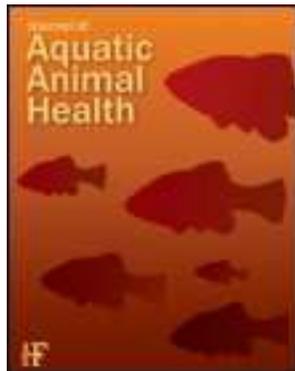


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Fish Disease and Biosecurity: Attitudes, Beliefs, and Perceptions of Managers and Owners of Commercial Finfish Recirculating Facilities in the United States and Canada

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Fish Disease and Biosecurity: Attitudes, Beliefs, and Perceptions of Managers and Owners of Commercial Finfish Recirculating Facilities in the United States and Canada

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Abstract.—In recirculation finfish facilities in the United States and Canada, biosecurity utilization is neither consistent nor uniform. Seeking reasons for this situation, we examined the beliefs, perceptions, and attitudes of managers and owners of such facilities about fish disease and biosecurity utilization. A questionnaire was mailed in the fall of 2001 to the managers and owners of 152 finfish-rearing recirculation facilities in the United States and Canada to gather information on their attitudes, beliefs, and perceptions regarding fish disease and biosecurity. The response rate to the survey was 86%. This paper reports on a subset of the overall responses, the responses of managers and owners who identified their facility as a business operation. Although respondents had a positive attitude towards biosecurity utilization, they had different beliefs about which disease types were of greatest concern for their farm. Respondents also had differing perceptions on the risk of disease transmission associated with different activities on their farms. In addition, respondents had various beliefs about the practicality and effectiveness of different biosecurity measures and why the practice of biosecurity was important to their farms. This study gives quantitative evidence that different fish farmers perceive disease and the practice of biosecurity differently. This study indicates that recognition of the human dimensions element is an important first step in the creation of biosecurity policies, strategies, and procedures that will be readily accepted and implemented and consistently applied by fish farmers on their farms. The findings challenge the heretofore traditionally accepted belief that poor biosecurity practice on a farm is primarily related to lack of knowledge about biosecurity.

For political, biological, and environmental reasons, a sustained, consistent practice of biosecurity is becoming an increasingly critical requirement for successful aquaculture (Noble and Summerfelt 1996; Browdy and Bratvold 1998; Timmons et al. 2002; Lee and O'Bryen 2003). Although the need

and importance of biosecurity utilization is widely recognized, the sustained, consistent use of biosecurity practices is not a reality in aquaculture today (Delabbio et al. 2004). In the past, poor biosecurity utilization on farms was assumed to result primarily from a lack of knowledge about biosecurity (Gillespie 2000; Sanderson et al. 2000). However, research by Delabbio et al. (2003) showed that managers and owners of finfish recirculation facilities in the United States and Can-

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ada generally had a high level of formal education, even while there was considerable range in the type and frequency of biosecurity practiced at their sites. In this earlier work, no statistically significant relationship was found between frequency of use of different biosecurity measures and owner/manager level of education. Seeking reasons other than lack of education for poor biosecurity utilization in aquaculture, we were led to the field of human dimensions.

Human dimensions is described as the body of theory and techniques that provide insights and information about the human element in various endeavors (Knuth and McMullin 1996). In fisheries management, the field of human dimensions has expanded dramatically over the last 20 years, with the realization that government agencies and their representatives need to understand the underlying values, perceptions, and beliefs of stakeholders to provide relevant and effective policies, strategies, and management programs that will be applied consistently. The theoretical foundations of human dimensions research propose that human behavior is an outcome of beliefs, perceptions, and attitudes about an activity. In aquaculture, the health of a farmed fish is directly influenced by the actions of its keepers. To date, no research has examined the human dimensions element of biosecurity practice, even though consistent biosecurity utilization (the action of the keepers) is critical to aquaculture success. The purpose of this study was to identify and give quantitative description of the beliefs, perceptions, and attitudes of managers and owners of finfish recirculation facilities in the United States and Canada about fish disease and biosecurity utilization. For clarification purposes, in this study a belief was defined as the acceptance of a fact, opinion, or assertion as real or true, without immediate personal knowledge; a perception was defined as a way of thinking about or considering something, or alternatively, as a set of assumptions from which an object can be viewed; and an attitude was defined as a tendency to respond positively or negatively to an idea, object, action, or person.

The scope of the study was limited to the finfish recirculation sector of aquaculture in the United States and Canada. Accordingly, we acknowledge that the findings represent the attitudes, beliefs, and perceptions of only a select portion of the greater aquaculture community in Canada and United States; therefore, the results of this study must be kept framed within the sector of aquaculture that was surveyed. In this regard, one may

speculate that each sector of aquaculture and perhaps each farm might have its own individual "culture" of beliefs, attitudes, and perspectives about disease or biosecurity. Nevertheless, we believe this study indicates that recognition of the human dimensions element, whatever it may be, is an essential step in developing biosecurity policies, strategies, and procedures that will be readily accepted, implemented, and consistently applied by fish farmers on their farms.

Methods

We mailed a self-administered questionnaire to 152 recirculation finfish facilities in the United States and Canada in the fall of 2001. In our survey, a recirculation facility was defined as an operation that used a biofilter in its fish culture system. To establish our mailing list of recirculation units currently rearing finfish in the United States or Canada, we contacted government aquaculture representatives for each state and province and executive representatives from national associations representing different sectors of aquaculture. In addition, we consulted with feed company representatives and research groups who have professional interaction with the recirculation sector of aquaculture.

The questionnaire and mailing protocol followed a modified version of Dillman's Total Design Method (TDM; Dillman 1978). Six different managers of finfish-rearing facilities representing different components of the sector (industry, research, and demonstration) pretested the questionnaire. Managers provided detailed comments on areas for improvement and identified areas of ambiguity that led to revisions in the questionnaire. The revised questionnaire was then mailed to facilities in the United States and Canada. Three consecutive mailings made during the fall of 2001 included a cover letter, the complete questionnaire, and a stamped return envelope. Respondents who returned the questionnaire were rewarded with an incentive. Each respondent was identified by a randomly assigned, confidential, individual number.

Most of the data collected on the human dimensions aspect of biosecurity utilization were nominal and therefore are reported in the form of percentages. The questionnaire included 61 items on beliefs, attitudes, and perceptions of disease and biosecurity practice, arranged in groups of 10 questions. The questionnaire can be viewed online at <http://scholar.lib.vt.edu/theses/available/etd-05012003-232119/unrestricted/Delabbio.pdf>.

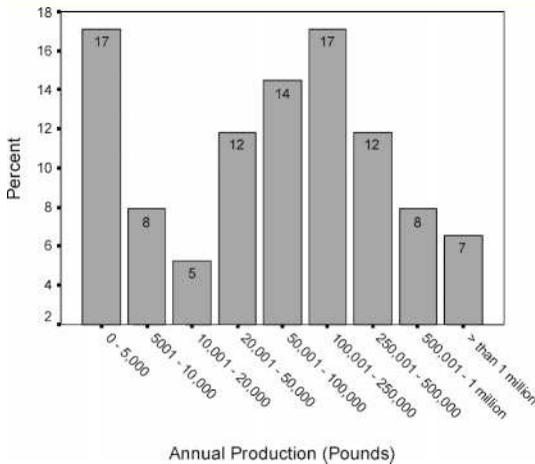


FIGURE 1.—Annual production of commercial finfish recirculating facilities in the United States and Canada, by size class. The numeral on each bar indicates the number of farms in the category.

Results

Background of Survey Respondents

The respondents to the survey, which had an 86% response rate, were the managers and owners of finfish recirculating facilities who identified business as their primary purpose (Delabbio et al. 2003). Sixty-seven percent of respondents were from the United States ($n = 54$) and 33% were from Canada ($n = 27$). Respondents were involved in a variety of business activities: 59% grew fish for the food market, 48% supplied fish for on-growing, 20% sold eggs, 16% produced ornamental fishes, 12% reared fish for stocking, and 11% were involved in other uncategorized business endeavors. In the United States, growing fish for the food market dominated as a business activity among respondents (64.8%), whereas in Canada, supplying fish for on-growing was the predominant business activity (77.8%).

The type of fish reared by the respondents was quite varied. However, four fish types dominated, together making up 71% of the respondents: *Tilapia* spp. culture 25%, Atlantic salmon *Salmo salar* culture 22.2%, ornamental fishes culture 13.6%, and hybrid striped bass *Morone sp.* culture 9.9%. The life stages grown also varied among respondents, with the early life stages being most prevalent (70.4% eggs, 74.1% fry, 97.5% fingerlings, 29.6% smolts, 56.8% adult, 53.1% market fish, and 53.1% broodfish).

The business side of finfish recirculating aquaculture was represented by farms of a variety of sizes. Respondents came from small-, medium-, and large-sized farms; no one class of farm-size dominated the group (Figure 1). Greater than 92% percent of respondents were involved in freshwater aquaculture. A high proportion of freshwater facilities (63%) used pumped groundwater as their primary water source, 12.3% used chlorinated municipal water, 8.6% used spring water, and another 8.6% drew on surface water as their primary water source.

Overall, the managers and owners of finfish recirculation facilities in the United States and Canada were middle-aged, educated men with significant aquaculture work experience. Sixty-two percent of respondents held a baccalaureate degree and had greater than 10 years of work experience in aquaculture. More than half of the respondents (55.4%) fell within the age range 35–50 years, and the mean age of respondents was 43 years.

Questionnaire Responses

Attitude about avoidance of fish disease.—Most managers and owners of recirculation facilities were very concerned about avoiding disease on their farms, though respondents indicated differences about which type of diseases were of greatest concern (Table 1).

TABLE 1.—Responses (%) of managers and owners of commercial finfish recirculation facilities in the United States and Canada to the question “How concerned are you about avoiding disease on your farm? On your site, please indicate the kinds of diseases you are most concerned about.”

Level of concern	Overall concern about avoiding disease	Bacterial diseases	Viral diseases	Fungal diseases	Parasitic diseases
Very high	80.2	57	30.7	27	25.3
High	9.9	22.8	13.3	14.9	20.0
Moderate	4.9	11.4	20	33.8	29.3
Low	2.5	5.1	20	12.2	12.0
Very low	1.2	1.3	8.0	6.8	9.3
None	1.2	2.5	8.0	5.4	4.0
Total	100	100	100	100	100

TABLE 2.—Responses (%) of managers and owners of commercial finfish recirculation facilities in the United States and Canada to the question “For your particular facility, what do you think are the most serious issues or concerns regarding disease transmission?”

Method of disease transmission	Level of concern				Total
	Very serious	Somewhat serious	Not very serious	No concern	
Water supply	16.3	15.0	23.8	45.0	100
New fish	60.5	24.7	11.1	3.7	100
People	35.0	32.5	20.0	12.5	100
Equipment	29.6	38.3	16.0	16.0	100

Perceptions of risk.—The majority of respondents (60.5%) thought that disease coming in with new fish was the most serious disease introduction risk to their farm (Table 2). Many believed that their water supply was adequately protected from pathogen introduction; 45.0% of the respondents reported that disease coming in with the water supply was of no concern.

Beliefs about effectiveness and practicality of different biosecurity measures.—Respondents were asked to evaluate eight biosecurity measures in terms of effectiveness and practicality on their farm (Table 3). Only three biosecurity measures—record-keeping of daily fish mortalities, disinfection of equipment, and isolation of incoming fish—were perceived by more than 50% of respondents to be both very practical and very effective in practice on their farms.

Perceptions of costliness of different biosecurity measures.—Three-quarters of respondents considered record-keeping of daily fish mortalities to be

an inexpensive biosecurity measure (Table 3). Restricted access was also regarded by the majority of respondents as an inexpensive biosecurity measure.

Attitudes about prioritization of biosecurity practices.—Respondents were asked to indicate which biosecurity measures they considered, given time constraints, to be of highest importance while performing their daily husbandry routine (Table 4). The collection of dead fish from rearing units was viewed by 88.9% of respondents to be very important, and three out of four respondents saw checking water flows to be a very important biosecurity practice. Almost all respondents saw some importance to completing biosecurity tasks even when time was limited.

Reasons for practicing biosecurity.—The impact of disease on their business image was perceived by 65% of respondents to be a very important reason for practicing biosecurity (Table 5). Other reasons for using biosecurity measures, such as gov-

TABLE 3.—Perceptions (%) of managers and owners of commercial finfish recirculation facilities in the United States and Canada of the effectiveness, practicality, and costliness of different biosecurity measures to reduce the risk of disease transmission on their site.

Biosecurity measure	Effectiveness				Practicality				Costliness			
	Very	Some-what	Not	Does not apply	Very	Some-what	Not	Does not apply	Very	Some-what	Not	Does not apply
Use of fish health specialists	19.2	39.7	19.2	21.8	26.3	35.0	26.3	12.5	21.3	37.5	22.5	18.8
Restricted access to facility	49.4	29.1	11.4	10.1	45.7	38.3	9.9	6.2	1.3	21.5	57.0	20.3
Isolation of incoming fish	59.5	25.3	3.8	11.4	58.8	22.5	11.3	7.5	12.3	35.8	34.6	17.3
Closed loop of supply (no new fish from outside sources)	43.8	13.8	11.3	31.3	39.5	22.2	18.5	19.8	26.0	27.3	16.9	29.9
Use of chemical treatments on fish prior to stressful situations	30.0	45.0	3.8	21.3	34.6	40.7	8.6	16.0	8.6	40.7	28.4	22.2
Disinfecting incoming water supply	22.8	17.7	17.7	41.8	21.0	16	25.9	37.0	26.3	18.8	8.8	46.3
Routinely disinfecting equipment	58.8	31.3	3.8	6.3	70.4	17.3	6.2	6.2	3.7	32.1	54.3	9.9
Recording daily fish mortalities	52.5	31.3	10.0	6.3	75.3	13.6	4.9	6.2	5.0	13.8	75.0	6.3

TABLE 4.—Responses (%) of managers and owners of commercial finfish recirculation facilities in the United States and Canada to the question “On your site, if you only have a limited amount of time during a very busy day, what do you see as the most important things to get done?”

Activity	Level of importance				Total
	Very important	Somewhat important	Not very important	Does not apply	
Remove dead fish from rearing units	88.9	8.6	1.2	1.2	100
Check water flows	76.5	17.3	4.9	1.2	100
Check dissolved oxygen levels	69.1	12.3	17.3	1.2	100
Clear wastes from rearing units	55.6	28.4	4.9	11.1	100
Disinfect equipment	50.6	30.9	17.3	1.2	100
Check ammonia levels	48.8	31.3	18.8	1.3	100

ernment regulations or previous disease problems on a site, were not viewed with the same significance of importance.

Discussion

This study identifies the human dimensions element of biosecurity utilization in aquaculture and gives quantitative evidence that different fish farmers perceive disease and the practice of biosecurity differently. Acknowledgment of the human dimensions aspect of biosecurity utilization is important in the creation of biosecurity programs, strategies, and policies that will be accepted, implemented, and applied consistently by commercial fish farmers.

Roberts (2003) suggested that for national control programs in biosecurity to have any success, the programs should have realistic objectives. Because it is the farmer who implements and maintains biosecurity practices, it seems reasonable to consider these primary stakeholders' perceptions of “realistic objectives” in the development of biosecurity regulations. Unfortunately, many biosecurity programs have been developed through a top-down approach with consultation and involvement of stakeholders being severely limited (O'Bryen and Lee 2003). Subsequently, tension between regulators of biosecurity programs and

practitioners in the field is not uncommon (O'Bryen and Lee 2003).

Related to this issue is the fact that government regulations in aquaculture, particularly in the area of disease control, have increased in the past decade (Cullinan and Van Houtte 1997; Scarfe 2003). Alderman (2003) observed that many people see government control and regulations as the most effective method to ensure biosecurity utilization. The results of our study challenge this precept. Although adherence to government regulations had some influence on the use of biosecurity on a farm, the survey respondents perceived the business advantages of biosecurity utilization, such as maintenance of a good business image or the ability to move fish off-site, to be more important reasons for biosecurity utilization. Thus, this study suggests that framing biosecurity utilization in a context that is relevant and significant to the user may ensure biosecurity utilization more substantially than further increasing government regulation of biosecurity.

In terms of improving on existing biosecurity programs, it has been suggested that, as in any remedial exercise, awareness of the existing condition is the first step toward the development of intervention strategies (Janz and Becker 1984). In other areas of agriculture, research has shown that

TABLE 5.—Responses (%) of managers and owners of commercial finfish recirculation facilities in the United States and Canada to the question “There are many reasons why a farm may use preventive procedures against disease. How important are these reasons for your farm?”

Reason for using biosecurity measures	Level of importance				Total
	Very important	Somewhat important	Not very important	Not at all important	
Disease affects the image of your business	65.4	14.8	9.9	9.9	100
Disease affects fish movement	50.6	13.9	10.1	25.3	100
There are disease problems in the area	27.5	32.5	20.0	20.0	100
Site has had problems with disease in the past	23.8	21.3	21.3	33.8	100
Government regulations impose certain practices	21.3	36.3	23.8	18.8	100

understanding the perceptions of farmers with respect to disease risk and control has been very important in the development of effective intervention strategies (Dujkhuisen et al. 1994). In the past, the prescribed approach to remedying lack of biosecurity utilization on a farm was to provide more technical information to the farmer about disease and biosecurity measures (Lotz 1997; Jory 2001). The current study suggests that this approach may be limited in its effectiveness if the farmer's perception of disease risk differs from that of the information provider or the farmer does not value the biosecurity measures as effective or practical. Experts studying risk perception argue that how people feel about a particular risk is itself the most important risk to assess, because that perception is in fact reality to the stakeholder (Fischhoff et al. 1978; Slovic 1987; Freudenburg 1988). It is therefore important that fish health specialists and extension agents working on farms be aware of farmers' perceptions of disease risk and biosecurity to work effectively with them in achieving biosecurity objectives. The human dimensions element of biosecurity utilization must be considered and integrated into the educational process.

Finally, if the existing beliefs, perceptions, and attitudes of farmers about biosecurity are to be changed to support higher levels of adherence and consistency in application, then research on biosecurity measures must evolve. One of the major deficiencies in biosecurity research in aquaculture today is that, except for vaccine application, there is very little information indicating the degree of effectiveness (value) of different biosecurity measures in actual farm situations. With the current paucity of information on this topic, fish farmers have been left to develop a multitude of perceptions, possibly faulty ones, on the effectiveness and benefits of different biosecurity measures. Cost-benefit analysis of different biosecurity measures is needed so that biosecurity utilization can be presented to the farmer as a business investment, not as an uncertain expense.

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