatory action plans in peri-urban settings where diverse and hierarchical stakeholder groups with markedly different powers coexist (Bunting 2006).

Stakeholder Delphi outcomes can highlight possible areas of conflict, which should be addressed with suitable mediation or resolution strategies; attention should also be given to ensuring the process engages with the full range of stakeholders that could be represented. As a preliminary element of a development project or program the stakeholder Delphi has the potential to avoid planned interactive participation lapsing to a less desirable functional type. Where the process leads to consensus and constructive dialogue, and, as Pretty (1995, 1252) put it, "an enabling framework of support" exists or emerges, then self-mobilization in pursuit of equitable and sustainable natural resources management must be more likely.

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