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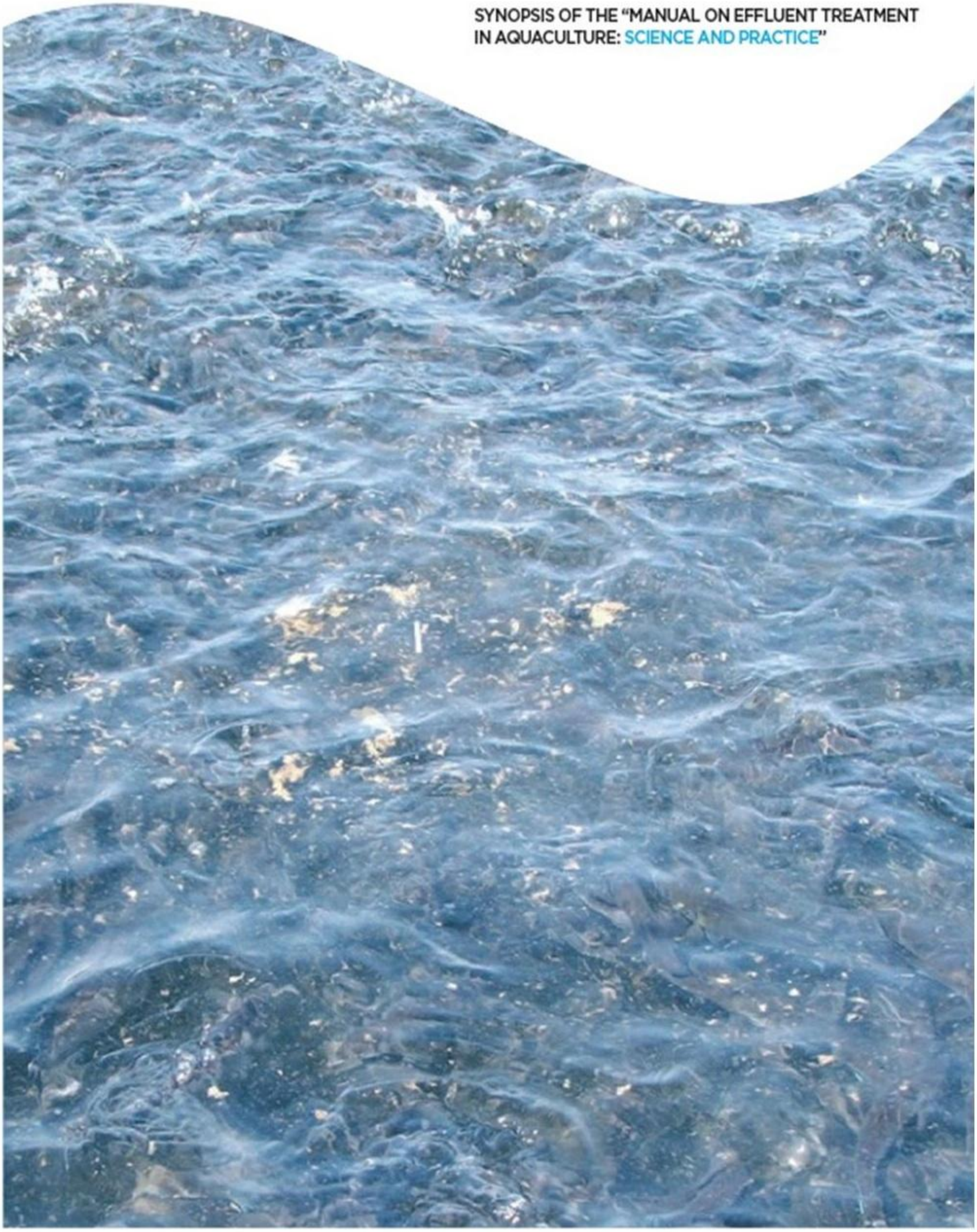
SYNOPSIS OF THE "MANUAL ON EFFLUENT TREATMENT IN AQUACULTURE: SCIENCE AND PRACTICE"



IMPROVEMENT AND INNOVATION OF
AQUACULTURE EFFLUENT TREATMENT TECHNOLOGY

AQUAETREAT

Synopsis of the "Manual on Effluent Treatment in Aquaculture: Science and Practice"

AQUAETREAT has developed new systems for the treatment, recycling and re-use of aquaculture effluent. Feasibility studies and subsequent cost-benefit analyses of the system at three diverse case study sites (Seawater flow-through, Freshwater Flow-through and Freshwater Recirculation system) were also undertaken. The AQUAETREAT manual provides a comprehensive report of the feasibility of developing and implementing cost-effective systems for the treatment of aquaculture farm effluent and the valorisation and re-use of the products and by-products. AQUAETREAT has been funded by the European Commission within the 6th Framework Programme (Contract COLL-CT-2003-500305). A copy, in English, of the full-length manual can be found at: http:// www.tecnosea.it/pdf/Aquaetreat_manual_web.pdf. An Italian version of the manual is also available at: www.tecnosea.it/pdf/TrattamentoRefluiAcquacoltura.pdf

This synopsis includes:

(I) Summary Introduction

There is increasing demand by citizens and environmental organisations for unpolluted waters in rivers, lakes, groundwater and sea. Research has shown that water pollution is one of the main environmental issues of concern for European citizens and the European Commission has made water protection one its main priorities.

Intensive fish farming/aquaculture operations require significant inputs of water and feed to maximise production. In aquaculture, the accumulated by-products (e.g. fish faeces, excretions, uneaten feed) must be removed continuously to maintain health and welfare of the fish and to achieve optimal growth. Suspended solids and dissolved nutrients in the effluents can have potentially negative impacts on the environment. The environmental impact can be lessened either by improved farm management, or by physical and/or biological treatment of the effluent.

Modern intensive land-based aquaculture systems can be divided in two types: open and closed systems. In open systems, water used to rear fish, from whatever source, is discharged (untreated) into the environment with its content of solids and nutrients. In closed systems, some part of the water is recycled after specific treatments to reduce the content of solids and dissolved nutrients. In this context, intensive aquaculture needs efficient, reliable, easy to implement and economically affordable systems to increase the efficiency of water use.

By developing and implementing innovative methods and technologies for farm effluent water treatment, water reuse and by-products recycling, the demand for clean water used in fish farming and the amount of materials discharged into the environment will be reduced.

Fish farmers make use of large quantities of water and competition for use of that water is increasing. To be able to retain the use of large amounts of water for fish farming, the industry must demonstrate a high level of responsibility and efficiency in its use.

(II) Legislative Requirements

The European aquaculture industry operates within an extensive array of tight legislation. There are three major European Directives dealing with protection of the quality and quantity of the water resource and with the management of effluent.

a) The Water Framework Directive (2000/60/EC)

The Water Framework Directive entered into force in December 2003 and is an essential component of Europe’s environmental protection policy. The natural hydrologic unit of the river basin has been adopted as the fundamental organisational and monitoring unit of the Water Framework Directive.

Under the terms of the Water Framework Directive, aquaculture producers are required to provide quantitative information regarding the ecological and chemical status of the water, aquatic ecosystem or wetland. Environmental objectives under the Directive must be met by 2015.

b) The Waste Framework Directive (2008/98/EC)

It is currently unclear to what extent the Waste Framework Executive will affect aquaculture production.

The EC has acknowledged that the definition of waste in EU law needs to be clarified before it can be determined whether or not aquaculture effluent is included under this Directive. The Directive describes waste as "any substance or object ... which the holder discards or intends or is required to discard". The difficulty for the aquaculture industry is deciding when waste is considered to be a resource for a subsequent process. Currently, notions such as by-product or secondary raw material have no meaning in EU law – materials are simply classified as being waste or not.

c) The Environmental Liability Directive (2004/35/EC)

This directive aims to establish a framework of environmental liability based on 'polluter pays' and sustainable development principles. An operator whose activity has caused environmental damage is to be held financially liable. The aim is to induce operators to develop practices that minimise the risks of environmental damage and so reduce their exposure to financial liabilities.

Requirements of the Directive also indicate that operators should ultimately bear the cost of assessing environmental damage and assessing an imminent threat of such damage occurring. It is hoped that this will prevent and remedy environmental damage and reduce human health risks and loss of biodiversity.

(III) Commercially Available Products and Services

TECNO.S.E.A. srl is a spin-off initiative promoted by the University of Salento (Lecce, Italy) (www.unisalento.it) and the Aquaetreat consortium. TECNO.S.E.A. aims to valorise the results of the research carried out by the University of Salento through the development of new products and services in the field of biological sciences and marine sciences, with particular reference to aquaculture and fisheries. TECNO.S.E.A.was established at the Department of Biological and Environmental Sciences and Technologies (DiSTeBA) of the University of Salento. Its headquarters are located at the Marine Aquaculture and Fisheries Research Centre of Acquatina (Frigole, Lecce). Here, TECNO.S.E.A.has free access to all research facilities and technological equipment.

The company provides a range of products/services, including:

- Designing, managing and monitoring aquaculture and mariculture farms
- Developing new processes and products
- Designing, managing and controlling systems for wastewater treatment and reuse
- Designing, implementing and maintaining systems for monitoring and remote control
- Planning of Environmental Management Systems (EMAS and ISO 14001) and Ecolabel certification
- Providing services with elevated biotechnological content and use of advanced diagnostic systems
- Designing and developing ICT application for aquaculture

TECNO.S.E.A. has commercialised the TR.E.A.T. system for the treatment and re-use of wastewater of land-based aquaculture farms (details are available at www.tecnosea.it). A full demonstration unit of the TR.E.A.T. system, which will also be available for training programmes, will operate at the Marine Aquaculture and Fisheries Research Centre of Acquatina, starting from Spring 2013 (see also Section X on P18).

(IV) Effluent Water Treatment

The metabolic process of growing fish results in by-products that have the potential to pollute river catchment areas as well as the surrounding landscape. Small scale or extensive aquaculture has minimal environmental impact but economic pressures from consumers seeking food at what they consider to be an affordable price, combined with ocean biodiversity depletion, have resulted in fish farming becoming an intensive animal husbandry business.

Fish farmers and other stakeholders whose activities involve the surrounding environment have responsibilities to protect the environment, and the authorities who regulate aquaculture will insist that fish farmers and other stakeholders conform to strict standards of effluent quality. Within this scenario, fish farmers must find effective and economical ways of dealing with the by-products of their processes. Water treatment is likely to become ubiquitous in aquaculture and fish farmers must develop solutions to the specific challenges posed by their site and business activity.

Effluent Water Treatment: Solids and Suspended Solids Removal

The metabolic activity involved in converting fish feed to fish flesh produces waste products. These consist of suspended solids and dissolved nutrients. Suspended solids amount to approximately 25% of the feed used on a dry matter basis. Methods for the relatively simple removal of suspended solids are applicable to both flow-through and recirculation farms.

Suspended solids from flow-through fish farms are relatively low and flow volumes are relatively high. In a fish farm, suspended solids and dissolved nutrients originate from:

- Uneaten feed
- Fish metabolism producing faeces
- Solids carried into the farm with the flow from the external water source
- Growth of micro-algae and bacteria.

The production rate of suspended solids within a fish farm is affected by a range of factors, including feed quality, feeding rate, feeding method, water exchange rate, tank hydrology, fish stocking density, dissolved oxygen level, efficiency of farm management and the skills of personnel.

The amount of uneaten feed can be reduced by a careful feeding regime that provides the correct amount of feed, at the time the fish require it, and by husbandry that provides water quality suitable for feed conversion. Significant improvements in feed conversion ratios, and reductions in the faeces generated, have been achieved by improving fish diets.

Market pressure driving the intensification of aquaculture practices has resulted in farms generating greater volumes of suspended solids. As fish farm units produce more fish, separation of solids from the water flow before discharge from the site becomes more important. This is particularly true where a number of fish farms are located close together on one river or, in the case of marine farms, where farms discharge close to one another into the sea. The need for treatment is greater where there is a low rate of dilution of the effluent by the residual river flow or marine tides. There are two methods for reducing suspended solids in fish farm effluent - Sedimentation and Mechanical filtration.

1. Sedimentation

Gravitational sedimentation uses the force of gravity to extract particles from a fluid. Differences in density between the particles and the fluid cause the particles to travel downward. The specific gravity of fish faeces is close to that of water and therefore the rate of their sedimentation is low. In contrast, minerals have a high specific gravity and settle more quickly. Sedimentation of suspended solids is made more difficult by degradation of the feed or faeces 'pellet' as it travels from the fish through the fish-holding area to the sedimentation basin. Very small particles become 'non-settling solids'. This degradation of faeces into smaller particles, when combined with time exposure in the water, leads to a portion of the nutrients contained in the solids becoming dissolved. Fish farm design should therefore aim to trap and remove suspended solids as early as possible after being deposited by the fish, to reduce this degradation process.

Please refer to the manual for more information:
www.tecnosea.it/pdf/Aquaetreat_manual_web.pdf

Figure 1) a large settling pond (photo STM aquatrade)

2. Mechanical Filtration

Mechanical filters remove solids from water using physical barriers through which the solid particles cannot pass. This is usually achieved using a medium such as sand or with mesh. Mechanical filters will remove both settling solids and those that will not settle due to their small particle size or low density.

Please refer to the manual for more information:
www.tecnosea.it/pdf/Aquaetreat_manual_web.pdf

Figure 2) Drum filter (photo STM aquatrade)

Sludge Content

Sludge refers to the suspension of fine particles of solids in liquid. A micro-sieve is generally considered to be one of the most efficient pieces of equipment to capture suspended solids as sludge due to the fact that it is relatively cheap and doesn't take up much space. Where sludge is to be stored or transported, the ratio of solid content to water will be increased to make the sludge drier for easier handling.

Please refer to the manual for more information:
www.tecnosea.it/pdf/Aquaetreat_manual_web.pdf

Effluent Water Treatment: Algal Ponds

Whatever the aquaculture production system, animals will produce waste, mainly composed of solids (carbon, nitrogen and phosphorous) and soluble wastes (carbon dioxide, ammonia, ortho-phosphate and trace elements). Bacterial dissimilation into gases and plant assimilation into biomass are the main types of treatment described in the AQUAETREAT manual. Algae culture (plant culture in general) is a type of extractive aquaculture. In integrated aquaculture, algal biofilters reduce the environmental impact of fish culture. The algae species selected as the biofilter can be chosen to provide additional benefits, including sale for human consumption, or for phycocolloid, feed supplement, agrichemical, nutraceutical and pharmaceutical-compound production. High rate algal ponds may constitute a second loop of water treatment of flow-through or recirculating aquaculture systems.

Figure 3) Pilot-scale High Rate Algal Pond (Ifremer Palavas station)

Refer to the manual for more information:
www.tecnosea.it/pdf/Aquaetreat_manual_web.pdf

Effluent Water Treatment: Constructed Wetlands

Natural wetland systems can have a positive effect on the quality of water that passes through them. Particulate matter suspended in the inflow water, along with dissolved organic nutrients, *coliform* bacteria and even industrial and agricultural chemical pollutants can be significantly reduced.

The concept of integrating constructed utility wetlands (CW) into municipal, agricultural and industrial water treatment provision has become widespread throughout Europe.

The aim in developing a constructed wetland as an integral element of an aquaculture production facility is to reduce the potential polluting effect of the discharge on the recipient water or ecosystem. Constructed wetlands

are very effective for removing suspended solids. Most of the removal occurs within the first few metres of the first cell, where the compacted gravel and soil provide a physical filter.

Constructed wetlands are considered a viable and cost-effective method to treat waste water. The addition or integration of a constructed wetland into an aquaculture production process represents an environmental enhancement, and has the potential to assist cost-effective compliance with increasingly stringent water quality regulations in Europe.

Please refer to the manual for more information:
www.tecnosea.it/pdf/Aquaetreat_manual_web.pdf

Figure 4) Free Water Flow (FWF) Wetland (photo G. Proffitt)

(V) Sludge: Valuable Resource or Disposal Problem?

Sludge comprises uneaten fish pellets, faecal material, soluble metabolite products and also any particles that enter the tanks/raceways with the water inflow. Fish sludge may be described as the 'solids' part of the waste stream in a fish farm. Since fish typically utilise only 30% of the ingested nitrogen and phosphorous, the remainder is voided. Most of the voided nitrogen is dissolved and lost through the gills, whereas for phosphorous, the majority is associated with the solid material and is excreted in the faeces.

Pros	**Cons**
Sludge can be removed from effluent water by mechanical filters or by settlement	Fish farm effluents containing phosphorous and nitrogen have been reported to have caused eutrophication of receiving waters
Sludge can be removed from recycled water to maintain healthy conditions for fish growth	Sludge from saltwater fish farms can also contain significant quantities of sodium (Na) which may adversely affect soil structure
Fish sludge contains nutrients and organic matter which have potential for spreading on agricultural land to reduce the amount of inorganic fertiliser required	Fish sludge can contain harmful substances, such as heavy metals and pathogens, which would limit its suitability for use as fertiliser
The reuse of nutrients may offer a low cost 'disposal' option	The risk of pathogen transmission from aquaculture to humans and domestic livestock remains a possibility via this route

The chemical composition of fish sludge can be expected to vary due to differences in management practices, species, size of fish, feed, aquatic environment (freshwater or saltwater), water flow dynamics and dewatering efficiency.

It has been shown that the nutrient content of Rainbow Trout (*Oncorhynchus mykiss*) sludge was in the range of that measured in land animal manures. Marine sludge has similar values to freshwater but may also have high levels of sodium.

Results from experiments carried out during the project have demonstrated that for most crops (e.g. tomatoes) tested, an application of fish sludge would be a valued contribution to the crop requirements. The economic value has been also calculated: as an example sea bass sludge, with a 15% dry matter concentration, has a value of 127 €/ha when applied at 50 m^3/ha (based on UK prices in 2007: N, P and K at 0,67, 0,74 and 0,30 €/kg, respectively).

Please refer to the manual for more information: www.tecnosea.it/pdf/Aquaetreat_manual_web.pdf

(VI) Alternative Potential Uses for Fish Sludge

Biofertilisation of ponds and growth of polychaete worms

Potentially, thickened sludge obtained from the system could be reused on-site for biofertilisation of (non-fish) aquaculture ponds, thus permitting a horizontal integration of marine fish-farm production through the cultivation of invertebrate species (worms, mussels, crustaceans) with important economic value. On-site use of sludge would remove or reduce the cost of sludge transportation and disposal.

Fungal growth

Schizochytrium limacinum produces high levels of unsaturated fatty acids from glycerol or glucose-supplemented waste waters. Sterile effluent seawater from a Turbot fish farm, supplemented with glucose or glycerol, has a potential use as a base for fermentation to remove organics and phosphorus, potentially producing high-value products either for fish feed or for other commercial uses (oils).

Phosphorus recovery

The release of phosphate via fermentation has been investigated in the absence and presence of glucose, and with the addition of lactic acid bacteria. The results have shown that phosphate is released only when the pH is in acid fermentation conditions. Because the sludge has high buffering capacity there is little or no pH change when the sludge is fermented alone (anaerobic digestion). The addition of glucose acidifies the sludge and releases substantial quantities of phosphate into solution. This work will progress to improvement of sludge dewatering so that the phosphate solution can be readily drained from the sludge.

Biogas production

There is potential for trout sludge to be used in biogas generation if it can be thickened sufficiently to allow its economic transportation to anaerobic digestion plants.

High value compost

If sludge can be thickened sufficiently, for example to 25% solids content, perhaps by using geotextile filter bags, then it would be reasonable to expect that the organic matter could be composted, thus stabilising the nutrients and potentially reducing pathogens to safe levels.

(VII) Case Studies

Three intensive aquaculture farms were directly involved in the project activity.

- Maribrin (Italy), producing Sea Bream and Sea Bass in a seawater flow-through system
- Murgat (France), producing trout in a freshwater flow-through system
- Hoghoj (Denmark,) producing trout in a freshwater recirculation system

Maribrin

Species reared: Mediterranean Sea Bass (*Dicentrarchus labrax*); Gilthead Sea Bream (*Sparus aurata*). Both species are reproduced in the hatchery using broodstock caught in the surrounding area or selected from within the farm.

Plant details: Four tanks of $50m^2$ for juvenile rearing, 20 of $100m^2$ for pre-growing and 26 of $200m^2$ for on-growing. Pre-growing and on-growing take place in concrete tanks using sea-water – at a constant T 24°C) pumped from the adjacent coast and from a series of deep wells. The fish are fed a commercial extruded feed.

Water treatment system: Effluent water from the various sectors of the farm flows through a concrete channel located between the two rows of raceways. From this channel, the effluent passes into two earth ponds, or lagoons, of about 12 hectares, where partial sedimentation occurs, and is then discharged to the sea.

Prior to installing a water treatment system, the fish farm characteristics were assessed in relation to rearing methods, species grown and water flow. Physical and chemical water analysis was made at different points of the farm and the phyto-zooplancton present in the lagoon was identified.

The choice of water treatment was dictated by the farming methods and water characteristics. In between the intensive rearing tanks and the lagoon are two unused earth ponds. It was decided to install the system close to this area to allow these ponds to be used.

The system installed used a drum filter for primary filtration and then passed the resultant backwash water through a flocculation and coagulation process step. The sludge was then directed either to a geo-tube, to a conical filter or to a belt filter to assess the effectiveness of the three processes. Cleaned water from this stage was passed to a wetland.

Results:
Analysis of data produced two conclusions:

- Overall quality of the farm effluent before entering the lagoon is good
- Solids are accumulating in the lagoon under anaerobic conditions and bioremediation is very limited

The content of organic matter and some heavy metals (lead, copper and iron) are higher in the lagoon sediment than in the effluent water. This is due mainly to run off water from surrounding agriculture but also because the solid particles, transported by the outlet flow from the farm, have been accumulating in the lagoon, over a long period of time.

In order to compare the effect of water treatment on the general quality of the effluent, the phyto-zooplankton population was assessed at two points in the lagoon. Surveys were made before installation of the treatment system and again one year later. Biodiversity increased after the introduction of the treatment system, with a wider range of species being recorded and in greater numbers.

An experimental trial to evaluate the opportunity to rear sea breams by re-using treated water (previously biofiltered and matured in an algal pond) was set up. During the trial, fish nutritional and physiological state was assessed at the beginning and at the end of the experiment by measuring indicators of the gastro-intestinal tract. Parallel analysis was conducted in sea breams reared under controlled conditions.

Results indicate that Sea Bream reared using treated effluent had better growth performance and higher survival when compared with control fish. Control fish showed significantly higher values of markers for stress such as cortisol concentration and antioxidant enzymes activity and had damaged intestinal mucosa. Flesh quality was comparable in the two groups of fish.

The results obtained suggest that re-use of farm effluent, after treatment with mechanical filtration and in an algal pond, is a useful tool for water use optimisation in land based marine aquaculture and allows the production of high quality fish, while maintaining animal welfare. The analysis of phyto-zooplankton in the algal pond also showed a quantitative and qualitative increase in biodiversity.

Murgat

Species reared: Brook Trout (*Salvelinus fontinalis*), Brown Trout (*Salmo trutta fario*), Rainbow Trout (*Oncorhynchus mykiss*), Arctic Char (*Salvelinus alpines*). Yearly production: 600 tonnes/year

Plant details: The on-growing unit is divided into two sectors: **1**) seven concrete raceways (each 70m x 6m x 0.8m deep) with four species reared from 50g to more than 2kg (55-70% harvested at 200 g) **2**) two concrete raceways, with only Rainbow Trout from 200g to 1kg (50% harvested at 500g). Both sectors are operated with high quality and constant temperature well water (around 11°C).

Water treatment system: Three mechanical filters, one in the pre-growing unit sited adjacent to the main farm and two in the on-growing unit, and primary and secondary effluent thickening systems. This treatment system reduces by 50% the suspended solids that would otherwise be released to the ecosystem (river). For an average annual farm production of 91 tonnes of solids, around 47 tonnes are collected by the treatment system.

Results

The Standardized Global Biological Index (IBGN) was used to assess the benefit of the aquaculture effluent treatment system at Murgat on the quality of the recipient river. The study recorded changes in the biological quality of a watercourse over a period of time from July 2006 to April 2007. The results were compared with the same type of assessment carried out at Murgat in 1985-1986, when the farm was releasing effluent without treatment.

Since the whole effluent treatment system was set up in 2006, the biological quality of the recipient ecosystem has improved and is currently classified as 'good' biological quality. The effluent treatment system had a positive impact on biological communities with more rare and pollution-sensitive species found in the 2007 samples.

Despite the relatively short duration of the AQUAETREAT project, the treatment of effluent at Murgat farm had a measurable and positive effect on the recipient ecosystem.

Hoghoj

Species reared: Rainbow Trout (*Oncorhynchus mykiss*). Yearly production: 90-150 tonnes/year

Plant details: the pre-growing unit is composed by 10 concrete raceway-type tanks (each 1m x 10m x 3m deep); the on-growing sector has 24 concrete raceway-type tanks (each 2m x 10m x 3m deep); two concrete tanks (each 5m x 20m x 1.5m deep) are used as stocking unit before fish selling. The amount of make-up water coming from the adjacent river is 15l/s while the total recirculated water volume in the farm is 700l/s

Water treatment system: A combination of the recirculation system used at Hoghoj and the introduction of lagoons for the treatment of the waste water and sludge capture significantly reduced the environmental impact of the aquaculture operation. The majority of additional nutrients added into the ecosystem through feeds were used by the fish or captured in the sludge.

Results:

Removal of BOD_5 and capture of phosphate are particularly effective. Nitrogen is still a problem with only 50-60% of the nitrogen in the effluent being removed. This is typical of the model recirculation fish farms in Denmark. Further innovation in technology will be required to reduce the nitrogen content of the effluents. This represents a considerable challenge. Constructed wetlands could offer a practical solution to nitrogen management.

(VIII) Cost Analyses

At **Maribrin**, the water treatment for an annual production of 60 tonnes of Sea Bass and Sea Bream produces 30-50kg/day of sludge containing 15 – 20% dry matter. The operating cost of the system is 0.26€/kg of fish produced, or 3% of the selling price.

At **Murgat** fish farm, the whole effluent treatment of 600 l/s for an annual fish production of 600 tonnes produces $3m^3$/day (0.03 l/s) of sludge containing 93% water. The running cost is 0.036€/kg of fish produced, or 0.9% of the selling price.

At **Hoghoj** fish farm, the annual production of 120 tonnes gives $26m^3$/day of sludge at 97% of water before deposit in the ponds. The running cost of the system represent 0.12€/Kg of fish produced or 4.8% of the selling price.

Cost of Effluent Treatment: General Conclusions

The cost of the treatment systems varies between farms and is linked to local conditions including the species reared, the rearing system used, the space available and the treatment techniques chosen. Great care has to be taken prior to any investment decision and the knowledge accumulated during the AQUAETREAT project will help to inform other farmers of available choices.
For all farms, other site-specific factors have to be considered:

- How much income will the eventual re-use of the sludge create?
- What is the value for fish farmers who use treated water?
- What value can be placed on the environmental benefit to the community?
- Is water treatment a pre-requisite for the farm to exist?
- Is there a benefit to the community in operating to best management practices (BMPs)?
- Are there benefits for fish farmers who implement BMPs, such as lower insurance cost or reduced monitoring by Competent Authorities?

Fish farmers will need economic and technical support to implement and adapt effective water treatment systems.

(IX) Future Developments and Trends

Mechanical filtration of effluent treatment is established practice in flow-through and recirculation farms. The promising results from constructed wetlands and algal and zooplankton growth ponds merit further development and understanding. Raised awareness of the processes involved is needed to optimise the use of wetlands. The application of constructed wetlands in marine environments needs to be better demonstrated. Please see below for details on a demonstration site soon to become available. Employment of algal ponds is a useful tool for water-use optimisation in land-based marine aquaculture and allows the production of high quality fish while maintaining animal welfare.

For partial water re-use, two treatment methods are currently used - trickling filters for low flow situations, since high pumping head is required and moving bed bio-filters for high flow situations. Both of these approaches use significant energy and warrant development to reduce energy use and simplification to reduce capital investment. Both types of bio-filter have improved performance in recent years and, with more attention, can be expected to be further improved.

Improved sludge thickening, stabilisation, storage and re-use are needed in order to achieve added value for this by-product as a soil conditioner or fertiliser in agriculture. The long term effect of disposing marine sludge on the land must be addressed to build confidence in its use. Alternatives for sludge re-use, including composting, heat production through combustion or pyrolysis, methane or phosphorous recovery, as a fibre source or as a growth medium for worm culture are possible but not yet sufficiently understood to be commercially exploited.

The demand for reduced impact on the environment from aquaculture can only be delivered on the back of improved technology. AQUAETREAT, having developed integrated systems that reduce nutrient release by up to 50% and found ways to re-use waste and by-products, is an important example of how increased technology research driven by the needs of the aquaculture industry can achieve new and novel approaches to decreasing the impact of its systems on the environment.

(X) Demonstration Site

The Marine Aquaculture and Fisheries Research Centre, Frigole-Lecce, represents the experimental pole of the University of Salento (Lecce, Italy), for research in the sectors of fisheries and aquaculture. The Centre is located in a natural wetland of more than 100 hectares, of which 45 hectares constitutes the coastal pond Basin of Acquatina. The following research facilities (Figure 5) and basic infrastructures are already available:

- 4 Research Laboratories
- 10 Concrete tanks (raceway type) of 100 sm/each
- 6 Earthen ponds of 1500 sm/each (one is already designed to be transformed in a constructed wetland)
- Pumping station (for a max water flow of 450 l/sec)
- Offices for researchers and staff
- Administration office
- Library
- Class room
- Service facilities

A new hatchery (located in a building of 800 sm), designed for research on vertebrates and invertebrates aquatic species, is also under construction and will be available in spring 2013. At that time a complete T.RE.A.T system will be also available. The system will treat the effluents (50-150 l/s) of a partial recirculating farm unit producing about 50 ton/year of marine fishes. A variety of options for sludge thickening, disposal and reuse will be also set up. The University of Salento's Spin-off company Tecnosea srl (www.tecnosea.it) will manage the system and, upon request, will organise demonstration and training sessions for farmers, technicians and researchers.

Figure 5: Aquaculture research facilities at University of Salento (Lecce, Italy) (photo V. Zonno)

(XII) Contact Details

For any further information please contact:

Dr. Vincenzo Zonno – Technical Manager
Department of Biological and Environmental Science and Technology
University of Salento
Via Prov. Lecce-Monteroni
73100 LECCE (Italy)
tel. +39 0832 298684
fax +39 0832 324220
vincenzo.zonno@unisalento.it

TECNO.S.E.A. (Tecnologie e Servizi d'Eccellenza in Acquacoltura) srl
Marine Aquaculture and Fisheries Research Center
Via C. Negri – Bacino di Acquatina
73100 Frigole, LECCE (Italy)
tel. +39 0832 295811
fax +39 0832 1830419
info@tecnosea.it
www.tecnosea.it

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