Developing environmental guidelines for freshwater aquacultural operations: A case study

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Summary

This paper reviews the progress towards the development of environmental guidelines for freshwater aquacultural concerns in the Western Cape. The guidelines are the product of over two years of collaborative work by a wide spectrum of individuals and organisations, both government and non-government, towards a common goal - efficient production of farmed aquatic species with minimal impact on freshwater aquatic ecosystems in the Western Cape. Particular attention is given to procedures which facilitated co-operation between the interested and affected parties. Our experience is documented in detail in order to provide other groups embarking on similar exercises with some assistance and direction. In accordance with this aim a number of recommendations, based on our experience, are provided.

Introduction

> "*Conflict of interest is a phenomenon that varies depending on the eye of the beholder. Many individuals feel that they can be very objective in areas of their expertise, regardless of affiliations, financial interest, intellectual passions, and so forth. Their opponents usually regard such claims with scepticism.*" (Koshland, 1992).

In September 1993, the Department of Agriculture in the Western Cape announced their *Guidelines for Freshwater Aquaculture in the Western Cape* (Table 1). These are management and water quality guidelines aimed at serving the freshwater aquacultural industry, facilitating procedures for new entrants to the industry and minimising its impact on the natural environment, particularly the aquatic environment. The guidelines are the product of over two years of collaborative work by a wide spectrum of individuals and organisations, both government and non-government, towards a common goal - efficient production of farmed aquatic species with minimal impact on freshwater aquatic ecosystems in the Western Cape.

The organisations involved in producing the guidelines included:

- Department of Agriculture, the lead agency for freshwater aquaculture
- Department of Water Affairs and Forestry (DWAF), responsible for maintaining the water quality in the rivers
- Cape Nature Conservation (CNC), responsible for protection of the natural environment
- Trout Producers Association (Cape)
- Aquaculture Research Programme, Genetics Department, University of Stellenbosch
- Freshwater Research Unit, Department of Zoology, University of Cape Town (UCT), involved in investigating the effects of trout-farm effluent on the downstream rivers
- Division of Agricultural Engineering, Department of Agriculture, Pretoria.

This paper documents the progress towards formulating these guidelines. It is hoped that by describing that process, the pitfalls encountered and the solutions employed, we will provide other groups embarking on similar exercises with some assistance and direction.

At present, freshwater aquaculture in South Africa is dominated by the culture of rainbow trout, *Oncorhynchus mykiss*, which is produced in land-based or cage-culture production units. Although the final guidelines are applicable to all commercial freshwater aquacultural ventures, trout farms, in particular land-based trout farms, were the primary focus during their formation. Consequently, the bias towards trout farming, as opposed to other forms of freshwater aquaculture, is reflected in this paper.

Definitions

Aquaculture may be defined as the cultivation and harvest of aquatic organisms for commercial utilisation (Safriel and Bruton, 1984).

Water pollution has been defined by the World Health Organisation as "the impairment of the suitability of water for some considered purpose" (International Standards Organisation, 1980) and, for the purpose of this paper, the term *pollutant* is taken to mean "any entity whose addition to an aquatic ecosystem by humans or their activities actually or potentially changes the characteristics of the system such that the natural biota of that system are adversely affected" (from Hart and Allanson, 1984)

Finally, **guidelines** are standard principles by which to determine policies or actions (*Collins Concise English Dictionary*, 1978).

Background

Trout farming in the Western Cape

Commercial trout farming began in the Western Cape in the early 1980s and by 1990 the region was producing some 550 t, almost

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45% of South Africa's trout production (Brink and Bekker, 1991). The industry showed a 30% growth rate between 1985 and 1990. In 1988, 72% of the aquacultural concerns in South Africa were between one and five years old (Brink and Bekker, 1991), several of these in the Western Cape.

The rapid growth of commercial trout farming in South Africa, in general, and in the Western Cape, in particular, outstripped legislation designed to protect the aquatic environment. No guidelines and very few permit systems were in place to advise and assist the farmers. Furthermore, aquaculture, like other intensive production activities, was classified as an industry (Amendments to the Water Act, 1984) and trout farmers did not have access to the sort of assistance given to farmers by the Department of Agriculture, such as extension and support services. The result was confusion on behalf of trout farmers as to their legal rights and what was expected of them, particularly with regard to the environment. In 1990, however, aquaculture was recognised as a farming activity (Nel, 1990) and, in 1993, it became the responsibility of the Department of Agriculture (Water Amendment Act No. 92 of 1993), thereby entitling trout producers access to the services available to other agricultural practices in their area.

An important consequence of the change in legal status was that the control over the quality of trout-farm effluents fell under agricultural law, namely the Conservation of Agricultural Resources Act 43 (1983) and the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act 47 (1947). Problems arising from pollution caused by trout-farm effluents can, however, still be dealt with under Section 23 of the Water Act 54 (1956), which states that effluents entering rivers ".... may not render the water less fit ..." for other uses. Farms situated in designated Mountain Catchment Areas, are a case in point. These areas fall under the Mountain Catchment Areas Act (1970) administered by the Department of Environment Affairs (DEA) and, through a process of devolution, Cape Nature Conservation. In designated mountain catchment areas, the jurisdiction of the Conservation of Agricultural Resources Act (1983) is excluded, but both Section 23 of the Water Act (1956) and the Fertilisers, Feeds and Remedies Act (1947) still apply.

Environmental impacts on river ecosystems

In the Western Cape, many land-based production units are situated on upper rivers or mountain streams. These reaches have low buffering capacity (Davies and Day, 1986), sensitive biota (King, 1981) and small flows, except when in spate, and hence low dilution capacities in dry seasons. Effluents from trout farms can have a detrimental effect on the aquatic ecosystems with which they are associated (e.g. NCC, 1990; Brown, 1992) and their impact on the aquatic environment has, for some years, been a major cause for concern in the northern hemisphere (Karr, 1981), the Western Cape and Mpumalanga.

The potential disturbances, and the results thereof, associated with aquaculture include the impact of water abstraction (in the case of land-based farms); nutrient enrichment (nitrates and phosphates); stimulation of algal and macrophytic growth; particulate organic enrichment (uneaten food and faeces); increased bacterial densities and increase in suspensoids; presence of toxins (nitrite and ammonia, present in uneaten food and faeces) and reduced oxygen concentrations. Of these, organic enrichment, in the form of suspended solids, is probably the most damaging to downstream river ecosystems (Brown and King, in press).

The amount of solids generated by cage-culture farms is generally recognised as being higher than those from land-based concerns because of a tendency for less efficient use of food by caged fish (Beveridge, 1987). Cage farms also pose a high risk of nutrient enrichment which can lead to eutrophication (NCC, 1990).

Other dangers include the escape of invasive exotic species and the subsequent effects on the native biota of the rivers in the region.

The influence of fish diet and management practices on fish farm effluent

"There exists a close relationship between fish diet and the constitution of fish-farm effluents. The quality of fish feed plays a major role in determining the amount and characteristics of fish-farm effluent. The formulation and manufacture of the food pellets, and the feeding methods employed on the farms all play an important role in this respect. Dietary control has been demonstrated as an efficient and cost-effective means of limiting ammonia and other soluble wastes (Henderson, 1988) and there is considerable scope for reducing phosphorus loadings (Matty, 1990). Fish that were fed on so-called 'low-pollution' diets showed better food conversion ratios, faster growth rates and greater resistance to disease than those fed on 'normal' diets (Phillips et al., 1988; Roberts, 1989)" (from NCC, 1990).

In the Western Cape, good management practices, such as not over-loading the lentic systems, and the upgrading of feed quality have, under experimental conditions, resulted in improved feed-conversion ratios for cage culture (Stellenbosch University, Aquaculture Research Project, unpublished data).

Other users of the upper rivers in the Western Cape

The DWAF policy of Receiving Water Quality Objectives (DWAF, 1991) recognises that the quality of effluent entering rivers should be determined by the requirements of the downstream users. Riverine ecosystems have also been recognised as water 'users' in terms of the above policy. As a result the water quantity and quality requirements for maintenance of the riverine biota now need to be taken into consideration when allocating water from impoundments or setting standards for effluent discharges into rivers. The policy changes make provision for site-specific standards for effluents that may be either less or more strict than existing Uniform General and Special Effluent Standards (Amendments to the Water Act, 1984; DWAF, 199 .).

Apart from the downstream biotic communities there are several other "users" of rivers that receive effluent from trout farms. These include the trout-fishing fraternity, represented in the Western Cape by the Cape Piscatorial Society, and recreational hikers (much of the catchment area of these rivers falls within state forests, wilderness area or nature reserves). Also requiring consideration are hotels and resorts situated on the river banks, farmers who abstract water for irrigation and communities living near the rivers that rely on the water therein for domestic purposes, including drinking water. Finally, in many instances, these rivers feed DWAF storage dams that supply water to metropolitan areas, and the increased nutrient levels increase the risk of eutrophication and toxic algal blooms. The latter is likely to become increasingly important as more and more of the rivers in the Western Cape are impounded (NSI, 994).

Chronicle of events leading up to the formulation of the guidelines

The chronology of meetings, workshops and other events leading up to the production of the guidelines is depicted in Fig. 1. Figure 1 also illustrates the number of times environmental issues

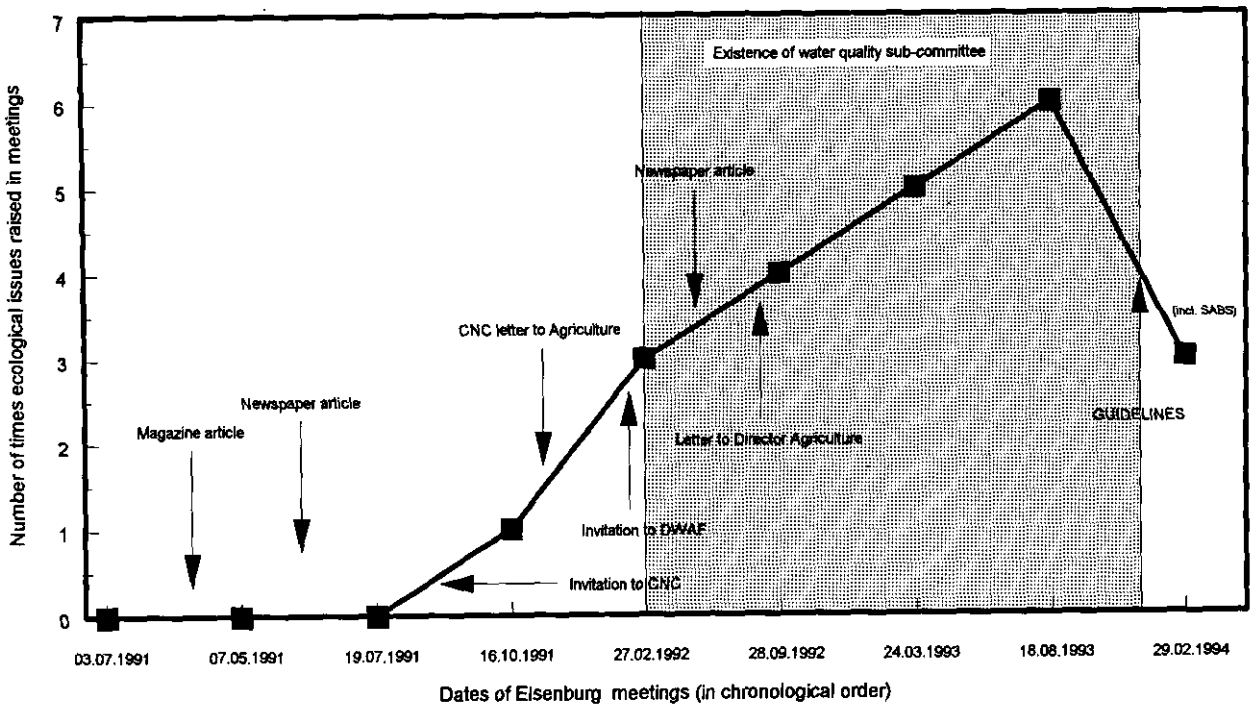

Figure 1

The chronicle of events leading up to the formulation of the guidelines and the relationship between the number of times ecological and other issues were raised during meetings of the Freshwater Aquaculture Working Group (1991-1994)

were raised during the meetings that took place, compared with other issues, such as extension work, research and management issues. Representatives of conservation bodies were not involved in the initial meetings and environmental issues received little attention. However, during 1992 the environment became an important point on the agendas of these meetings. The environmental impacts associated with trout farming moved from a situation in which little or no concern was expressed, or at least insufficient to warrant documentation in the minutes, to one where discussion on possible mitigation of these impacts took up more than half of the time at the working-group meetings. It is, however, important to note that the meetings continued to devote a considerable amount of time to other aquaculture-related issues.

The formulation of the guidelines was merely one of the results of better co-ordination and co-operation between aquacultural interests in the Western Cape:

- During **1990** aquaculture became the responsibility of the Department of Agriculture
- **Early 1991** saw the appea.rance of several situation articles in newspapers and magazines, highlighting alleged negative impacts that some trout-farming concerns were having on rivers.
- In **1991,** the Freshwater Aquaculture Working Group of the Western Cape was formed. The stated objectives of the group were to provide guidance and advice to the industry and development agencies, with regard to the promotion of various enterprises within the industry, and to seek solutions to the problems which hamper efficient production in existing enterprises (Walters, 1991).
- In **early 1992,** informal workshops were conducted with the managers of two trout farms in the region. During these workshops the methods for collecting the information used to assess the effect on the river ecosystem were demonstrated.
- A formal workshop on water quality, under the auspices of the Department of Agriculture, was held on **30 September 1992,** and the following papers were presented: Brink and Swart (1992), Purser and O'Sullivan (1992), Hamman et al. (1992), Coxhill (1992) and (Brown, 1992).
- The Regional Aquaculture Task Team was established by the Aquaculture Working Group on **29 October 1992** in order to draw up guidelines for aquaculture in the Western Cape.
- On **2 August 1993,** a second formal workshop, also under the auspices of the Department of Agriculture, was held on pigmentation and vitamin requirements of trout.
- On **16 September 1993,** the draft guidelines were sent to all freshwater aquacultural production units in the Western Cape for their information and voluntary implementation (Table 1).

The learning curve

Botha and Huntley (1989) stated that guidelines will operate more effectively in a context in which individuals and groups have the opportunity to express their aspirations, and in which open negotiation concerning the resource is facilitated. Taking consideration of this, the *Guidelines for Freshwater Aquaculture in the Western Cape* were produced by a group of people drawn from a wide range of professions and organisations, brought together by the Department of Agriculture as part of their facilitation of aquaculture in the Western Cape. As would be expected, there were differences of opinions, agendas and priorities, which at times threatened to derail the entire process. That the guidelines were eventually produced was, in our opinion, attributable to several positive factors. These are:

TABLE 1
THE GUIDELINES FOR MANAGEMENT AND MAINTENANCE OF WATER QUALITY IN THE COMMERCIAL PRODUCTION OF FRESHWATER SPECIES IN THE WESTERN CAPE

Guidelines for freshwater aquaculture in the Western Cape

Management

- All applications for, and extensions to, an aquaculture venture shall be processed through the Department of Agriculture, who will determine conditions in accordance with Act 43 of 1983.
- Aquacultural development will be considered in accordance with loading capacity assessments of river systems by the Department of Agriculture.
- A permit is required from Cape Nature Conservation for transport, sale and importation of approved live organisms, including eggs of such organisms in accordance with Ordinance 19 of 1974.
- Adequate precautions must be taken to prevent farmed species from being introduced into rivers.
- Precaution must be taken against predation by indigenous birds and animals, which may not be killed or captured without a permit issued by Cape Nature Conservation.
- There shall be no processing of fish on site without the approval of the relevant authorities, for example, Department of Health and Population Development, and Regional Services Council.
- Any chemical substance, feed or fertiliser used, must be registered under Act 36 of 1947, some medications must be registered and are controlled under Act 101 of 1966.
- Incidents of unnatural fish mortalities and pollution on the farm or water course shall be reported immediately to the Department of Agriculture and the Department of Water Affairs and Forestry, as required by law.

Water quality

- The flow of water in the river, past the water intake point in the facility, shall be sufficient to maintain the natural biota.
- The cleaning/desludging/disinfection of fish ponds and processing of fish shall be conducted in such a way that no contamination of the water-course takes place.
- The outflow from the production ponds shall be discharged into a settling dam or any other approved filtration system to contain the settleable material, before discharge into the water course.
- The quality of the effluent disposed of shall be monitored by the Department of Agriculture with pH, conductivity, ammonia, TSS (total suspended solids) and phosphate as indicators or any other variable that may be necessary.
- The production premises and facilities shall be protected against storm-water runoff into a river.
- With regard to rivers in upper mountain catchment areas, special precautions will be considered when application is made.

- Shortly after the Department of Agriculture acquired the responsibility for aquaculture, Elsenburg Agricultural Development Institute appointed an aquaculturist to co-ordinate the industry in the Western Cape and to undertake research and extension. This meant that there was a single person with whom all the parties could liaise
- All interested and affected parties were involved
- The task team established to develop the guidelines only involved representatives of the major role-players and was therefore a smaller, more effective group which reported back to the main committee
- The workshops fulfilled two main roles, namely, education about aquaculture in general, and providing structured time for people to air their views.

Perhaps the single most valuable attribute of the people involved in producing the guidelines was that they were able to form a mutual understanding of each other's positions, which enabled them to work effectively as a team.

Further work in Western Cape

In the past, new aquaculture developments and extensions to existing concerns required applications to be submitted to a number of different authorities, for example DWAF and CNC. The guidelines, however, make the Department of Agriculture a "one-stop shop" for the farmers, with that department taking the responsibility for liaising with the other government departments. There remain, however, several unresolved issues. These include the following:

- Clearly defined channels for applications are needed, as well as transparency of decision-making. This is particularly so with respect to cage-cultures in public waters, and developments in Mountain Catchment Areas.
- Additional guidelines are needed for cage-culture production.

Once the above issues have been resolved, they will be included, along with the *Guidelines for Freshwater Aquaculture in the Western Cape* (Table 1), in a booklet which provides detailed explanations of the protocol for applications and the reasons for each of the guidelines, relevant to the Western Cape.

A further development is a co-operative venture initiated between the Western Cape Department of Agriculture and the Freshwater Research Unit, UCT, to design and evaluate a device to remove suspended solids from the effluent of a farm in the region, and to monitor the downstream river.

Discussion and recommendations

Discussion

The co-operation between relevant government departments and the Western Cape trout producers in drawing up environmental guidelines which filled a gap in current legislation, was in keeping with a discernible shift in business attitudes in South Africa towards environmental management, where environmental, technical and financial considerations are integrated (Smuts and Hobbs, 1989).

The development of these guidelines is an on-going process. They are open to review and can be altered as and when information on improved management techniques, feed manufacturing or the reactions of the environment to trout-farm effluent becomes available. For example, a report on a three-and-a-half year investigation into the effects of trout-farm effluent on upper river reaches in the Western Cape is due in April 1995, and its main findings will, in all likelihood, be incorporated into the guidelines.

In the Western Cape, it has been shown that it is possible for diverse parties with conflicting interests to work together and reach consensus. Guidelines, however, by their nature, depend on continued co-operation and goodwill among all parties concerned, and in order to be effective they must be understood by, and made accessible to, all the producers of aquacultural products.

Recommendations

Interest shown in the Western Cape guidelines for freshwater aquaculture by other regions suggests that similar guidelines will in future be produced for other parts of the country. There are, however, several problems associated with simply transferring the Western Cape guidelines to these regions. For example, the role players may differ between regions, as may production methods and the aquacultural species produced. The types of ecosystems may also be different. Nevertheless, some valuable lessons were learnt and, were we to repeat the exercise, there are several recommendations we would follow:

- To invite representatives of all interested and affected parties to become involved in the process.
- To make a special effort to ensure the involvement of the key role-players.
- To acquire the services of a good chairperson (preferably from the lead agency) for the main working group.
- To acknowledge that there is a common goal.
- To encourage everybody to be transparent with regard to relevant information in their possession and frank as to their motives for involvement.
- The group responsible for drafting the guidelines should be a subcommittee of the main working group and consist of representatives of the major role-players. This group should be as small as possible whilst still being effective.
- To have a single person with whom all parties can liaise.

The resulting guidelines need to be clear, concise and practical, and, to make them as 'user-friendly' as possible, a publication explaining reasons for each guideline should also be produced.

Finally, administration of the guidelines is an ongoing process, and regular short courses and/or extension work are necessary to inform all the involved parties of the need to follow them.

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