

AQUA-TNET

AQUA-TNET
SOCRATES Thematic Network
For Higher Level Education
in Aquaculture

Education & Training in Aquaculture for the
New Millennium

White Paper

PREFACE

AQUA-TNET SOCRATES Thematic Network for Higher Level Education in Aquaculture

AQUA-TNET is a network of co-operating European University bodies, formed under the EU SOCRATES Programme. Its main objective is to establish a higher education forum to assess, compare and analyse the current state of the aquaculture tertiary sector in Europe and to identify key curriculum development and assessment objectives, ultimately leading to the dissemination of best practice and a more open, transparent and innovative system of education.

The AQUA-TNET partnership itself comprises some of the leading European academic institutions offering aquaculture courses and has representatives from 15 EU-EEA countries, all of whom maintain active contact with key industry players in their own countries.

This White Paper, drawn up by the AQUA-TNET partnership, is primarily intended to stimulate discussion and promote debate on issues of education and training in aquaculture with a view to addressing the long-term training needs of the European industry in the new millennium.

This publication would not have been possible without the financial assistance of DGXXII of the European Commission (Youth, Education and Training) and the individual contributions of many third level institutes throughout Europe. The authors, the editors, the individual institutional representatives and AQUA-TNET gratefully acknowledge this assistance and support.

Editors: M.Eleftheriou, C.Boylan, D.Murphy

The views and opinions expressed in this document represent the collective edited inputs of many contributors and should not be construed as the opinion of the individual representatives, AquaTT or the European Commission

CONTENTS

PREFACE.....	3
CONTENTS.....	5
AQUA-TNET REPRESENTATIVES.....	7
INTRODUCTION.....	9
SECTION 1 CHANGES AFFECTING THE EUROPEAN AQUACULTURE INDUSTRY	11
1.1 European Macro-Environment.....	12
1.2 Demographic Changes.....	12
1.3 Changes in Markets.....	13
1.3. Globalisation of markets for aquaculture products.....	13
1.3. Changing European political and market context.....	13
1.3. The role of the consumer.....	14
1.4 1.4. Environmental concerns.....	15
1.4. The EU legal and regulatory framework	
1.4. The nature and scope of EU Directives	15
1.4.4 Emergence of Codes of Conduct, Codes of Practice, Best Environmental Practice	
1.5 Technological Change and Research and Development.....	15
1.6 Social Changes.....	15
SECTION 2 ISSUES IN AQUACULTURE EDUCATION AND TRAINING	17
2.1 AQUA-TNET educational concerns and activities	
2.1.1 IRDQAC requirementsfor industrial change in education and training	
2.1.2 AQUA-TNET group objectives	
2.1.3 Vocational training	
2.1.4 New types of validation for workplace training- the European Pathway for Training (EUROPASS)	
2.2 Analysis of course content and education practices	19
2.2. Data collection and preliminary analysis	19
2.2. Results	20
2.2. Curriculum content and educational provision	22
2.2. Curricular content provision-undergraduate and M.Sc. (“Masters”)	23

2.2.	Development o ‘Methodology series of courses’	23
5		
2.3	Transnational Mobility.....	24
2.3.	Background	24
1		
2.3.	Review of aquaculture staff and student mobility in	25
2	Europe	
2.3.3	Student mobility	
2.3.4	Obstacles to transnational mobility	
2.4	Mutual Accreditation Activities and Achievements	
2.4.1	Background	
2.4.2	Classical difficulties in mutual accreditation/recognition	
	of diplomas and awards	
2.4.3	AQUA-TNET activities	
2.4.4	Need for transparency	
2.4.5	Results	
2.4.6	Formats for mutual recognition/accreditation	
2.5	Industry-University Co-operation.....	27
2.6	The European Dimension in Education.....	28
2.6.	Widely varying approaches in Europe.....	28
1		
2.6.	Adapting to the labour market.....	28
2		
2.6.	Cost consciousness.....	28
3		
2.6.	Preparing students for change and a lifetime of	29
4	learning.....	
2.7	Unemployment of higher education graduates.....	30
SECTION 3	INDUSTRIAL TRENDS IN THE AQUACULTURE	31
	INDUSTRY DURING THE 1990’s	
3.1	Growth in production output.....	32
3.2	Species diversification.....	33
3.3	Supply/ Demand Issues, Markets and Consumer	34
	Power.....	
3.4	Economy of Scale, Production Efficiencies and	35
	Reliability.....	
3.5	Vertical integration versus Specialisation...	36
3.6	Increasing use of Technology and	37
	Mechanisation.....	
3.7	Requirements for Specialists.....	37
3.8	Increased Regulatory Control and Competition for	37
	Resources.....	
3.9	Computers and Information Technologies.....	38
3.10	Biological, Technical and Operational	39
	Innovations.....	
SECTION 4	AQUA-TNET METHODOLOGY SERIES OF COURSES	41
4.1	Biology of Fish Larvae Production.....	43
4.2	Applied Fish Nutrition.....	44
4.3	Design and Operation of Recirculation Systems	46

4.4	Fish Diseases Control.....	47
4.5	Molecular Biology and Ecology in Aquaculture...	49
4.6	Fish Reproduction.....	51
4.7	Pathology, Physiology and Biotechnology in Aquaculture.....	52
4.8	Fish Vaccination.....	53
SECTION 5	AQUACULTURE CAREER OPPORTUNITIES	59
SECTION 6	RECOMMENDATIONS.....	65

AQUA-TNET Representatives

.....

Promoters of the Debate on Education & Training in Aquaculture

Belgium

**Prof Patrick Sorgeloos
(Ir. Jean Dhont)**
Laboratory of Aquaculture &
Artemia Reference Centre
University of Ghent

Ireland

Dr. Gavin Burnell
Aquaculture
Development Centre
University College,
Cork

Denmark

**Dr Ewen McLean
(Bent Ronsholdt)**
Biotechnology
Aalborg University

Italy

Prof. Marco Saroglia
Dept. of Science of
Animal Production
University of
Basilicata

Finland

Prof Hannu Molsa
Dept. of Applied Zoology
and Veterinary Medicine
University of Kuopio

Norway

**Prof S. Stefansson
(Dr Karen Pittman)**
Dept Fisheries Marine
& Biology
University of Bergen

Germany

Prof. Dr. Harald Rosenthal
Institut für Meereskunde an
der Universität Kiel

Netherlands

Dr Johan Verreth

(Ing. Ep Eding)
Dept. of Animal
Sciences
Wageningen
Agricultural
University

Greece

Mrs Margaret Eleftheriou
Institute of Marine Biology
of Crete

Portugal

Prof Jeff Wallace
Dept. of Science and
Technology of
Aquatic Resources
University of Algarve

Iceland

Prof. Logi Jonsson
Dept of Physiology
University of Iceland

Spain

Dr Lluís Tort
Dept de Biologia
Cellular I de
Fisiologia
Universitat
Autònoma de
Barcelona

Ireland

Lisa Owen
Sinead Malone

(Melanie Mercer)
AQUATT Ltd
61 Middle Abbey Street
Dublin 2

Sweden

Dr Anders Alanara
Dept. of Aquaculture
Swedish University of
Agricultural Sciences

UK

Dr Lindsay Laird
Department of
Zoology
University of
Aberdeen

Introduction

.....

The Aquaculture Industry

.....

The aquaculture industry has seen rapid expansion over the past decade in many parts of Europe. Although forms of aquaculture have long been in existence in Europe, for instance, the ancient Romans farmed oysters, it is only in the past few decades that intensive forms have emerged and aquaculture has been exploited as a commercial venture. Intensive fish farming has developed to such an extent that it now makes a notable and growing contribution to many national economies and, significantly, it functions as a key economic activity in the more remote and coastal regions of the European Union.

Aquaculture is a diverse and dynamic industry, depending on knowledge bases from a series of disparate disciplines (e.g., biology, engineering, marketing), and it is constantly evolving, drawing on new technologies, and benefiting from innovations and the outputs of a range of RTD activities. Each European country or region, being unique in a biogeographic sense, cultivates a certain species-mix and utilises a variety of farming methodologies and practices which take into account available natural resources and local topography. Consequently, each country potentially has need of highly trained and skilled personnel with specific, though varying, skills sets. At the same time, there are differing educational systems in place in each country/region. The interaction between industry requirements and educational systems has led to a diversity of third level courses being provided across Europe and, as might be expected, new courses have emerged in response to specific national requirements within existing frameworks.

Why a White Paper?

.....

The expansion of the aquaculture industry will affect increasing numbers of people in Europe. The demand for courses and qualifications is bound to grow as the industry expands and matures and as it absorbs the changes wrought by new technologies and further diversification. Factors such as these call for the training of a highly skilled and specialised workforce. At the same time, young entrants to the job market are expected to have greater flexibility and to be more mobile. Considerations such as these demonstrate that there is a need for qualifications to be more flexible, both in content and form, as well as more transparent (in accreditation and recognition), if they are to address the needs of all the players involved.

It was with these issues in mind that the AQUA-TNET partnership drew up this White Paper on Education and Training in Aquaculture for the new Millennium. The document identifies some of the main issues, environmental, educational and commercial, affecting the European aquaculture industry in general and proposes mechanisms which could lead to solutions of ongoing problems.

Target Audience

.....

The White Paper is intended to be a preliminary attempt to engage these issues in a straightforward manner and therefore it is targeted directly towards all stakeholders in the aquaculture industry: farmers and their representative organisations, allied commercial sectors from upstream service providers to downstream processors, state agencies and regulatory bodies, research institutions and all providers of education and training to the industry (basic, vocational, ongoing, adult) as well as the tertiary level.

AQUA-TNET welcomes all comments or suggestions which should be sent in the first instance to :

Sinead Malone

AQUA-TNET Co-ordinator

White Paper – Education & Training in Aquaculture in
the New Millennium

AquaTT Ltd

61 Middle Abbey Street

Dublin 2, Ireland

Tel: +353-1-8747088

Fax: +353-1-8747090

Email: aquatt@aquatt.ie

Section 1

Changes affecting the European aquaculture industry

**Comments by the
AQUA-TNET group
of representatives**

Summary outline

.....

Section 1 examines some of the general trends and changes influencing the European aquaculture industry, and identifies some key demographic, market, environmental, technological and societal changes.

.....

1 CHANGES AFFECTING THE EUROPEAN AQUACULTURE INDUSTRY

Key trends and changes influencing the macro-environment in which the European aquaculture industry currently operates are presented in this section. However, AQUA-TNET carried out, as part of its network activities, a survey and analysis of specific trends which occurred in the European aquaculture industry during the 1990s. This detailed analysis was undertaken by Dr. Lindsay Laird and Dr. Richard FitzGerald and is presented in Section 3. In this section, some of the more general factors acting upon the aquaculture industry are presented and discussed

1.1. European Macro-environment

As has been pointed out by the European Commission itself on many occasions and in diverse situations, the European Union is at present typified by:

- great disparities across regions
- high labour costs and severely regulated social structures
- soaring and inefficient public spending
- a lack of incentives for the introduction of innovation
- the absence of a common ethos which could unify European ideas and inform large-scale projects
- weak political organisation at the European level.

This much- abridged socio-political synopsis may serve as a useful backdrop against which to consider some of the factors which impinge on public policies, the market and commercial developments.

1.2 Demographic changes

The changing demographic patterns now observed in Europe have become a familiar topic in general discussion in national policy debates. Though they do not have a direct impact on the aquaculture industry, the following general demographic trends should not be ignored.

- Over 20% of the EU population has now reached the age of 60 or above, with the trend forecast to continue to climb.
- In 2000, the number of young entrants to the European labour market is lower than the number of those retiring.
- The average age of the workforce is likely to increase significantly.
- Immigration pressures will probably increase, mainly from low-skilled non-EU immigrants, or refugees.

There is little doubt that these changes have serious implications for the structure and form of the European workforce over the next decade, which will in turn affect the aquaculture industry.

1.3 Changes in Markets

Across Europe, there is widespread evidence of fundamental changes in the aquaculture market. The overall patterns of production output continue to point to expansion and increase in tonnage (though not all elements of the industry have increased to the same extent). Geographical expansion of aquacultural activities has occurred, particularly in Ireland and in the Mediterranean countries, and there has also been diversification in the species produced. For many species, production and market, supply and demand, are not always in harmony. This causes dramatic fluctuations in prices and, in certain cases, particularly salmon, with commoditisation there has been an overall price decrease in the past decade.

Other factors influencing the aquaculture market are treated in more detail below.

1.3.1 Globalisation of markets for aquaculture products

Economic growth and advances in production, processing, packaging and transport techniques have created an international market for a growing number of aquaculture products and services. European producers, potentially, are now able to exploit not only new markets within Europe but also more lucrative niche markets in more distant regions such as North America and Japan. However, this globalisation of markets also leads to stronger competition both within and outside Europe. The EU continues to be the largest single import market (6.7 million tonnes) in the world and consequently there exists a significant trading deficit. It is worth noting that developing countries play an ever-increasing role in the supply of fishery products to the EU. In 1995, the share was 27% (995,000 tonnes worth 2,834 million Euro). Most prominent are the APC countries, the EMLA and HPAs (17%) and Eastern Europe (3.5%).

Nevertheless there is still no explicit policy in Europe to limit the expansion of internal aquaculture production expansion although continued increases in output and the import of marine species from third countries may eventually lead to market problems in the EU for internal suppliers.

1.3.2 Changing European political and market context

Many changes in the market environment are economic, political and global in nature. Few of these developments, however, directly impinge on the European aquaculture industry. Viewed from an internal perspective, therefore, the establishment of the EMU and trading in EUROS have been beneficial in so far as they have facilitated common currency exchanges (though such benefits are not as relevant on the global scale).

However, the continued expansion of the European Union, the creation of a Single Market and the growing impact of tightening European regulation will all have to be considered in the next few years. A larger, unified market will certainly facilitate the internationalisation and competitiveness of European companies but, concomitantly it will also ease access to non-European competition. The opening up of Eastern Europe (Poland, Hungary, the Czech Republic) and the former Soviet Republics will mean

ready access to new markets for EU producers, but will also allow large-volume imports of fisheries products from these low-wage countries. There is also the possibility in the short term of the movement of skilled and unskilled labour from these countries to the more affluent western regions.

On a global scale, it is also necessary to consider the ramifications of successive round of the GATT negotiations which will further reduce the barriers to international trade with the removal of most tariffs, facilitating the importation of, for example, Chilean scallops to Europe.

1.3.3 The role of the consumer

There is broad agreement that overall the consumption of food in the European Union has reached saturation point, or a temporary plateau, in terms of volume in the last five years. The competitiveness and development of firms within such a 'static' market is expected to rest on:

- an ability to meet consumer choice
- responsiveness to new and emerging needs
- successful adjustments to changing wholesale/retail patterns and distribution channels.

The drive for convenience coupled with the production of value added products has been responsible for a major shift in purchasing behaviour and eating habits. There is ample evidence that there is a demand for, and increasing sales of, prepared, pre-packaged and convenience foods.

These demands are being driven by several factors including socio-economic changes (increased financial affluence, changing work patterns, more leisure time and increased eating-out), changes in population demographics (older population and single-person households) and even changes in human behaviour and food preferences (snacking and a desire for freshness, wholesome and 'organic' products). With the increase in human longevity, there is greater awareness of the importance of healthy eating and quality food. The result is that red meat consumption has declined while demand for poultry has soared and there is also an increase in demand for fish, because of its healthy attributes. Fish and fishery products continue to play an important role in food supply.

Total per capita food fish supply in Europe increased from 16.9kg or 8.2% of total animal protein intake in 1984 to 18.1kg or 9.0% in 1993 (FAO, 1995). Total aquaculture production in Europe was 1.65 metric tonnes in 1997, 44% higher than in 1988 (FAO, 1999). With increased production volumes, costs and prices have been driven down (the unit price of salmon has decreased by almost 2.88 US dollars over a 14-year period (FAO, 1999)). This trend has been seen by some as an indication of the improved efficiency of the farming systems, achieved through technological advances and improved management, bringing some highly valued species within the reach of a larger section of the population. This improved efficiency, particularly with regard to high-value species such as sea bream and sea bass (where production has soared to 90,000mt in 1999 (FEAP, 1999) and market prices have more than halved from 1990-

1999) has enabled the returns for investments to be maintained through higher yields per unit area, lower feed costs and better health management .

Trends towards processed/prepared/packaged foods are also a major influence on consumer acceptability and the maintenance of sales. The aquaculture industry must meet this demand for high quality products and critical specifications simply to be on a par with competing food sectors. The aquaculture sector has to be able to satisfy a spectrum of needs and desires. Moreover, the supply of goods must be reliable and reasonably priced. There is a growing awareness within the industry of product development and meeting market requirements.

A final consideration, in this context, is the change in sales/distribution patterns for food produce with the emergence of, and the growing power of, the 'multiples' (chains of stores/supermarkets) as the dominant sales route/outlet across Europe.

1.4 Environmental concerns

1.4.1 Changes in EU environmental legislation affecting aquaculture

In the Maastricht Treaty, the EU had introduced environmental provisions into all policy areas in order to emphasise the importance of environmental protection. Though these provisions do not in themselves constitute an environmental code they nevertheless exert a direct influence on the aquaculture sector.

Thus, in the 1990s, environmental considerations became an integral part of aquaculture operations, closely following, not only the raft of European, national and regional legislation concerning aquaculture, referred to below, but also many previous Directives which touched indirectly on aquaculture activities.

1.4.2 The EU legal and regulatory framework

However, previous to the Maastricht Treaty, from the 1970s, the EU had introduced many Directives which led to the implementation of national legislation relevant to aquaculture. A point worth noting in addition, is that the legal framework used in the EU to control aquaculture activities has also been built up in response to external international requirements (the Oslo and Paris Convention(1974), the Helsinki Convention, MARPOL, the North Sea Declarations, MEDPOL, the Barcelona Convention(UNEP)).

Many of these laws and regulations applied to aquaculture activities were adapted from other sectors and pertain to matters at the centre of most legal systems, such as anti-pollution measures, public health and sanitary laws, animal health and animal disease laws, tax laws, trade laws, land laws (including use of public domain land) and water laws.

For example, the Water Quality Directive (85/337/EEC, updated by Directive 92/43/EEC) includes an assessment of the effects of certain public and private projects on the environment and requires that, before permission for development is given, certain projects likely to have significant effects are subjected to an assessment of possible environmental impacts". One of the categories is "intensive fish farming" and an amending Directive (97/11/EC) extended its provision to cover intensive farming of all marine finfish, to come into effect from March 1999.

1.4.3 Nature and scope of EU Directives concerning aquaculture activities

EU Directives set up environmental protection measures in the aquaculture sector at three levels: i) general policy, ii) specific measures, and iii) regulations which control specific local conditions:

- i) under the terms of the Maastricht Treaty, the EU is obliged to include environmental protection requirements when formulating its policies
- ii) member states are required to ensure that all aquaculture enterprises operate within the laws, regulations and rules of the individual country and also of the EU
- iii) legislation aimed at protecting the aquatic environment is also intended to safeguard aquaculture activities against damage to their resource base by controlling polluting discharges from nearby activities.

There is therefore a range of specific control measures over aquaculture impacts on the environment. Aquaculture enterprises must comply with:

- legislation in force in all European member states designed to reduce pollution and safeguard environmental protection by the introduction of controls and measures in different formulations and giving emphasis to the environmental approach
- the emission standards fixed under the Dangerous Substances Directive which requires Member States to adopt pollution reduction programmes involving water quality objectives
- environmental impact assessment procedures for watershed management, cage/pond siting, design and operation
- limited access rights for water
- effluent control techniques involving feed control ratios, limited use of drugs, antibiotics and other chemicals.

These Directives and Acts and others have now been combined into one overarching Water Framework Directive (COM(97)49). This harmonising legislation on water quality parameters and protecting all types of waters, will also replace groundwater Directive (80/68/EEC), Surface Water Directive (75/440/EEC), Fish Life Directive (78/659/EEC), Shellfish Cultivation Directive (79/923/EEC) and Discharges into Water Directive (76/464/EEC) and has enormous implications for the regulation and monitoring of aquaculture activities.

1.4.4. Emergence of Codes of Conduct, Codes of Practice, Best Environmental Practice

Faced with the increasing difficulties of regulating aquaculture activities because of the number of interests involved, the variety of institutions involved, the diversity of natural resources involved, what has been called “the tangled web of laws and regulations”, as well as the series of initiatives to direct the industry towards environmentally friendly and socially sustainable practices, increasing importance is being given to Codes of Conduct and Codes of Practice built on Best Environmental Practice. For instance, the Federation of European Aquaculture Producers (FEAP) drew up a Code of Conduct which was unanimously adopted by its members in June

2000. Such recommendations are not legally binding but constitute a code of practice to be consulted and used by countries to promote environmental protection when formulating national policies and legislation governing aquaculture and fisheries activities.

It is clear that all the above factors have a direct bearing upon the training needs of fish farmers.

1.5 Technological Change and Research & Development

The pace of technological innovation is a critical factor for industrial development including European aquaculture. The 1990s saw a considerable increase in the use of technology on farms, and increased mechanisation of farm operations drawing on a well-developed R & D support base and targeted research programmes both at national and European level.

1.5 Societal changes

Some of the changes taking place in European social structures and reflected at national, regional and individual levels, are directly relevant to the aquaculture industry.

a) Demographic trends

Across Europe there has been a gradual shift in population numbers/density from rural areas to cities and towns. While this trend has marked and well-documented impacts on community structure in rural areas, it poses particular difficulties for industries such as aquaculture based in remote and coastal areas which are starved of staff, particularly those with advanced management /technical skills

b) Heightened aspirations

The trend coincides with a heightening of the aspirations of young people, who wish, very understandably, to improve their social and professional position. These aspirations have been given a certain impetus because of the growth and increased skill requirements of the European economy.

c) Mobility

Many forms of mobility (geographical, social or functional) are guided, if not driven, by the above considerations. In Europe, however, mobility is even further constrained by its variety of language, culture and social structure. (Aspects of mobility are discussed in more detail in Section 2.)

Section 2

Issues in aquaculture education and training

AQUA-TNET Working Group Activities

Compiled by:

Mrs Margaret Eleftheriou
Hellenic Centre for Marine
Research, Crete
Dr Lluís Tort
University of Barcelona
Spain

Summary outline

.....

Section 2 outlines general issues in aquaculture education and training in Europe and examines how such systems should adapt in order to meet new industry requirements, the Bologna reforms and the proposed VET restructuring resulting from the Copenhagen Declaration

AQUA-TNET Working Group activities as a source of information and provider of solutions

.....

2. ISSUES FOR EUROPEAN AQUACULTURE EDUCATION AND TRAINING

2.1 AQUA-TNET concerns and activities

2.1.1 Background

2.1.1.1

Section 1 considered some macro-environmental changes which have imposed certain changes in procedures in the European aquaculture industry. Section 2 considers and describes the reforms currently taking place in European higher education and training organisations as part of the Bologna Process in higher education and following the Copenhagen Declaration (November 2002) in Vocational Education (VET).

These changes, quite correctly described as “seismic”, were nevertheless anticipated to some extent in the first edition of the AQUATNET White Paper¹ which appeared in 1998. In this section, these changes and the procedures and processes which promoted and fostered the proposed reforms, are given in chronological order, in order to comprehend, not only the rate at which these proposals were made, but also to give some idea of the difficulty of obtaining reliable and factual information as to what was actually taking place within the inner decision-making bodies. Also within this section are descriptions of the earlier work carried out which enabled the Network to remain abreast of the seemingly sudden changes contained in the incredibly rapid progress of the Bologna Process and the inter-related Copenhagen Declaration. For the group/network had already made, working on its own, considerable progress towards many of the far-reaching strategic, curricular and pedagogic proposals made as part of these inter-related Processes.

2.1.1.2 AQUATT’s initial thrust towards Mutual Recognition of Aquaculture Courses

AQUATT, since its establishment in 1992 and its subsequent involvement in preparing, planning and running courses in aquaculture at the tertiary as well as at the vocational level for its members, had from the outset been concerned with the lack of reliable certification and mutual accreditation awarded to certain aquaculture courses. It obtained EU funding (FORCE) to address these issues in a study covering the course provision, course assessment and certification of four important aquaculture industry countries (Norway, Greece, Scotland, Ireland), in depth and in detail. The results, in a valuable publication entitled “Framework for Future Mutual Recognition of Aquaculture throughout Europe” (FORCE 1995)² highlighted the proliferation of courses and the significant differences in course content, duration of courses, assessment instruments used, as well as the methods used to quantify and indicate the quality of the degree/certificate/qualification obtained

2.1.1.3 Educational and training needs of industry (IRDAC involvement)

In the early 1990s, the Industrial Research and Development Advisory Committee of the European Union (IRDAC) published two seminal documents outlining what it saw

¹ “White Paper on Education and Training in Aquaculture for the New Millenium”. Eds. L.Owen, M.Eleftheriou & R.Fitzgerald. AQUA-TNET, Dublin, 2000.

² “Framework for Future Mutual Recognition of Aquaculture throughout Europe” (FORCE 1995).

as the skills needs³ of the industrial base in Europe and its recommendations⁴ for educational action in the light of those perceived skills shortages. The 1994 report considered the implications for industry, education and training, giving an overview in tabular form which is given here as Appendix 1 to this Section. Far from being out-of-date, or water under the bridge, this Report now looks remarkably prescient and influential, and is still being quoted in recent publications concerning the effects of the Bologna declaration. This is not surprising given the nature of its recommendations, and their clear links to such features as learning outcomes in the Ministerial recommended actions of both the Bologna and Copenhagen processes.

2.1.2 Setting the AQUA-TNET agenda

2.1.2.1

It is also unsurprising that AQUATT took on board certain key features of the IRDAC recommendations, particularly when it obtained funding to set up the AQUA-TNET SOCRATES Thematic Network.

One of the main purposes of the AQUA-TNET Thematic Network (1996) was to set up a higher education forum focusing on issues such as: control of curriculum content and delivery, the mutual acceptance of degrees (mutual recognition and accreditation, mobility of trainers, and co-operative education (student placements), and strong industry-university co-operation. AQUA-TNET established working groups with the following objectives:

- a) to assess, compare and analyse the state of the aquaculture tertiary education sector in Europe
- b) to identify key curricular development objectives
- c) to produce and disseminate a review of best practice in European tertiary education
- d) to move towards a more open, transparent and innovative system of course provision and assessment
- e) to review aquaculture staff and student mobility patterns.

2.1.2.2 AQUA-TNET's first published pan-European review of aquaculture course provision

The Network used the partners' previous experience in mutual accreditation of course work and certification to update the previous collection of data to include all fifteen AQUA-TNET partners, resulting in another key publication "Higher Education in Aquaculture and Related Sciences - Guide to Courses within Europe" (1998)⁵. This publication, the first of its kind in aquaculture, gave details of all academic aquaculture course units/modules and courses in each participating country. The information was presented in a comparable format according to the EURYDICE⁶ recommendations (thus anticipating the UNESCO Diploma Supplement Initiative which later became an integral part of the Bologna Process). In the AQUA-TNET

³ Industrial Research and Development Advisory Committee (IRDAC), "Skills Shortages in Europe: IRDAC Opinion", November, Brussels, 1990.

⁴ Industrial Research And Development Advisory Committee of the European Commission (IRDAC), *Quality and Relevance, The Challenge to European Education, Unlocking Europe's Human Potential* (Brussels, IRDAC) 1994.

⁵ Higher Education in Aquaculture and Related Studies: Guide to Courses within Europe. Eds: R.Fitzgerald, M.Mercer, C.Hobbs. Dublin, 1998.

⁶ Key data on Education in the European Union, 2nd edition, EURYDICE, 1996.

publication the diversity of provision throughout Europe in aquaculture courses was highlighted, another non-sectoral phenomenon which predated a SOCRATES-funded study⁷ carried out under the auspices of the European University Association (EUA) by more than two years. This will be referred to in greater detail in the section concerning M.Sc. degrees.

2.1.2.3 AQUA-TNET's second published review: the White Paper on Education and Training in Aquaculture for the New Millennium

In the light of the run-up to the year 2000, AQUA-TNET carried out another comprehensive review of the European aquaculture industry and its education and training needs, the first edition of the present publication. The White Paper(2000), once again, well in advance of the Bologna process, made formal recommendations covering the following areas:

- promotion of geographic and functional mobility
- transnational placements at various levels (post-grad and post-doc)
- exchanges of trainers between countries and organisations
- delivery of highly specialised and advanced education and training
- joint development of specific specialised courses
- accreditation and mutual recognition of qualifications

2.1.3 Need for update of the White Paper

Although AQUA-TNET had anticipated several European initiatives, with its unique database of comparative data on aquaculture course provision in higher education, and its second publication ensured that its partners had kept fully abreast of all European developments, it is blindingly obvious that, no matter how prescient its previous pronouncements had been, their context was at that point completely out of date, superseded by the very rapid changes and reforms occurring on an annual basis as a result of the legislative impact of the Bologna process, the Copenhagen Declaration, and the EU policies on Education and Training for the year 2010.

Though much of the previous work done by AQUA-TNET was carried out in advance of these reforms, its research and the resulting conclusions anticipated many of the Bologna and Copenhagen reforms. Much of the work therefore has remained relevant and is included in the present publication. These details are given after the outlining of the radical changes that are taking place in the EU higher education background. The rapidity of these, as seen on an educational timescale, makes it desirable to describe this changed and changing context in some detail (given below). Otherwise even seasoned EU coordinators and experienced academics find themselves lost in a strange new maze.

2.2 The Bologna Process and the European Higher Education Area (EHEA)

2.2.1 Diploma Supplement emerges, predating the Bologna Process

2.2.1.1

⁷ "Survey on Master Degrees and Joint Degrees in Europe". Christian Tauch and Andrejs Rauhvargers, EUA, SOCRATES, 20 Sept. 2002.

When the AQUAT-NET group discovered the Diploma Supplement initiative, it seemed to mirror the group's own priorities at that time and therefore the initiative was closely followed by the group. AQUATT had shown that the curriculum and assessment diversity in aquaculture studies, called by EURYDICE/CEDEFOP⁸ in 1995 "the richness and diversity of the education systems in the European Union" seemed to be proving a source of confusion rather than richness. In the wider international perspective this led to the creation of a Joint Working Party set up by the Council of Ministers, the European Commission and UNESCO in December 1996, to develop a model for a Diploma Supplement. Initially this project was not widely publicised and its results were not widely available until the summer of 1999. As mentioned above, it was apparent to AQUA-TNET that the aims of the Diploma Supplement Working Party were remarkably similar to the aims of AQUATT in its early work (1995) on Mutual Accreditations which were:

- i) to ease the problems of recognition
- ii) to promote transparency
- iii) to promote the international recognition of qualifications.

The recorded motivation for the Diploma Supplement initiative as reported in the Summary of the Working Party Report⁹, reflected almost exactly AQUA-TNET's spur to action within the aquaculture sector. As such they can bear the weight of reiteration in the present context:

- "a) educational systems and qualification structures are constantly changing under the impact of economic and technological change
- b) non-recognition and under-valuing of qualifications is a global problem
- c) mobile citizens need clear explanations of their qualifications
- d) original qualifications alone do not provide sufficient information".

2.2.1.2

The Diploma Supplement model had been intended to be a document attached to a higher education diploma or certificate, designed to provide a description of the nature, level, context, content and status of studies carried out and successfully completed by the person named in the original qualification/certificate/ diploma. It is regarded as an important tool to improve international transparency and fair academic and professional recognition of qualifications (Example is shown in Appendix 3).

However, extremely important developments were taking place in Europe, of far greater significance than the relatively simple Diploma Supplement which was incorporated in the more radical and far-reaching reforms being adopted as part of the ongoing Bologna Process, and it was specifically mentioned¹⁰ as an important part of the Lisbon Convention on the Recognition of Qualifications concerning higher education in the European region.

⁸ "Report on Education Structures in the European Union", EURYDICE/CEDEFOP, 1995

⁹ Joint European Commission, Council of Europe, UNESCO/CEPES Diploma Supplement. Summary of Joint Working Party, on <http://europa.eu.int/en/comm/dg22/recognition/dsen.pdf>

¹⁰ Council of Europe Steering Committee Document CD-ESR-GTI (2002) 1, 3 June 2002, Strasbourg

2.2.2 History of the Bologna Process

2.2.2.1 The Bologna Declaration

The Bologna Declaration (1999) made a commitment towards establishing a Higher European Education Area by 2010, to be pursued by means of six objectives:

- i) the adoption of a system of easily readable and comparable degrees; also through the implementation of the Diploma Supplement
- ii) the adoption of a system essentially based on two main cycles, undergraduate and postgraduate studies
- iii) the establishment of a system of credits
- iv) the promotion of mobility
- v) the promotion of European co-operation in quality assurance
- vi) the promotion of the European dimension in higher education.

2.2.2.2 The Prague communique

A further meeting of European Ministers for Higher Education was held in Prague in May 2001, to review the progress achieved towards the European Higher Education Research Area, and to set directions and priorities. In the Prague communique, Ministers reaffirmed their commitment to the objectives of the Bologna Declaration and added three new and important elements of the Higher Education Area

- Lifelong learning
 - Involvement of students
 - Enhancing the competitiveness of European education (globalisation of education)
- “Ministers emphasised that for greater flexibility in learning and qualification processes the adoption of common cornerstones of qualifications, supported by a credit system such as the ECTS or one that is ECTS compatible, providing both transferability and accumulation functions, is necessary. Together with mutually recognised quality assurance systems such arrangements will facilitate students’ access to the European labour market and enhance the compatibility, attractiveness and competitiveness of European higher education. The generalised use of such a credit system and of the Diploma Supplement will foster progress in this direction.”(Prague Declaration, May 19, 2001)

2.2.2.3 Timetable of events and publication of important documents

There were six official subjects for Bologna Seminars, with two seminars devoted to each subject: Accreditation and Quality Assurance; Recognition issues and the use of credits; Development of joint degrees; Degrees and qualification structures; Social dimension; Lifelong learning. There were also a series of other, related events, such as the meetings held by the (then)newly created European University Association: the SOCRATES TUNING projects (1 and 2); the launch of the SOCRATES Pilot Projects in European Masters with 11 selected programmes; the TRENDS II AND III reports; the response of the universities to the EU consultation paper “The Role of the Universities in the Europe of Knowledge”. These Bologna and Bologna-related events are set out in Table 1 below. Fuller details are also given.

Table 1. Overview of Bologna and Bologna related events from 2000 – Sept. 18 2003

2000	March	European Summit Lisbon: Europe as knowledge-based economy ➤ Life-long learning
------	-------	--

		➤ Increased transparency of qualifications ➤ Promotion of mobility ➤ European CV
2001	March	Salamanca Convention of Higher Education Institutions ➤ Affirmation of Bologna aims ➤ Quality Assurance issues ➤ Use of ECTS, Diploma Supp. NARIC/ENIC for mobility ➤ Compatible qualifications at undergrad and graduate levels
	March	Creation of European University Association- 1st meeting ➤ Merging of Association of European Universities (CRE) and Confederation of Rectors' Conference
	May	Prague communique (32 signatories) Bologna reaffirmed +3 new areas ➤ Lifelong learning ➤ Involvement of students ➤ European dimension(globalisation of education)
	May	Brussels: Launching of TUNING Project ➤ 2-yr project (70 universities, 105 depts, 128 partic., 7 subjects) ➤ Aims: To bring about convergence in 5 main subject areas ➤ Identify common subject-based reference points, curricula content, learning outcomes, ➤ Identify methods of teaching, learning and assessment ➤ To facilitate transparency
	July	Brussels COM(2001) 385: Involvement of Third countries ➤ Globalisation of European higher education ➤ ECTS ➤ Joint diplomas
	Nov.	EU Education Council of Ministers meeting ➤ Rpt. On concrete objectives of education & training systems

2002	Feb.	EU Education Council of Ministers meeting.
		➤ Recommendations to Barcelona Summit concerning globalisation of EU education
	Feb.15	➤ Recommendation for European CV
		Dublin: Standards/benchmarks for Bachelor and Master programmes
	March	c) Dublin Descriptors
		➤ Barcelona Summit Presidency Concl. SN 100/02 ADD 1
	March	➤ No 44. «To introduce instruments to ensure transparency of Diplomas and qualifications (ECTS, Diploma and certificate Supplements, European CV)»
		Bologna Seminar No 1. Amsterdam
	April	➤ Accreditation and Quality Assurance
	May	➤ Amsterdam Consensus
		Bologna Seminar No 2: Lisbon
	May	➤ Recognition issues and the use of Credits
		Bologna Seminar No 3: Stockholm
	May	➤ Development of Joint Degrees
		EU Education Council of Ministers mtg: follow-up to Barcelona
		➤ Transparency of qualifications, ECTS, Diploma Supplement
		European Parliament: Report on universities/higher Education (2002/2174(INI)) A5-0183/2002-11-19
	May 31	➤ Recommends acceleration of Bologna but not standardisation
		➤ Recommends rapid, flexible recognition of diplomas/qualifications
		➤ Supports proposals for European Masters
		Brussels: TUNING Final meeting
		Recommendations:
		➤ Common approach to length of studies within Bologna two-cycle system is essential
	July 17	➤ Adoption of framework based on common ECTS understanding to include grades as well as credit transfer
		➤ Competences (skills) and learning outcomes (both subject-related and generic)
	July	➤ Universities shd. have common terminology and methodologies for convergence at both disciplinary and multi-disciplinary levels
	Sept.8	Viviane Reding Brussels: European Masters proposal
	Sept 20	EU Brussels COM(2002) 401. 2002/0165 (COD)
		➤ Proposal for ERASMUS MUNDUS (180 million Euros, 2004)
		➤ 4000 student exchanges
		➤ 1000 scholar (teacher) exchanges
		➤ Involvement of third world but also US/Canada
		EUA Pilot Project for European Masters for 2002/2003
	Oct.11/12	➤ 11 selected, report for Graz (May 2003)/Berlin(Sept 2003)
		EUA Survey on Master Degrees and Joint Degrees in Europe
	Nov.30	➤ 1 st analysis of Master level and joint degrees across Europe
		➤ Serious discrepancies in Master degrees:
		➤ professional and academic; taught and research;
		➤ Credits discrepancies
		➤ Long Masters: 270 –300 ECTS. Short Masters: 60-120 ECTS
		➤ Reliance on Diploma Supplement to make sense from confusion

2003	Jan. 10	The role of the universities in the Europe of knowledge
	Feb 5	Consultation paper from EU. Deadline for comment 31 st May
	Feb 14	2nd EU Bologna Progress Report
		I. aims to set Bologna in wider framework
		II. Action Plans, elearning, Copenhagen, and LifeLong Learning
		III. Diploma Supplement Label
	Feb 19	5th Bologna Seminar: Athens -Social Dimension (Overview)
	Mar.14	6th Bologna Seminar Helsinki:Master Degrees
		• Call for common framework of education qualifications • All Bachelors to open access to Masters (Rec. 3) • All Masters to give access to doctoral studies (Rec.3) • Bachelors/Masters described in Content, Quality and learning Outcomes, not only duration of programme (Rec.4)
	Mar.27	• Joint degrees shd.be developed (Rec. 6) • Min. credits for Masters to be 60 (Rec. 7)
		7th Bologna Seminar: Copenhagen: Qualification structures
	Mar.28	• Develop overarching European Qualifications Framework (Rec. 2) • Descriptions of workload, level, quality, learning outcomes, profile (Rec. 4) • Council Europe/UNESCO Recognition Convention to be ratified as soon as possible (Rec. 9) • Diploma Supplement/ECTS to be reviewed (Rec. 10)
	April 11	
	May 9	EUA Conference Bristol:Role of the universities
	May 28	8th Bologna Seminar: Mantova: Integrated curricula
		Legal obstacles to joint degrees shd be removed
		Learning outcomes,competencies, + workload, crucial elements
	June 5	Importance of linguistic diversity
		Launch of TUNING 2
		Graz: EUA Convention of Higher Education Institutions
	June 12	I. Many important contributions, especially Mrs Reding's
		II. TRENDS III Report
		III. Response of EUA to Role of Universities
	Sept. 18/19	9th Bologna Seminar:Prague: Validation of non-formal Learning Experiences
		Diploma Supplement to record learning outcomes
		10th Bologna Seminar: Oslo: Student Involvement in the Bologna Process
		Ministerial Conference in Berlin
		Ministerial Statement – Berlin Communique

2.2.2.4

What became apparent from the overview of the changes envisaged as part of the Bologna Process, and the changes actually taking place in conformity with the

process, was that the Bologna Process was acting as a catalyst and was doing far more than merely harmonising the external structure of European 1st and 2nd degrees into a 3+2 format. For instance, the pilot project TUNING was described by Ms Reding, EU Education and Culture Commissioner, at its Final Conference on 31st May 2002, as “being at the heart of the Bologna Process”. Yet very few of those who would mainly be concerned in the future with the results of this project, the academic community, were even aware of its existence. Because many of those most concerned are still not familiar with the fine print of these far-reaching reforms, more detailed descriptions of the Seminars are given below.

2.2.2.5

a) **The Zurich Seminar in October 2002**, concerned the use of credits, with one presentation from S.Adams dealing specifically with ECTS and the Diploma Supplement, the title being “Complementary tools for recognition and transparency”. (with a recommendation that the final ECTS transcript should be integrated into the Diploma Supplement).

b) 10th January 2003 saw the publication of the communication from the Commission entitled “***Investing efficiently in education and training: an imperative for Europe***”¹¹, a hard-headed and remarkably frank paper which explains the rationale behind “the new investment paradigm in education and training” and sets out the main components and success factors to achieve this.

- “The achievement of greater efficiency of educational investment and the completion of a European labour market call for a step change in the recognition of qualifications and competencies acquired anywhere in the EU.
- In various instruments that were introduced to support these policies progress has been much slower than anticipated.....
- No European knowledge area and no European labour market can exist without a transparent, user-friendly and predictable system for the recognition of degrees and qualifications across internal borders. The cumbersome and tardy recognition processes remain the biggest single obstacle to a fluid and effective European labour market....”

c) On 5th February 2003 came the DG Research consultation paper “***The role of the universities in the knowledge society***”¹², and there is no doubt that this communication achieved its purpose “to start a debate on the role of universities within the knowledge society”. The universities are seen as firmly set within the framework of the global market place, and their role as that of managers and providers of knowledge as a product, with students and business as consumers and clients. The Communication also places considerably increased research funding (3% of GDP, two-thirds to come from the private sector) in the hands of the universities, but with certain provisos, one of which is full acceptance of the greatly speeded up Bologna reforms. These reforms, coming thick and fast from the official Bologna seminars and officially supported conferences, include:

¹¹ “Investing efficiently in education and training: an imperative for Europe”.COM (2002) 779 final, European Commission, January 2003

¹² “The role of the universities in the Europe of knowledge”, European Commission, COM(2002) 58 final, Brussels, February 2003

- a much more comprehensive role for ECTS which will also become a transfer accumulation system
- universities to consider widening access to tertiary education by considering the creation of ECTS for Lifelong learning.
- Diploma Supplement is mentioned on p.20 as one of the instruments having been developed for transparency and easier mutual recognition.

d) The **EU Second Bologna Progress Report, From Prague to Berlin** (14th February 2003) ¹³ sets the Bologna Process within a wider framework, which aims to integrate Action Plan Skills and Mobility, Action Plan on Mobility, eLearning, Bruges/Copenhagen process, “*all of them set within a Lifelong Learning perspective*”.

Action Line 1. Adoption of a system of easily readable and comparable degrees

- A wide-scale introduction of the Diploma Supplement, increasing substantially the understanding and recognition of degrees at all levels. Synergies with similar documents in vocational training will be sought.
- The wide-scale introduction of the Diploma Supplement will be supported (as an eligible expense) through the grants which Socrates-Erasmus National Agencies provide to universities for the Organisation of Mobility (OM) as from the academic year 2003-04.
- The promotion of the Diploma Supplement is closely linked to the successful promotion of ECTS. A joint pool of ECTS/DS Counsellors has been formed in order to help universities, which make a proper use of those instruments, prepare for the ECTS label and/or the Diploma Supplement label (application date 1 November 2003 and subsequent years).

e) In **Helsinki (March 14/15 2003)** there was a **Bologna Seminar on Master degrees**. The ten Recommendations adopted by the participants concerning useful common denominators for a master degree in the EHEA are essential reading for any university academic.

- Recommendation 3. All bachelor degrees should open access to master studies and all master degrees should give access to doctoral studies.
- Recommendation 4. Bachelor and master programmes should be described on the basis of content, quality and learning outcomes, not only according to the duration of programmes or other formal characteristics.
- Recommendation 6. Joint European programmes at the European level should be developed to promote intra-European cooperation.....
- Recommendation 7. While master degrees normally carry 90-120 ECTS credits, the minimum requirements should amount to 60 ECTS credits at master level.....
- Recommendation 10. In order to increase transparency, it is important that the specific orientation and profile of a given qualification is explained in the Diploma Supplement.

Page 2 of the final recommendations states

“All higher education establishments should make use of the Diploma Supplement.

f) The **Bologna Seminar on Qualifications Structures in Higher Education in**

¹³ “From Prague to Berlin: the EU Contribution. Second Progress Report”. Brussels, 14 February, 2003.

Europe met on 27/28 March in Copenhagen and made 12 Recommendations .

Recommendation 10 states

“ Transparency instruments such as the Diploma Supplement and the ECTS should be reviewed to make sure that the information provided is clearly related to the European Higher Education Area (EHEA) framework.”

This seminar is noteworthy for its publication of one of the most comprehensive and detailed papers from Stephen Adam of the University of Westminster, one of the organisations that had helped to develop the Diploma Supplement. His 60-page paper¹⁴ entitled “Alternative Approaches for clarifying the cycles and levels in European Higher Education qualifications” gives a succinct yet detailed overview of the events and their defining conclusions; his description of other developments which led to some of the TUNING aims is particularly useful. A large part of the TUNING initiative was devoted to bringing about convergence by defining accepted professional and learning outcomes and by developing professional profiles and desired learning outcomes in terms of knowledge, skills and competencies. He also outlines the emergence of the DUBLIN DESCRIPTORS¹⁵ and the AMSTERDAM CONSENSUS¹⁶, both of which were produced under the Joint Quality Initiative, itself a Bologna creation.

The Dublin Descriptors produced generic BA/MA qualifications descriptors which have been combined in both TUNING projects with subject-specific elements and resulting in a learning outcomes approach to credit awards. A further significant conclusion is that the ECTS should be refined into a pan-European credit accumulation framework based on learning outcomes. Thus, Adams goes on to show that one of the Zurich recommendations is that the specific orientation and learning outcomes of a given qualification should be included in its title and explained on the Diploma Supplement issued to the student. The final paragraph of the Executive Summary merits unedited quotation, because it foresees or predicts almost exactly what was to be recommended in the Berlin Statement 6 months later.

“Several urgent questions face European education systems. These can be summarised in the following checklist of issues for consideration: the nature of national and any over-arching European qualifications framework in the context of the Bologna 10 action-line; the role of levels, credits and Bachelor/Master descriptions; the use of qualifications descriptors, programmes profiles/specifications, learning outcomes, competencies and subject benchmark statements. Progress in these areas is central to the creation of the European Higher Education Area.”

h) The **Mantova Bologna Seminar** on Integrated Curricula(11/12th April 2003), reiterated the conclusions of the Stockholm Seminar held in 2002, the 5th of which stated “full use should be made of the Diploma Supplement and ECTS in order to ensure comparability of qualifications”

i) On May 9, **TUNING II** (odur.let.rug.nl/TuningProject/index_phase2.htm) was

¹⁴ “Qualification Structures in European Higher Education:Alternative Approaches for clarifying the cycles and levels in European Higher Education qualifications”. Stephen Adams, SOCRATES, March 3, 2003.

¹⁵ “Towards shared descriptors for Bachelors and Masters” Joint Quality Initiative, Informal group report, February 2003.

¹⁶ “Working on the European dimension of Quality”, Joint Quality Initiative, Amsterdam, March 2003.

launched, with more partners, and new subject areas (European Studies and Nursing). New activities included:

- To fine-tune the general methodology for measuring workload developed in TUNING 1, make it operational and test it
- To establish a link between competences and ECTS and test ECTS as a tool for curriculum design
- To develop reference points for common curricula on the basis of agreed competences, enhancing in the is way the recognition and integration of diplomas

AQUA-TNET has made a comparison of the TUNING project generic and subject-based competences as it became apparent that there were significant similarities. In fact, it could be said quite accurately that AQUATT had anticipated the TUNING findings by about 3 years. This comparison is shown in Appendix 2.

j) On **May 29, the EUA Graz conference** presented the EUA response to the EU Communication of the role of the universities¹⁷ and the **TRENDS III Report**¹⁸

Some bullet points from the EUA response are illuminating and deserve repetition:

- Re-definition of the terms universities ‘institutions with full power to award doctoral degrees’ which reduces the EU estimate of 4000 such institutions to a maximum of 1000.
- Coherent European policies and implementation mechanisms allowing more co-operation , and not just increased competitiveness, need to be put in place, as a means of strengthening Europe
- Rethinking the approach to mobility and strengthening European co-operation at the doctoral and postdoctoral level. This means redoubling efforts at all levels to tackle barriers to mobility

The Trends III Report: Bologna four years after (Reichert and Tauch) likewise made some very trenchant comments which deserve wider circulation:

- The reforms have yet to reach the majority of the Higher Education grassroots who are supposed to implement them and give them concrete meaning, and that administrative staff and students seem to be even less included in the discussions.
- The emerging European Higher Education Area (EHEA) regards Higher Education is a public good and a public responsibility
- Only 20% of HEIs are fully aware of the GATS inclusion of Higher education as a global product
- It will be essential for HEIs to elaborate qualifications frameworks based on external reference points (qualifications descriptors, level descriptors, skills and learning outcomes)
- Institution-wide procedures for recognition seem to be quite under-developed
- The Diploma Supplement is being introduced in a growing number of countries, but the main target group – employers – are still insufficiently aware of it. The introduction of a Diploma Supplement label would lead to a clear qualitative improvement in the use of the Diploma Supplement

¹⁷ European University Association (EUA) Response to the EU Commission : the Role of the Universities in the Europe of Knowledge, Graz, May, 2003.

¹⁸ “Trends in Learning structures in European Higher Education III: Bologna four years after: Steps towards sustainable reform of higher education in Europe”. Sybille Reichert and Chrisian Tauch, SOCRATES, Brussels, June 2003.

- Lifelong Learning is not targeted towards the Higher Education sector in most European countries. In order to position themselves in an expanding market and clarify the added value of their expertise, HEIs will have to make more of an effort to integrate Lifelong Learning into their core development processes and policies.
- In practically all action lines of the Bologna reforms, two potentially conflicting agendas have merged

k) The Prague Seminar on Recognition and Credit Systems in the context of LifeLong Learning(5-7 June 2003)

The Recommendations are made to four different target audiences

- i) higher education institutions and others
- ii) public authorities responsible for higher education
- iii) international institutions and organisations
- iv) The Berlin Higher Education Summit

There are seven Recommendations for higher education institutions of which the following are particularly relevant to this summary of events

- * to use the Diploma Supplement, ECTS credits and skills portfolios to record learning as well as to facilitate individual learning paths
- * to express all qualifications in terms of explicit reference points: qualifications descriptors, level descriptors, learning outcomes, subject related and generic competencies
- *to adopt internal policies to promote the recognition of prior formal, non-formal and informal learning for access and study exemption
- *to reconsider skills content in courses and the nature of their study programmes

A point made which has had a clear impact on current thinking as expressed in the latest Maastricht Declaration (December 13, 2004) concerns lifelong learning and Qualifications Frameworks: *“the issue of LifeLong Learning links directly with the issue of defining a Qualifications Framework. A key function of qualifications frameworks is to guide individuals and help them reach their educational goals with as few complications as possible. The traditional concepts of workload and level have been refined and are no longer expressed only in terms of years of study. Learning outcomes are also an integral part of the discussion on qualifications frameworks.”*

l) GATS in European Higher Education Council of Europe (June 2002)

An important issue given the TRENDS III report (June 2003) stating that only 20% of Higher Education Institutions were fully aware of the GATS negotiations. Information can be found at the EU website on World Trade in Services <http://gats-info.eu.int>.

The GATS (General Agreement on Trade and Services) is a multilateral agreement under the World Trade Organisation (WTO) which came into effect in 1995. GATS applies to almost all service sectors (two exceptions) including education. The EU which is of course a signatory has included higher education in their schedule with clear limitations on all modes of trade except “consumption abroad” which usually means foreign tuition paying students.

There are two areas where GATS could have an effect on the Bologna Process:

- the lack of opportunity to qualify as a degree granting institution is designated as a “barrier to trade”

- lack of recognition of prior qualifications from other countries is also designated as a barrier to trade.

2.2.2.6 The Berlin Communiqué

The Ministers in charge of Higher Education of almost all European states met in Berlin on 18 and 19 September 2003 to exchange views on the progress made in the Bologna Process and decide on where to go from there. Ministers decided to give the Process further momentum, by committing themselves to three intermediate priorities for the next two years:

- * quality assurance,
- * two cycles systems and
- * the recognition of degrees and periods of studies.

By 2005 they expect to have detailed reports on the progress achieved in each country in these three areas.

As for Quality Assurance, Ministers stressed that consistent with the principle of institutional autonomy, the primary responsibility for quality assurance in higher education lies with each institution itself. They agreed that by 2005 all national quality assurance systems should include:

- * A definition of the responsibilities of the bodies and institutions involved.
- * Evaluation of programmes or institutions, including internal assessment, external review, participation of students and the publication of results.
- * A system of accreditation, certification or comparable procedures.
- * International participation, co-operation and networking.

Moreover, Ministers called upon ENQA to develop an agreed set of standards, procedures and guidelines on quality assurance and to prepare a report for the Ministers Conference in 2005.

With regard to the introduction of Bachelors/Master, Ministers they committed themselves to having started the implementation of the two-cycle system by 2005. In that context Ministers encouraged the elaboration of qualifications frameworks at national but also at European level. Such qualifications frameworks should describe qualifications in terms of workload, level, learning outcomes, competences and profile.

In the context of the recognition of degrees and periods of study, Ministers underlined the importance of the Lisbon Recognition Convention, which should be ratified by all countries participating in the Bologna Process as soon as possible. At a very concrete level, they set the objective that “every student graduating as from 2005 should receive the Diploma Supplement automatically and free of charge” and that it should be issued in a widely spoken European language.

Apart from these three intermediate priorities, Ministers considered it useful to

promote closer links between the European Higher Education Area and the European Research Area in a Europe of Knowledge. They therefore went beyond the present focus on two main cycles of higher education and decided to include the doctoral level as the third cycle in the Bologna Process.

A somewhat smaller Board, like the Follow-up Group to be chaired by the EU Presidency, shall oversee the work between the meetings of the Follow-up Group. Finally, the overall follow-up work will be supported by a Secretariat provided by Norway, as it will host the next Ministerial Conference: in May 2005 in Bergen.

2.2.2.7

A similar set of Bologna seminars has been taking place during 2004 but it is not proposed to describe these at present as this section would become far too unwieldy.

2.2.3 *Curricular content provision-undergraduate and M.Sc. (“Masters”)*

2.2.3.1 *Development of third level aquaculture courses*

From the data compiled from the survey previously referred to, together with the outcomes of several workshop discussions, AQUA-TNET produced a paper outlining the best practices in European aquaculture course provision. The paper, entitled “Recommended structure for a European Aquaculture Academic system’ gave recommendations as to the development of third level aquaculture education in Europe, identified best practices, provided a conceptualisation of a European Aquaculture M.Sc. (Master) degree and suggested for methods of achieving a harmonised European structure for aquaculture tertiary education.

2.2.3.2 *Best practice curriculum structure – undergraduate courses*

It was felt that the schema below provided the best practice curriculum structure of European aquaculture academic under-graduate courses, bearing in mind the suggestions made in the IRDAC Report on Quality and Relevance and results from various kinds of training needs analyses made in the 90s. In this schematic representation, it is envisaged that the individual course should contain a group of core modules, supported by further recommended modules, and finally, optional specialisations. It is noteworthy that many of these subject-related competences and also the generic competences feature in the TUNING project list, which did not appear until July 2003. A comparison between the TUNING and the AQUA-TNET lists is given in Appendix 2.

Table 2. *Recommended curriculum structure of European aquaculture academic Under-graduate courses*

Year		Acquired Collateral Skills
------	--	----------------------------

Year 1	<u>Elementary Foundation Phase</u>	<u>Compulsory</u> (Bio)Maths, Physics Chemistry, Biology	• Computer Skills
Year 2/3	<u>Broadening Knowledge Base</u> <u>Introduction to Specialisation</u>	Core subjects e.g. Animal Sciences, and Complementary subject areas eg: Biochemistry	• Library searches • Literature review • Statistics • Report Writing • Good Lab. Practice
B.Sc/Lic 3/4 years	<u>Advanced courses & (Options)</u> <u>Core Competencies</u> • Life Requirements and Biology of aquatic organisms • Tech & engineering of Culture Systems • Health and Welfare • Production and Environment • Nutrition • Genetics • Reproductive Physiology • Business Management <i>Research project(s)</i>	<u>Specialisations</u> <u>Optional Competencies</u> • Economics • Informatics • Zootechnology • Water quality • Food Technology • Pathology • Freshwater & marine environments • Larviculture • Aquariology of ornamental fish • Restocking • Broodstock Mgt. • Polyculture • Molecular Biology • Hydrodynamics • Quality Management	• Team work • Case Studies • Communication • Presentation skills • Exp. Design • Problem solving • Analysis of systems • Simulation models • Discussion groups • Hands-on experience • Farm husbandry skills
Ir./M.Sc 4/6 years	Major Research Thesis/Dissertation		

2.2.4 M.S.c (Masters) course components and learning outcomes

2.2.4.1 Differences of Provision, Content and Length

It is perhaps in the curriculum and assessment of the Master's degree that the sharpest differences were to be found across Europe and occasionally these differences amounted to actual disparities, even at the national level. In some countries, there are no first degrees in the marine sciences, and specialised aquaculture components are offered only after the first degree. In other countries, there is more than one type of

M.Sc. on offer, with an equivalent disparity in the length and the content of each course - though the final degree award is the same. In other countries there are specialised aquaculture degrees lasting five or more years, with the final award being equivalent to a Master's degree. Thus even the duration of the course varies from a standard 12-month course, to a variable 18 to 24-month course, to a standard 24-month course, and also includes an 18-24 month topping up of a first degree.

2.2.4.2 *Differences in Organisation and Structure*

The structure and the organisation of the courses also differ considerably. Some are totally prescribed, with lectures, tutorials, practicals, field work and work experience, with little variation, flexibility and modularisation, whereas others have a core of compulsory modules with a kaleidoscope of options or electives.

These documented differences across Europe may have come about because each country genuinely recognises and responds to its own needs in the rapidly developing, multidisciplinary, multi-skilled aquaculture sector. Departments may have responded to scientific advances and industrial needs by the introduction of differing components to fill different kinds of gaps. The result is that there does not seem to be a uniform structure of the M.Sc. degree.

2.2.4.3 *Confirmation of these trends in official reports to the Bologna Group*

It is instructive at this point to consider once again some details from the TRENDS II Report which makes it clear that Bologna's proposed changes in the two-cycle degree structure are also having an effect on the content and even the nature of many of these courses, including aquaculture. The continuing diversity in first degree structure has been confirmed by the Survey on Master Degrees and Joint Degrees in Europe (20 Sept 2002), carried out by the European University Association as a SOCRATES-funded study. The information contained in this latest survey confirms that the situation as described by AQUA-TNET for first and second degrees with an aquaculture component remains very diverse. The situation with regard to second degrees, ie., Master degrees, has since then been subjected to more changes which have been formalised and "ensconced" in certain national educational structures. The differences between what are termed in the 2002 Survey the "professional" Master and the "academic" Master, not to mention the taught and the research Master variety (used by the UK and Ireland) are further emphasised by the extreme differences in the credits which are necessary to obtain these different kinds of Masters degrees.

Paragraph 7 of the Executive Summary of this latest survey states roundly

"In all countries where long (270-300 ECTS credits) and short (60-120 ECTS credits) Master programmes exist in parallel, their academic value is considered to be the same. Therefore, in many countries, little (sic) attempts are made to differentiate between the two in terms of nomenclature. One rather relies on the Diploma Supplement to explain the exact nature of the Programme."

2.2.4.4 *Suggested common curricular starting point*

The AQUAT-NET group therefore considered the types of knowledge and skills desirable for entry into a Masters level course: whether a common starting point was necessary, how to bring students up to the same introduction level etc. From the

Agricultural University of Wageningen, Netherlands, came a series of learning outcomes which were adapted to represent an “idealised” end point to the recommended under-graduate curriculum shown above in Table 2.

Such an end point represents a generalised pre-entry requirement, expressed below as a series of summarised learning outcomes shown below. Again, it is instructive to look at Appendix 2 to see the similarities with the TUNING approach which appears to have been given official blessing.

- to have knowledge of the biology of farmed animals (finfish, shellfish etc.) and to know how to apply this knowledge in animal production
- to be capable of characterising, analysing and evaluating different forms and systems of animal production
- to indicate and prevent side effects of animal production on man and environment
- to acquire a scientific attitude, oriented to formulation and the testing of hypotheses, to design research protocols, to collect and analyse data in different fields
- to value strategic and operational questions in the field of animal Sciences and to search for solutions through a multidisciplinary approach
- to be capable of reporting both orally and in writing the results of their work

2.2.4.5

A consortium whose core group are AQUAT-NET members have now obtained SOCRATES funding for a European Masters degree in Aquaculture and Fisheries, which aims to develop a complete degree cycle, with tailor-made courses designed to meet the need of students in each of the seven partner universities. Progress has already been made, taking the form of a Model Agreement for the academic year 2004-2005, and an Agreement of Cooperation on a joint Master Study Programme which has already been signed by all parties. Student mobility is also a major aspect of the project, with all participants spending at least one full semester in another university, and the final award will consist of a mutually recognised EU Master degree. The Consortium, led by the University of Ghent, will build on the TUNING experience and recommendations in which the University of Ghent played a leading role. The experience of the AQUA-TNET partners in ECTS and the Diploma Supplement will also be of benefit to the project. It is hoped that there will be some important feedback concerning the best method of implementing such projects, which are very much part of the future as envisaged by the EHEA and the aims for 2010.

2.2.5 Development of a Methodology Series of Courses

As a direct follow-up of the European curricular analysis which has just been described, the AQUA-TNET partnership developed a Methodology Series of block courses which is given in detail in Section 4. It was originally envisaged that these courses would be held in one or two week block periods in an appropriate European Academic Centre of Excellence (i.e. an institution with specific expertise in the subject area and with state-of-the-art current information, knowledge, research results and facilities relating to the area). It should also be possible for a non-partner institution to approach AQUA-TNET with a request to host one (or propose a new course) in the series and with details of their funding source. However, the

development of this series of courses has remained under university/educational control as they will primarily be used as part of academic studies.

The “AQUALABS - European Advanced Laboratory Courses in Aquaculture” project aims to provide state-of-the-art advanced training for younger researchers in four specific areas of aquaculture; (i) Quality in Fish Products (ii) Biology of Fish Larvae Production (iii) Molecular Biology and Ecology in Aquaculture (iv) Design and Operation of Recirculation Systems.

The project comprises a series of four events, known as AQUALABS (AQUALAB 1-4), which are courses specially designed to provide advanced, intensive training in the topics concerned. Each AQUALAB is a collaborative effort between four or more European Universities, and will allow up to 30 participants to be trained by leading scientists in the latest practical and field techniques. Courses will be hosted at European ‘recognised centres of excellence’ i.e., institutions with specific expertise in the subject area and possessing the current best available knowledge, generating key research findings and having fully-equipped facilities relating to the area, and each will last from 4 to 6 days .

2.2.6 Vocational education

2.2.6.1

“Validation of occupational achievement, outside paper qualifications, is even more difficult to achieve”¹⁸.

Vocational training did not, strictly speaking, fall within the AQUA-TNET remit, and thus no Working Group was set up to consider good practice. However, AQUATT had since its inception been engaged in the provision of short courses to fill perceived gaps in conventional and academic training, and had also carried out several socio-economic and certification projects which were relevant to the overall aims of the network, and from which a good deal of data had been compiled and analysed. These have been described above and need not be repeated here.

2.2.6.2

However, as a direct result of some of the Bologna Seminars, in November 2002 the Bruges/Copenhagen Declaration on enhanced co-operation in Vocational Training¹⁹ (europa.eu.int/comm/education/copenhagen/index_en.html) took place on 29/30 November. The aims of the Conference were :

- to harness the rich diversity of VET systems
- to improve the standing of vocational qualifications and competences
- to facilitate individual learning pathways
- to promote occupational and geographical mobility

Full participation of social partners would be essential to find strategies to develop competences and qualifications, which should be adopted by enterprises and industries

¹⁸ “Towards the Learning Society. White Paper on Education and Training, European Commission, 1995

¹⁹ Council Resolution on the promotion of enhanced cooperation in vocational education and training (VET), Document 14343-2002 and “Copenhagen Declaration” of the European Ministers in charge of VET and the European Commission of 30th November 2002.

acting autonomously. Specific VET issues were those of transparency, information, guidance and above all, the recognition of qualifications and competences, with Quality Assurance ensured within a European dimension. At the end of the Conference, Commissioner Reding, made the following announcements:

- there would be an attempt to create a single framework for transparency of competences and qualifications
- there would be an attempt to bring together in a single user –friendly format, the certificate supplements and diploma supplements and
- there would be an attempt to develop an ECTS system for vocational training.

2.2.6.3

Since then, Technical Working groups (TWGs) have been set up and have come up with some rather startling suggestions in the Copenhagen Interim Report.

- New EUROPASS single framework for transparency
- Draft set of common principles for validation of non-formal and informal learning
- Draft inventory of methodologies
- Strategy for development of VET credit transfer system
- Outline strategy for development of qualifications/competencies at sectoral level
- Mapping of education/training initiatives at sectoral level
- New EUROPASS to include European CV, Certificate supplement.

2.2.6.4 New types of validation for workplace training- the European Pathway for Training (MOBILPASS)

The description which follows concerns the former EUROPASS initiative. As shown in para 2.2.6.3, this acronym is now used to describe something very different from the original conception. The former EUROPASS was to contain five existing documents which cover qualifications and competences in a lifelong learning perspective: the European CV (covering personal and vocational skills); the European Language Portfolio (language skills); the Certificate Supplement (vocational qualifications); the Diploma Supplement (higher education qualifications); the MOBILPASS (the renamed EUROPASS).

It seems that the inclusion of the Diploma supplement is not now to take place, as this is not specifically referred to in the Maastricht Communiqué which is given in the following paragraph (para 2.2.6.5)

However, the Mobilpass is to be an expanded version of the present European training document and it can be used to record all instances of educational mobility. It was envisaged that a prototype electronic Mobilpass will be ready by the end of 2004.

The rationale for the development of the EUROPASS Training document (now Mobilpass) is retained for information within the updated White Paper.

Much thought had been given to the possibility of amalgamating such types of course, or course module, within an overall skills profile. In practice, students who carried out workplace training, could hope for, at best, a SVQ in Animal Husbandry at one of two rather basic levels. With the development and introduction of the Europass Training document, periods of training carried out as part of a mobility measure will be given a

valuable new dimension. “European Pathways for training refer to any period of vocational training completed by a person undergoing work-linked training as part of their training in another Member State, complying with a number of quality criteria. Europass Training, whose contents and presentation are defined at Community level, provides the personal details of the person undergoing the training, information on their vocational training in progress and details of training periods abroad (host partner, mentor, etc)”.

2.2.6.5 Maastricht Communiqué (December 14, 2004)

On 13th December 2004, EU education Ministers met in Maastricht to review the Copenhagen Declaration, and to consider the future priorities of enhanced European cooperation in Vocational Education and Training. They stated that in two years the Copenhagen Process had succeeded in raising the visibility and profile of VET at the European level and that participating countries and stakeholders had come to a common understanding of the specific challenges that have to be met, have agreed on strategies to address these challenges and have developed concrete means to support their implementation.

The necessary reforms and investment should be focused particularly on:

- the image and attractiveness of the vocational route for employers and individuals, in order to increase participation in VET achieving high levels of quality and innovation in VET systems in order to benefit all learners and make European VET globally competitive linking VET with the labour market requirements of the knowledge economy for a highly skilled workforce the needs of the low-skilled and disadvantaged groups for the purposes of social cohesion Since VET is increasingly taking place at all educational levels, the parity of esteem between VET and general education need to be fostered by innovative strategies and instruments at the national and European levels.

National Priorities

- i) the use of common instruments, references and principles to support the reform and development of VET systems and practices, regarding transparency (EUROPASS, quality assurance, validation of formal and non-formal learning)
- ii) improving public and/or private investment in VET, including incentive effects of tax and benefit systems use of Social and Regional Development Funds to support development of VET (for equipping young people with key competences and updating skills of an ageing population) development of VET to meet needs of early school leavers, migrants, the disabled, by assessment of prior learning, tailored training and learning provision development and implementation of open learning approaches, flexible and open frameworks for VET, in order to reduce barriers between VET and general education and to integrate mobility into initial and continuing training involvement of all key partners in quality assurance in VET training further development of learning conducive environments in training institutions and at the workplace, which will entail the enhancement and implementation of pedagogic approaches which support self-organised learning and utilise the potential provided by ICT and e-learning continuing competence development of teachers and trainers in VET

European priorities

- i) the consolidation of the priorities of the Copenhagen Process
- ii) the development of an open and flexible European Qualifications Framework which will provide a common reference to facilitate the recognition and transferability of qualifications covering both VET and general (secondary and higher) education, **based mainly on competences and learning outcomes**. It will provide permeability within educational and training systems, provide a reference for the validation of informally acquired competences and support the smooth and effective functioning of the European, national and sectoral labour markets. The framework should be underpinned by a set of common reference levels. It should be supported by instruments agreed at European level, particularly quality assurance mechanisms to create the necessary mutual trust. The framework should facilitate the voluntary development of competence based solutions at the European level enabling sectors to address the new education and training challenges caused by the internationalisation of trade and technology. The development and implementation of the European Credit Transfer system for VET (ECVET) in order to allow learners to build on the achievements resulting from their learning pathways when moving between learning systems. **ECVET will be based on competences and learning outcomes, taking into account their definition at national or sectoral levels**. It will take into account the experience of the ECTS in the field of higher education and the EUROPASS framework. The practical implementation should include the development of voluntary agreements between VET providers throughout Europe. The system will be broad-based and flexible to enable its progressive implementation at the national level, with priority given initially to the formal learning system.
- iv) the examination of the specific learning needs and changing role of vocational teachers... A coherent framework should be envisaged to support the improvement of the quality of vocational teaching and training
- v) the improvement of the scope, precision and reliability of VET statistics.

Implementation and Follow-up (abridged version)

- i) National networks on which all stakeholders are represented, especially ministries, social partners and regional authorities, should be set up.
- ii) education and training processes should be rationalised and streamlined at the European level by bringing these priorities within the framework of the 2010 Programme.
- iii) Proposals for a European Qualifications Framework and ECVET system should be prepared and examined
- iv) Coherent approach and closer cooperation with the Bologna Process, with pre-accession instruments and funds
- v) closer links to be developed between the social partners, taking into account the work priorities defined in their framework of actions for the lifelong development of competences and qualifications
- vi) Effective use of LDV and the future integrated action programme for Lifelong Learning to support the development, testing and implementation of innovative actions to advance VET reform

- vii) CEDEFOP and ETF to support the implementation of the Copenhagen Process by means of: the mapping of sectoral activities; LDV study visits to support mutual learning

2.3 Transnational Mobility

2.3.1. Background

“The free movement of people makes it essential for national education and training systems to consider the European dimension”²⁰.

Trans-European mobility has been put forward as one of the best methods of achieving a genuine sense of “European Consciousness” which can complement the existing citizenship of the country of origin. Mobility can make a substantial contribution towards the development of human resources, the most valuable asset of any community, whether viewed from the economic, social or cultural viewpoint.

Through the encouragement of mobility initiatives the Commission has tried to create a shared outlook across the Member States, an outlook that recognises the importance of cooperation and shared expertise in the closely linked fields of training, research and education. It is hoped that these experiences may promote certain competitive advantages for the EU and act as a catalyst for further employment opportunities, for the acquisition of innovation and its application, for the updating of skills, for enhanced technology transfer and the fostering of linguistic abilities.

The Erasmus experience has been a very successful initiative for knowledge sharing between student movers and home students, the development of autonomy in a foreign environment and also had a major part to play in the process of mutual recognition of credits.

Over the last few years the accelerated process of convergence among European universities has been taking place in the framework of the Bologna process leading to the European Higher Education Area. The adoption of common rules and schemes for both the structure of third level education and the search for an agreement in the mutual recognition of studies should bring the whole process of student mobility to an easier position in Europe.

2.3.2 Review of aquaculture staff and student mobility in Europe

The very nature of the aquaculture industry, located in remote and peripheral areas, necessitates the movement of skilled workers to areas where the industry conducts its

²⁰ White Paper on Education and Training, adopted by the European Commission on 29th Nov., 1995

activities. Many opportunities exist for the trans-national mobility of both students and trainers of aquaculture. It has been proved in the past that there is genuine interest among aquaculture students to visit facilities and companies of foreign countries and to start acquiring practical aquaculture skills all over Europe. Similarly, through common knowledge and common projects real thematic working networks have been created among those university or research teams concerned. The AQUA-TNET partnership therefore possesses considerable experience in mobility initiatives from direct participation, administration, co-ordination, monitoring and supervision of a variety of programmes and mobility measures available to staff and students, including e.g., LEONARDO, SOCRATES, TMR and mobility under some RTD programmes (FAIR).

One part of AQUA-TNET's studies referred to above was devoted to the collection of data concerning mobility participation. Group expertise and analysis of completed surveys led to the compilation of a detailed report covering the opportunities, extent, benefits, obstacles, and enhancement measures of aquaculture mobility throughout Europe.

2.3.3 Student Mobility

Due to the specialised nature of the subject, it is becoming increasingly common for students to travel overseas to particular institutions or recognised training centres in order to take up a chosen course of study, or to gain valuable work experience on a particular technique, species or region.

Several opportunities exist for students or recent graduates to undertake such trans-national mobility placements. These may be regional (funded by a university/college), national (funded by government/ public authorities or trust funds and limited to nationals), or international. The latter mainly concerns mobility programmes funded by the European Union including LEONARDO DA VINCI, Training and Mobility of Researchers (TMR), TEMPUS, LINGUA and SOCRATES.

The vast majority of student placements in aquaculture take place under the SOCRATES and LEONARDO DA VINCI Programmes. However, both the shortage of grants and the difficulty of managing such exchanges and placements have reduced their success.

ERASMUS was established in 1987 to promote co-operation between universities, providing direct financial support to students by means of grants to cover the cost of mobility (language courses, travel and differences in the cost of living), and establishing the European Credit Transfer System (ECTS) pilot project to facilitate recognition for academic purposes of periods of study completed abroad. The ECTS is further described in Section 5 of this document. As said before this programme has been a key factor in the design of a common policy of student mobility in Europe

LEONARDO DA VINCI, the Community action programme for vocational training, was established in 1995 to improve vocational training systems by means of cooperation between universities and undertakings and it includes activities in several strands. Strand 2 in particular, supports vocational training measures including

university/industry cooperation, with a view to taking into account technological change and its impact on work and the necessary qualifications. Support is also granted for trans-national placement and exchange programmes and for exchanges of people in charge of training.

The Erasmus-MUNDUS initiative undertaken by the EU in the last two years represents a further step in the mobility schemes for students. This programme involves not only students from European countries but overseas students. Thus, it will give more opportunities to European students to experience other remote education and aquaculture systems and at the same time it will attract good students from all over the world to European research and educational centres

2.3.4 Obstacles to transnational mobility

Though trans-national placements offer valuable opportunities, it is recognised that a number of obstacles exist which hinder student mobility.

- **Rights of Residence.** Students in vocational training have right of residence in a country provided they can meet the conditions laid down by Community Directive 93/94 on the right of residence for students. For stays of over three months, students must apply to the authorities of the host Member State for a residence permit. At present, writing at the end of 2004, there are much stricter regulations related to serious questions of transnational security. These should not adversely affect mobility students, however, as the individuals concerned are well identified and covered by the home educational system.
- **Compulsory contributions.** These include both tax and social security contributions. Differences can exist in the way grants are treated for tax purposes in different Member States; in some countries, grants are regarded as income and subject to personal income tax; while in others, grants are classed as a reimbursement of expenses and not as taxable income. It is possible for persons engaged in training to be taxed on their grants by both the country of origin and the host country. Students are, without exception, exempt from taxation in the host country on sums from abroad.
- **Social security.** Students are covered if they are insured under the social security scheme of one of the Member States as workers or as a member of the family of an employed worker. This also covers them for immediate health care requirements (by means of form "E111").
- **Recognition, certification and validation** The lack of recognition and of transparency of training diplomas / certificates, and the lack of certification or validation of placement periods in another Member State can be a handicap to people participating in mobility programmes. Under the SOCRATES programme, academic recognition is a prerequisite for mobility and therefore generally obtained. The ECTS (see Section 5) is entirely based on cooperation by universities of their own accord to facilitate academic recognition of periods of study. Recently, and stemming from the development of the European Higher Education Area, transparency and recognition is approaching a general agreement.

In addition, the AQUA-TNET has been continually and specifically working in this area of common recognition, and a basis for the identification of what are core competencies, required skills and specialized knowledge in aquaculture has reached a significant degree of agreements between European partners.

- ***Territorial Restriction of National Grants.*** The territorial restriction of most national grants makes it difficult for students travelling abroad to transfer their grants. In most Member States, it is impossible to transfer the grant in order to undertake a full course of study abroad.
- ***Inadequate financial support.*** A common cause for complaint is the inadequacy of the prime grant aid. The limited nature of the funds provided by grants have resulted in some students being interested and enthusiastic about taking up placements abroad but being unable to do so because of an overall lack of alternative supporting resources.
- ***Administrative obstacles.*** There are also a number of administrative obstacles that may limit participation, including:
 - Structuring of the academic year - Aquaculture is very seasonal and certain types of training can only occur during set times of the year,
 - Examinations - Students benefiting from mobility may not be in the host country when examinations are held, or cannot take it in their home institutions,
 - Periods of training not incorporated in the course curriculum - Some Member States do not recognise the work placements of students undergoing vocational training as an integral part of the course curriculum; consequently, periods of work experience must be combined with holidays or carried out at the end of the academic year.
- ***Linguistic and cultural obstacles.*** The lack of knowledge of a foreign language remains one of the main obstacles to mobility. Nevertheless, there are some countries with a long tradition of English language competence and it often seems as if this is a major factor determining or modulating the flow of students to certain countries. In the aquaculture area this is a relevant issue as remote countries such as Norway and Greece have obvious interest as developed aquaculture countries. In addition, even assuming that English knowledge may be widespread in particular countries, lectures and activities at graduate levels may take place in the local language. One of the AQUA-TNET partners has created several online language courses in English, Greek, Portuguese and Swedish, with some content modules in Norwegian, Greek and Portuguese, with the intention of alleviating this problem..
- ***Practical Obstacles.*** These obstacles often prevent the achievement of high quality mobility and sometimes discourage participants or reduce their opportunities once on placement:

- Lack of general information (host organisation, living conditions, training opportunities)
- Lack of host companies: companies may be unwilling/ unable to accept students who require a high degree of supervision
- Lack of suitable or affordable accommodation (levels of rents, deposits etc) and students leaving for short-medium term placements also have difficulty in giving up accommodation in their country of origin
- Students must often take out additional insurance at their own expense to cover cost of repatriation in the event of serious illness etc.
- Family and or personal commitments may have a negative impact on mobility.
- Bank and exchange charges can consume up to 20% of an individual grant, and procedural delays also inflate the cost to the student.

2.4 Mutual Accreditation Activities and Achievements

2.4.1 Background

Assessment methods/degree awards/certification is a crucial aspect of all courses, and aquaculture is no exception. and as such has been considered in all stages of the AQUA-TNET project. In this respect also, the statement that “the objective is not to impose common rules, but rather on the basis of a broad debate to identify the points of convergence and the actions capable of meeting the current challenges ” lay behind all the group discussions which took place.

2.4.2 Classical difficulties in mutual accreditation/recognition of diplomas and awards

Mutual accreditation is never achieved without mutual trust and a high degree of transparency in respect of curriculum and assessment procedures, as attested by another statement made in the White Paper on Education and Training, “Mutual recognition of qualifications is guaranteed for the regulated professions. But recognition of diplomas still comes up against restrictions for other occupations.” The multi-disciplinary marine aquaculture student or technician can find that there is a distinct disadvantage, academically, in having carried out an otherwise rewarding work/study placement in another country. This is, as has been shown, a major obstacle in respect of student mobility supported the position of aquaculture studies in general.

2.4.3 AQUA-TNET activities

2.4.3.1 Previous relevant activities

Some of the AQUA-TNET partners had previous experience of this area, having

contributed to a FORCE publication brought out by AQUATT in 1995, “Framework for future mutual recognition of aquaculture throughout Europe” which covered four of the AQUA-TNET partner countries. AQUA-TNET activities, in the transnational questionnaire, survey and analysis, enabled the data to be expanded and updated.

2.4.3.2 *Basis and rationale of accreditation survey and analysis*

Assessment methods, on which any reputable and acceptable accreditation procedures must be based, should derive from the aims, objectives and content of courses, depending on reliable and valid assessment instruments which carry out consistent and coherent measurements of performance on which certification at any level can be made. However, the group as a whole, felt that they needed a working definition of “Accreditation System”, as a genuine ambiguity seemed to have arisen, partly at least caused by the different definitions and concepts which were being floated in 1995/96, i.e., the European Skill Accreditation project which is directed more towards the accreditation of vocational skills and prior learning, rather than the mutual accreditation of academic courses which takes place under the clear and sharp credit definition and transfer system embodied in the highly successful ECTS system, whose extent was gradually expanding.

The AQUA-TNET group took the decision that for the purpose and the duration of the project the phrase “Accreditation System” should be defined as “the joint and agreed acceptance of those syllabus and assessment standards made use of by the participating European universities”.

2.4.4 *Need for transparency*

The most important element was the need for transparency of course provision and standards/criteria of assessment. Already achieved by the group in respect of course provision, this gave promise of equal development in the accreditation area. The painful, gradually achieved transparency could pave the way towards a genuine pan-European comparability- and in this way a framework containing a basic set of standard curriculum and assessment requirements could be put in place.

2.4.5 *Results*

In aquaculture, there is a genuine need to balance theoretical knowledge with the acquisitions of knowledge, skills and competencies and this need is by and large reflected in the way each individual undergraduate course is assessed.

It is clear from the returns made by the partners that many types of assessment instruments are used in the grading of aquaculture courses across Europe. In no department is the formal written examination the sole criterion of performance. There is nearly always some continuous assessment, whether of laboratory work, research experiments, report/essay writing, which is a significant part of the assessment methods and is usually built into the weighting or final scaling procedures. In addition, there is also the writing up of projects, case studies, lab reports, literature reviews, etc. In some cases where courses have been modularised, the final assessment includes the accumulation of credits points assigned to each module. It was found, through the survey, that some of these credit points were linked to ECTS credit points, and this seemed to point to one way forward.

2.4.6 ECTS Format for mutual recognition/accreditation

2.4.6.1 General description of system

The ECTS (European Credit Transfer System) was scrutinized by the group in some detail and though by now very well known, a short description is retained in this publication for reference purposes.

ECTS, the European Credit Transfer System, was developed by the Commission of the European Communities in order to provide common procedures to guarantee academic recognition of studies abroad. It provides a way of measuring and comparing learning achievements, and transferring them from one institution to another. In ECTS, each department must describe the courses it offers, not only in terms of content but also showing the agreed credit points for each course described. The credit system is based on student workload, which includes lectures, practicals, laboratory work and self-study. The ECTS system is based on the principle of mutual trust and confidence between the participating higher education institutions. The rules of ECTS, concerning information (on courses available), agreement (between the home and host institutions) and the use of credit points (to indicate student workload) are set out to reinforce this mutual trust and confidence.

2.4.6.2 ECTS credits

ECTS credits are values allocated to course units to describe the student workload required to complete them. They reflect the quantity of work each course requires in relation to the total quantity of work required to complete a full year of academic study at the institution, that is, lectures, practical work, seminars, private work - in the library or at home – and examinations or other assessment activities. ECTS credits express a relative value.

In ECTS, 60 credits represent the workload of a year of study; normally 30 credits are given for a semester and 20 credits for a term. It is important that no special courses are set up for ECTS purposes, but that all ECTS courses are mainstream courses of the participating institutions, as followed by home students under normal regulations.

It is up to the participating institutions to subdivide the credits for the different courses. Practical placements and optional courses which form an integral part of the course of study receive academic credit. Practical placement and optional courses which do not form an integral part of the course of study do not receive academic credit. Non-credit courses may be mentioned in the transcript of records. Credits are awarded only when the course has been completed and all required examinations have been successfully taken.

2.4.6.3 ECTS students

The students participating in ECTS will normally receive full credit for all academic work successfully carried out at any of the ECTS partner institutions and they will be able to transfer those academic credits from one participating institution to another on the basis of a prior agreement on the content of study programmes abroad between

students and the institutions involved. When the student has successfully completed the study programme previously agreed on between the home and the host institution and returns to the home institution, credit transfer will take place, and the student will continue the study course at the home institution without any loss of time or credit. If, on the other hand, the student decides to stay at the host institution and to take a degree there, he or she may have to adapt his or her study course due to the legal, institutional and departmental rules in the host country, institution and department.

2.4.6.4 Bologna Developments in ECTS

As part of the Bologna reforms, there have been some major changes within the ECTS structure. Firstly, the use of the Diploma Supplement has been closely linked to the use of the ECTS, in spite of their totally dissimilar functions. Though both the ECTS and the Diploma Supplement are seen as transparency instruments, as is clear from the above description, the ECTS is itself a credit award, while the Diploma Supplement is a mere description of courses taken and has no award value whatsoever.

A joint pool of ECTS/DS Counsellors has been formed in order to help universities, which make a proper use of those instruments, prepare for the ECTS label and/or the Diploma Supplement label (application date 1 November 2003 and subsequent years). In recognition of its unique function in mutual accreditation procedures and processes, the ECTS is now seen as having the potential to assume a credit accumulation function and thus to play an important role in the setting up of both National Qualifications Frameworks as well as the European Qualifications Framework which is seen as a crucial part of the preparation for the European Higher Education Area in 2010.

2.5 The European Dimension in Education

2.5.1 Widely varying approaches in Europe

Public recognition of the need for higher qualifications continues to give rise to an increasing number of higher education students in almost all EU countries (Note: agriculture / aquacultural colleges have seen a serious decrease in recent years in the number of students entering courses). Consequently, the relative number of young people entering employment without a higher education degree continues to decline. However, it is advantageous to have graduates with a broad and continuous spectrum of qualifications. In fact, it would appear that many European students drop out before completing higher education, or study far too long and eventually get a job far below their level of education. In reality, many of these students would be better off with a higher quality vocational education.

2.5.2 Adapting to the labour market

The nature of employment often does always not correspond with previous education.

A European-wide survey amongst young working Europeans revealed that almost half of them were using skills for their jobs that were not directly related to their previous education and training. It can be observed that there are better matches between education and employment in countries with strong vocational education structures (Denmark, Netherlands, Germany).

Public acceptance and higher quality vocational training have become more important because of the pressures stemming from industrial change. There appears to be two key demands emerging:

- a strong industry-institutional link and involvement in vocational education
- targeted and responsive curricula which prepare graduates with up-to-date knowledge and skills and the capacity for further development.

The mobility of trainers and teachers is also an important element. Some traditional education providers do not respond well to innovative ideas and procedures. Mobility can help to create new attitudes and enrich current practice. The mobility of trainers can be a more efficient and cost-effective process than student and obstacles due to important variations in national systems.

2.5.3 Cost Consciousness

Universities should be encouraged to prioritise education and research areas in order to become strong knowledge centres, or centres of excellence. However, each Centre should be encouraged to focus on a limited number of research fields and course provision (see Methodology Series, section 4). By concentrating on fewer areas, universities will be in a position to provide intensive and high quality courses, rather than each attempting to cover the entire broad spectrum of courses required for the multi-disciplinary area of aquaculture.

2.5.4 Preparing students for change and a lifetime of learning

In preparing students for employment it is important that their skills set should include other elements that complement a good technical knowledge base. These should include:

Social competence - Graduates not only need to learn theoretical concepts and transfer of knowledge, but they also need social competency skills, including communication skills, language skills, teamwork, flexibility, project management, problem-solving and creativity.

Business Culture - It is of critical importance that students understand the company environment and the relevance of their studies in that context. Perhaps the most effective way to achieve this is to carry out a work placement in industry as part of the course of study. Associated problems and limitations of such initiatives should not be disguised. It has been argued that industrial training cannot reach the necessary academic standard and on those grounds, would deny it as an integral part of the course. An entirely different type of reservation is voiced by some in the industry reservations, to the effect that organising placements consumes time and money and the lack of support from some universities undermines the value of the placements undertaken by students.

There appear to be two main advantages for the fish farming in university-industry links;

- Fish farms are often small SMEs who rely on the education system more than large enterprises. SMEs cannot afford to take on graduates, though they may have

seasonal work requiring skilled workers for periods of 3-6 months. Graduates who have had some industrial experience are more valuable resources for smaller companies.

- Industry-university collaboration is often stimulated through student exchanges, and is often extended to more substantial partnerships between universities and companies.

AQUA-TNET is of the opinion that all M.Sc. aquaculture courses attracting a substantial number of graduates should include a compulsory industrial training period, and recognised towards the end of the period of training. Placements should be designed as integral schemes contributing formally to the student's academic achievements.

2.6 Unemployment of higher education graduates

There are currently high levels of unemployment in some areas of Europe and higher level graduates are not sheltered from this process. Graduate unemployment of graduates is a symptom of a mismatch between educational aims and the reality of the workplace and this manifests itself in several ways:

- there is a growing trend for students to take additional degrees (M.Sc./ Ph.D.) and staying longer in tertiary education with no corresponding improvement in their employment prospects
- The take-up of graduates by SMEs is still relatively low, below the average of other sectors
- 'under-employment' may affect 25-50% of higher education graduates, pushing less qualified people out of jobs to which they previously had access. The net effect is that those less qualified are driven into unemployment or lower job levels, as employers take on highly-qualified graduates for low-grade technician positions.

2.7 Conclusions

The

Appendix 1 IRDAC Review of Requirements of Industrial Change for Education and Training

Initial Education			Continuing education and training
General Education	Vocational Education	Higher Education	
Implications of technological changes			
• Technology literacy • Information processing and methodology • Basic sciences • Memory skills • Image improvement of vocational training	• Image improvement and attractiveness • More on-the-job training • Use of up-to-date equipment • Updating of trainers and teachers • Stronger industrial involvement • Broader technology base	• Tighter control on nature and volume of teaching • Prepare for lifelong learning • Higher involvement in CET • Technology understanding and management • Higher number of engineering and science graduates • Teaching of modelling and simulation phenomena • Higher emphasis on materials processing • More IT based education	• Increase technical competence of staff • Stronger industry-university co-operation • Systematic updating of teachers • Use for technology transfer • New training models for advanced topics use of multimedia
Implications of market changes			
• Environmental economics • Economic reflexes • More attention to skills development	• Higher industry involvement • Qualifications for all young outside higher education • Mobility of teachers and trainers • Attention to minority groups	• More cost-consciousness • Mutual acceptance of degrees • Total quality management • More multidisciplinary approaches • Collaboration culture • Better awareness of economic context • Prepare curricula for CET	• Quality concepts • Needs assessment in companies • Customer services • Co-operation in training
Implications of industrial adaptation			
• People management • Teamwork • Prepare for CET • Developing quality • Cost consciousness • Observation skills	• Ability to learn all life long • Time management • Broader skills discipline • Work organisation • Professionalism • Methods to improve efficiency	• Shorter study periods • Better balance between knowledge and skills • Promote teamwork, creativity and flexible attitudes • Communication and instructing skills • Language skills • Project management • Methods for increasing efficiency, time management • Research and documentary methodology • Cooperative education: student placements	• Social competence • Move from training to learning • Understanding cost and value of training • Methods for improving efficiency

Appendix 2

All given here in combined ranking (grads & employers)

1. *Capacity for analysis and synthesis*

Capacity to learn

Problem solving

2. *Capacity for applying knowledge in practice*

3. Capacity to adapt to new situation

Concern for quality

4. *Information management skills*

Ability to work autonomously

5. *Teamwork*

6. *Capacity for organisation and planning*

Oral and written communication in native language

Interpersonal skills

Will to succeed

Combined ranking (grads & employers)

7. Capacity for generating new ideas

8. *Elementary computer skills*

9. *Decision-making*

10. *Critical and self-critical abilities*

11. *Ability to work in inter-disciplinary team*

Initiative

12. *Basic general knowledge*

Grounding in basic knowledge of profession

Ability to communicate with experts

13. *Ethical commitment*

14. *Knowledge of 2nd language*

Project design and management

15. *Research skills*

Leadership

16. *Ability to work in international context*

17. *Appreciation of diversity/multiculturalism*

18. *Understanding of other cultures.*

Discussion group skills

Simulation models

Library/Literature searches

Case studies

Presentation skills

TUNING Common Subject-specific competences

Identify a common core

Identify a common study programme

Identify subject areas which seem to be different

But are similar

Identify a common set of learning outcomes

- *To have knowledge of the biology of farmed animals (finfish, shellfish, etc)*
- *To know how to apply this knowledge in animal production*
- *To be capable of*

- characterising*
 - analysing*
 - evaluating different forms and systems of animal production*
- *To indicate and prevent side effects of animal production on man & environment*
- *To acquire a scientific attitude, oriented towards*
 - formulation of hypotheses*
 - testing of hypotheses*
 - designing of research protocols*
 - collection of data*
 - analysis of data in different fields*
- *To value strategic and operational issues in the field of aquaculture sciences*
- *To search for solutions through a multi-disciplinary approach*
- *To be capable of reporting both orally and in writing the results of their work- To have knowledge of the biology of farmed animals (finfish, shellfish, etc)*
- *To know how to apply this knowledge in animal production*
- *To be capable of*
 - characterising*
 - analysing*
 - evaluating different forms and systems of animal production*
- *To indicate and prevent side effects of animal production on man & environment*
- *To acquire a scientific attitude, oriented towards*
 - formulation of hypotheses*
 - testing of hypotheses*
 - designing of research protocols*
 - collection of data*
 - analysis of data in different fields*
- *To value strategic and operational issues in the field of aquaculture sciences*
- *To search for solutions through a multi-disciplinary approach*
- *To be capable of reporting both orally and in writing the results of their work*

Appendix 3

Outline structure of the Diploma Supplement

The Diploma Supplement is designed to provide a description of the nature, level, context, content and status of the studies that were pursued and successfully completed by the individual named on the original qualification to which this supplement is appended. It should be free from any value judgements, equivalence statements or suggestions about recognition. Information in all eight sections should be provided. Where information is not provided, an explanation should give the reason why.

1. INFORMATION IDENTIFYING THE HOLDER OF THE QUALIFICATION

- 1.1 Family name():
- 1.2 Given name():
- 1.3 Date of birth (day/month/year):
- 1.4 Student identification number or code (if available):

2. INFORMATION IDENTIFYING THE QUALIFICATION

- 2.1 Name of qualification and (if applicable) title conferred (in original language):
- 2.2 Main field() of study for the qualification:
- 2.3 Name and status of awarding institution (in original language):
- 2.4 Name and status of institution (if different from 2.3) studies (in original language):
- 2.5 Language() of instruction/examination:

3. INFORMATION ON THE LEVEL OF THE QUALIFICATION

- 3.1 Level of qualification:
- 3.2 Official length of programme:
- 3.3 Access requirement ()

4. INFORMATION ON THE CONTENTS AND RESULTS GAINED

- 4.1 Mode of study:
- 4.2 Programme requirement :
- 4.3 Programme detail : (e.g. module or unit studied), and the individual grade /mark /credit obtained:
(if this information is available on an official transcript this should be used here)
- 4.4 Grading scheme and, if available, grade distribution guidance:
- 4.5 Overall clarification of the qualification (in original language):

5. INFORMATION ON THE FUNCTION OF THE QUALIFICATION

- 5.1 Access to further study:
- 5.2 Professional status (if applicable):

6. ADDITIONAL INFORMATION

6.1 Additional information:

6.2 Further information source :

7. CERTIFICATION OF THE SUPPLEMENT

7.1 Date:

7.2 Signature:

7.3 Capacity:

7.4 Official stamp or seal:

8. INFORMATION ON THE NATIONAL HIGHER EDUCATION SYSTEM

(N.B. Institutions who intend to issue Diploma Supplements should refer to the explanatory notes that explain how to complete them.)

Section 3

Industrial trends in the aquaculture industry during the 1990s

Compiled by:

Dr Lindsay Laird

University of Aberdeen, UK

and

Dr Richard FitzGerald

National University of Ireland,

Cork.

Summary outline

.....

Section 3 highlights major trends in the European aquaculture industry during the past decade.

The growth of the industry has been rapid, and technological changes have been continuous, but in parallel, there has been a major effort to correct some of the more negative aspects of the industry. The challenge for trainers is to identify trends and predict future developments and to modulate courses to match these needs.

.....

3. Introduction

In many countries, the aquaculture industry has been one of the star performers in terms of industrial growth over the past ten years. Increases in quantities of fish and shellfish produced have been accompanied by increased use of technology on farms and a growing feeling of confidence that modern fish farming has become established as a significant player in the food industry. There have also been some negative aspects associated with the growth of the industry, particularly the mismatch of production supply with market demand, the much-publicised environmental impacts and the proliferation of infectious diseases caused by a variety of microorganisms and parasites.

The pattern of change in aquaculture, as in all sectors, has a number of important characteristics i.e. it is not easily predictable and it occurs rapidly with changes being readily assimilated into the existing practices or lost to experience. One practical example is the use of helicopters to transport salmon smolts to sea which, within two years, went from preliminary trials to standard practice of the industry.

The developments in the aquaculture industry over the past ten years should be viewed within the context of overall changes in world business and trade referred to earlier in Section 2. These include, for example, increased demand for prepared food products, the increase in number of two-income families and resultant reduction in time available for food preparation. There are, however, a series of changes which directly affected and have been incorporated into aquaculture practice during the last decade which have profoundly altered this commercial activity.

Because aquaculture in its modern forms is a relatively new activity, the training of professionals to work in and with the industry is also for the most part a fairly new development. With such a fast developing and changing industry, trainers are faced with the problem of identifying changes and predicting trends and adjusting their educational courses to match these predictions. This review aims to provide a means of assisting the identification of training requirements, for the future decade and beyond, by examining changes in the European aquaculture industry over the past ten years. We have been assisted in the preparation of the report by reviews of the aquaculture industry in most European countries supplied by country representatives participating in AQUAT-NET, a project operated under the EU SOCRATES programme.

3.1 Growth in production output

The overall pattern throughout Europe is one of expansion and growth in production output, although when examined in detail it is clear that some countries and some elements of the industry have shown spectacular growth while others have only grown to a minimal extent or not at all. Production has increased to the greatest extent in Atlantic salmon (Norway, Scotland and to a much lesser extent Ireland), sea bass and sea bream (Mediterranean countries, particularly Greece and Spain), turbot (France and Spain) and a number of shellfish species (Ireland and Mediterranean countries). Those countries with the longer established more traditional trout, carp and shellfish industries have tended not to increase production to the same extent. In some cases,

tighter new regulations controlling water usage or effluent discharges, increasing feed costs and fixed/reducing sales margins have brought about a stabilisation or decrease in production tonnages of these traditional species.

In some instances, it is apparent that increases in production tonnages have been achieved through the utilisation of novel/modified growing systems and technologies that have opened up hitherto unusable or inaccessible natural resources (water bodies) to economically viable farming practices. The farming of salmon in sea pens began in the late 1960s, with small near shore cages, but in the 1980s and 1990s, this model was changed in countries such as Ireland which pioneered the use of larger cage units in more exposed offshore sites far away from sheltered coastal waters. In the same vein, it should be noted that the significant advances made in recent years in land-based farming and the use of recirculation technologies - as they are virtually closed systems with a controllable environment - have the potential to circumvent the limitations of local ambient conditions. Thus, the usual biogeographic constraints placed on aquaculture activities may be removed in the coming years.

Conversely, the transfer of established cage technologies and husbandry practices from Northern Europe has allowed the expansion of finfish farming in Southern Europe and the use of traditional systems (e.g. trestles, longlines) has tended to persist in the expanding shellfish operations.

3.2 Species diversification

At the start of the decade, aquaculture in Europe was based primarily on the culture of a small number of traditionally farmed species such as trout, carp, oysters, mussels, as well as salmon which had been brought into full scale commercial cultivation in more recent times. Since then, significant research and development efforts, supported by the EU and National policies, have focused on the diversification of the sector, particularly into higher valued finfish species, in order to ensure greater economic stability and security and also to sustainably utilise the available natural resources.

Thus, the past decade has seen several new finfish species progress into large scale intensive farming including sea bass, gilthead sea bream, eel, and turbot with increasing volumes being produced. At the same time, a number of other species are still emerging from the R & D process including Arctic char, sea trout, sturgeon, other sparids, wolffish and cod, as solutions are found to a variety of basic biological and husbandry issues. It is anticipated that in the coming decade some of these species will come into active production, e.g., halibut and char, are already underway, and significant quantities will be produced. On the shellfish side, there has been much less effort and R & D has focused on a smaller number of species with mixed success, including scallops, clams, sea urchins and abalone. In Ireland, France and the UK there is a small but increasing production of sea urchins and scallops. Crayfish and lobsters represent an increasing interest in the farming of crustaceans; nevertheless this currently remains at a low level in Europe in comparison to other parts of the world.

Within Europe, there is also an increase in the production of ornamental fish for the aquarium trade and growing interest in the cultivation of more ‘exotic’ non-native species e.g. catfish and tilapia in closed systems for local niche markets in Northern Europe.

3.3. Supply / Demand issues, Markets and Consumer Power

A criticism of the aquaculture industry in the past that unfortunately, to some extent, still holds true today is that it has been production-led. The emphasis has been on overcoming technological problems, using a strong, EU-backed, R & D base, and increasing production of farmers, based on financial forecasts that assume the ready availability of a buoyant market and a satisfactory price. As has been most clearly recorded with the salmon industry, production (supply) and market (demand) are not always in harmony and prices may drop and remain close to, or below, costs of production for months at a time. This trend has been observed in the Mediterranean aquaculture business with sea bass and bream and, in Northern Europe, with shellfish supplies even on a seasonal basis. It does not apply only to production for the table market but also to internal suppliers involved in the growth cycle i.e. the production of seed (eggs, juveniles, smolts, spat) for on-growing.

In most cases, such cyclical trends can be attributed to asynchronous growth of either supply (usually) or demand where one outstrips the other in a developing industry which has not reached ‘maturity’. It must be remembered that a confounding factor within aquaculture is the myriad of biological problems which may unpredictably reduce/enhance production output. These events are regarded as ‘catastrophic’ losses and of their very nature it is virtually impossible to take precautionary measures against their occurrence. Thus, an infectious epidemic may kill large numbers of on-growing stock this year immediately limiting production in the season while a poor spatfall may irreversibly affect oyster output in two years’ time. No aquaculture business can be described as 100% reliable as, apart from recirculation systems, there is still a close interaction with factors in the environment such as pollutants, predators and disease organisms. Indeed, it should be noted that “new” diseases have continuously arisen throughout the 1990s (ISA, *Bonamia*, Herpes virus in oysters) and there is and will always be a timelag between their discovery and their control, during which production from affected stocks is unpredictable.

With a larger, diverse and more mature industry, it is to be anticipated that there would be a relatively stable equilibrium level, that can absorb most catastrophic losses, as is observed with, for example, the rainbow trout and carp sectors. Even in such circumstances, it is possible that there will be fluctuations in production over time as is commonly encountered in agriculture where they refer to the ‘pork cycle’.

As part of the development of individual sectors of the aquaculture industry, it should be noted that there are inevitable rationalisation phases, with the fallout of less efficient and less cost-effective players, and, in some cases, it is equally clear that there is an apparent market saturation at relatively low levels of output. The latter has been cited as a primary reason for the tapering off of active diversification efforts in

recent years, with policy makers arguing for the development of markets rather than increased production.

In the past, farmed fish and shellfish were sold whole, fresh, chilled or, in the case of finfish at most, gutted. Even smoked salmon was generally sold as whole sides. There has been a major change during the 1990s with increasing sales of what are termed “value-added” products that are processed to varying degrees from basic fillets up to pre-prepared meals. These are all packaged attractively which helps in the promotion of the product and are easy to handle and are ready to cook or prepare as meals. The trend in salmonid farming towards production for specific markets is being aided by the development of diets for fish destined for smoking and for organic salmon and trout. However, fish such as sea bass are generally still sold whole or with a minimum of processing. Many molluscs and crustaceans are sold alive.

It is envisaged that, in the coming years, primary producers in aquaculture will have to be more keenly aware of the needs and requirements of the processors and consumers, targeting their efforts to give the desired products with quality assurance programmes and full traceability as is the norm in allied food sectors.

3.4. Economy of Scale, Production Efficiencies and Reliability

Though it is not a universal trend across the aquaculture industry, there is a tendency towards the emergence of larger-sized production units in most sub-sectors as they develop and mature. Thus, while there may be a large number of initiators with small-scale production for a particular species, over time with successive rationalisation phases, there will be commercial casualties and the more efficient and cost-effective will gradually emerge. The survivors will invariably expand both around the original business and through acquisition and merger of the less successful units. In the case of salmon farming, it is apparent that there are few, small-sized or family-run businesses left in operation. Similarly, with bass/bream farming, the companies are joining together and also linking with feed producers to achieve the necessary production efficiencies and economies of scale. Again, an increase in farm size has been noted in the Swedish rainbow trout industry where production levels have remained about the same (7,000 tonnes) throughout the 1990s but the number of farms has declined.

Overall, the commercial advantages of economies of scale are obvious with efficiencies in purchasing power for inputs (feed, juveniles, equipment, etc.), asset utilisation, overhead allocation and in the supply of product to the market. Smaller farms may only be able to maintain output over part of the year whereas these larger units are better able to meet the demands of larger markets both local and international all-year-round. There are exceptions to these trends, for example, many German and Austrian trout farms are small, family-run enterprises, successfully supplying local markets in the face of competition from the outputs of other countries and it is possible that this traditional model will survive in a ‘national’ environment. Specific national policies may also indirectly support smaller units as in the case of Finland and Denmark, where environmental restrictions limit the size of farms.

Overall, in the past decade, market pressures and improvements in production practices and technologies have driven or led to increased production efficiencies. These may be measured using a variety of different metrics including:

- feed conversion factor (or efficiency)
- production output per employee
- juveniles required per tonne produced
- stock survival.

In terms of feed conversion factors, on salmon farms this has been reduced to 1.1:1 from a previous level of 1.5:1 or more, through improvements in dietary formulations, feed delivery systems, feeding practices and better husbandry. In some Danish rainbow trout farms, FCRs have been reduced to 0.8:1 and for sea bream it is now about 1.2:1. In all cases, these values continue to decrease and the net impacts in terms of financial performance and reduced environmental impacts are tangible. In the Scottish salmon industry, annual output per employee has risen from an average of 40 tonnes in 1993 to over 85 tonnes in 1998. It should be noted that there is a considerable range of values across the industry with the larger farms managing > 100 tonnes per employee. In the salmon industry in Ireland and Scotland, mortalities during the sea stage have fallen from >45% at the beginning of the 1990s to <10% at the end, through improved husbandry, vaccines and better understanding of the farming process. Overall, the number of smolts required to produce a tonne of salmon has decreased from c. 1,000 to almost 300 in the past decade.

With improved systems and the increased knowledge of factors affecting growth and survival rates has come increased reliability. The advantage of this is that fish farms can be treated as “standard” businesses with reliable cash flow forecasts and production outputs based on predictions of stock performance.

3.5. Vertical integration versus Specialisation

Although individual sites may have become more specialised for the farming of some species, the increase in the size of companies operating in fish farming resulted in an increasing degree of vertical integration within certain parts of the industry during the early 1990s. It was not unusual for a salmon farming company to have units for broodstock, eggs, freshwater and seawater rearing as well as packing, processing and even retailing interests. Such companies had linked operations in different countries, for example growing, harvesting and processing fish in Scotland and Ireland and selling them in the company outlets in Germany or Belgium. This has not happened to the same degree in trout and shellfish farming although there are signs of an increasing degree of vertical integration in marine fish production. This trend towards complete vertical integration may, however, have become a little outdated in recent years.

The more recent trend, in most species, has been for units to focus and specialise on one stage of the life cycle. For example, most Mediterranean marine fish farms buy in their juveniles from a few hatcheries, capable of producing millions of small fish each year. The ongrowing facilities are likely to be relatively low technology pen farms as distinct from hatcheries that are complex operations, in many ways more similar to a microbiology laboratory than a farm. Likewise, in the Norwegian salmon industry, it

is clear that there are distinct specialisations emerging in the case of most units (broodstock, fry, smolt and finished fish), with the exception of some of the larger existing conglomerates.

In future years, it is likely that this trend in specialisation will come more to the fore with long-term linkages developing between the successive producers in different phases of the growth cycle to take advantage of greater production efficiencies.

3.6. Increasing use of technology and mechanisation

Although trout, carp and most shellfish continue to be mainly produced using traditional methods even these operations have benefited from mechanisation in the form of improved grading and handling equipment and enhanced hatchery facilities. However, salmon, bass and bream, eels and flatfish producers are all using far more complex and expensive equipment than at the start of the decade. This includes the use of larger rearing units (tanks and pens), fish pumps, feed distribution systems, recirculation systems and environmental monitoring units (eg computerised systems for measuring and responding to changes in oxygen, ammonia concentrations). One result of this is the decline in the number of hatcheries in France; bigger units are now in operation throughout the year. In some countries, such as Italy, it is felt that major technological developments (e.g., use of liquid oxygen under computer control) are still needed in order for the industry to expand. The Dutch shellfish industry is moving towards increased use of suspended rope culture rather than seabed culture.

3.7. Requirements for specialists

In traditional types of aquaculture where farms are small, employees (and owners who tend to work on the site) are generalists who have to be capable of stock management, equipment maintenance and even selling the end product. The trend towards increased mechanisation, specialisation and increase in size of units has led to the need for specialists. Recirculation units, used for the production of salmon smolts, eels, turbot and even some shellfish (abalone) need both fish husbandry specialists and maintenance personnel, familiar with the complex equipment needed to maintain the water quality within the system. Larger boats, cranes and forklift trucks, normal items of equipment on a sea pen farm, all need special training and certification for staff. Other specialists are required in fields including bioengineering, biotechnology, fish biology, environmental issues, fish health, HACCP and food quality systems. The increased complexity of aquaculture products and direct links with buyers also requires staff with special skills.

3.8. Increased Regulatory Control and Competition for Resources

Most of the laws and regulations covering aquaculture operations were not formulated with fish or shellfish farming in mind (Section 1, 1.3.5) and have been seen as being either too restrictive or not restrictive enough, depending on whether it is an internal or external perspective. Environmental pressure groups have, often rightly, focused

on the industry as a source of organic and chemical pollution and adverse interactions with wild fish. It is obviously important for farmers to understand regulations and to operate within them: most countries have had to develop more stringent planning requirements over the past ten years in accordance with EU legislation (Section 1, 1.3.6). In Italy, administrative bureaucracy and pressure from environmental lobbies are thought to be restricting the growth of fish farming. In Denmark, the closure of some trout farms has been attributed to increasingly stringent environmental regulations. Other regulations affecting the aquaculture industry include those concerned with animal welfare and with the production and processing of food for human consumption (Section 1, 1.3.5). In future years, nothing is more certain than that these will have to be incorporated into aquaculture activities.

In an attempt to harmonise previous legislation on water quality parameters and to protect all types of waters, the EU drew up a new Water Framework Directive (COM(97)49), which came into effect on June 30 2000. This legislation replaces seven previous Directives and will certainly have a profound and a prolonged effect on aquaculture activities. In their quest for expansion fish and shellfish farms face competition from other users of the water resources. Many areas suitable for coastal aquaculture (Adriatic, Aegean, and Alpine lakes) are also desirable places for developments associated with tourism and watersports. In Spain, a framework has been established for all coastal developments. In other places, (eg the Algarve) water itself is at a premium and the more efficiently it can be used, the better. Increasingly, throughout Europe, charges are being made for abstraction and discharge of water. This has led to a search for ways of reusing water or farming fish in combination with other activities.

Recirculation systems where water flows through a system, is treated and sent back around the system again with only a small top-up of water each day, provide a way of limiting both abstraction and discharge. Such systems have now passed from the pilot stage to being a standard part of some production farms and their use is likely to increase. Still at the pilot stage are systems where the farming of fish is combined with that of vegetables such as lettuce or tomatoes in a hydroponics system. Such systems have the advantage of efficient water usage as well as using the wastes produced by fish such as eels to provide nutrients for the plants. These systems have been slow to come to commercial stages and have been unsuccessful in the Netherlands. Another aspect of competition for resources is the competition for fish oil; this is likely to become increasingly fierce and may restrict expansion of fish farming.

Overall, however, it is clear that fish farming must take its place alongside other users of the coastal resource and accept its ethical and social responsibilities, as well as its legal obligations..

3.9. Computers and Information Technologies

In the early part of the 1990s computers were rarely seen on fish farms. Farms with computers used them for accounts or word processing. Now, most farms are likely to make a much greater use of computer and information technologies. Programmes and training are provided by feed companies and others to help farmers maintain stock

records, analyse farm performance and predict production schedules. Data concerning feed input, the results from sample weighing and mortalities can be entered to provide a continuous update. This may be manually or directly from feeders or graders for example. Computers are also used as part of process control, for example in association with equipment for measuring oxygen levels and injecting oxygen if levels fall below a desired minimum. Such developments are more likely to be seen on larger, more technically advanced farms but may also be found on traditional ones. The degree of computer use may reflect the different stages of maturity of the industry.

3.10 Biological, Technical and Operational Innovations

The business of fish farming has benefited greatly from numerous biological, technical and operational (husbandry) innovations that have cumulatively impacted over the past decade on a number of key areas and which, in turn, have contributed to more effective/efficient production and yield. Some of these have been referred to in previous sections but a number of key areas will be described here.

3.10.1 Management of the life cycle

An overriding problem which faced fish and shellfish farmers in the past and persists in more traditional operations at present is that most species tend to spawn only once a year and over a very limited period. This imposes constraints on farming by producing gluts of juvenile stages for limited periods of time in the year and, perhaps more importantly, there may be significant year-to-year variations in the quality and quantity of juvenile supply. For example, eel farming and many forms of shellfish farming have always depended on the supply of juveniles from the wild. Likewise, salmonids were produced by collecting gametes from wild fish for at least 150 years but broodstock are now farmed and wild fish are only used to supply eggs for restocking purposes. The trend in most forms of farming (exceptions are some molluscs such as *Mytilus edulis*) is to have control over the whole of the life cycle of the animal by selecting as broodstock (fish or shellfish with) preferred characteristics which are, at least partially, genetically controlled. This means that juvenile availability can be controlled in terms of quantity, timing and quality and, equally, that wild stocks are not under pressure from collectors of seed for aquaculture purposes.

During the 1990s, major progress has been made in the production of juvenile marine fish (sea bass, sea bream and flatfish) and shellfish (oysters, abalone) in hatcheries although production of suitable larval diets still remains a complex task.

At the other end of the production spectrum, there is the problem of maturation before the optimum market size occurs in several species: in salmonids and flatfish, males often mature earlier and at a smaller size than females while many shellfish species may spawn unpredictably with consequent loss of condition. Through a combined approach, based on monitoring and control of the environment, management of feed input and genetic selection has helped to alleviate the problem. For some species (e.g. rainbow trout) the farming of monosex stocks has been partially successful though the problem has been by no means solved.

3.10.2 Stock Selection and Breeding Programmes

In Norway, the effects of breeding in salmon have been carefully measured as part of a genetic improvement programme, and other countries such as Scotland are now adopting modern genetic techniques to speed up the selection process. These processes are now becoming established on a scientifically planned basis for many species of finfish and even some shellfish. Desired characteristics in finfish include stress resistance, fast growth rate, resistance to disease, late maturation, good Feed Conversion Efficiency and desired flesh quality. In France, breeding programmes based on the selection of oysters for resistance to *Bonamia* have been instituted. However, aquaculture still lags far behind traditional agriculture (eg cereals, pigs) in terms of the sophistication of breeding programmes.

3.10.3 Health control measures

In the 1980s the salmonid farming industry gained a reputation for solving problems associated with infectious diseases by the use of chemotherapeutants such as antibiotics and organophosphates in an emergency response to the sudden and severe outbreaks of diseases, e.g., furunculosis and infestations with sea lice. These diseases, often present in wild fish with few signs or symptoms, thrived in the more crowded conditions prevailing on farms and their spread was favoured by lack of knowledge of transmission paths and the interactions between fish, disease organisms and the environment. During the 1990s, major improvements were instituted and health measures which are now incorporated into the operation of many farms include:-

- **Fallowing.** Sites (sea pen or pond) are left empty for varying periods of times between production cycles to break the life cycles of pathogens and parasites
- **Reduced stocking densities.** Reductions in stocking density appear to have an overall beneficial effect on fish health
- **Improved regulatory controls** over movements of fish. Quarantine measures and establishment of disease free zones assist in the containment of diseases
- **New forms of prophylaxis** including vaccination. Reducing antibiotic use (and consequent environmental contamination) to a very small fraction of the former figure
- **Epidemiological studies** linked to inspection services.

Section 4

AQUA-TNET Methodology Series of Courses

Compiled by:

Dr Johan Verreth
Wageningen Agricultural
University, The Netherlands

Summary outline

.....

Section 4 gives details of AQUA-TNET's Methodology Series of courses. These are viewed as leading-edge, state-of-art, series of advanced courses to be held across Europe in future years.

.....

Introduction

The SOCRATES Thematic Network for Higher Level Education (AQUA-TNET) consists of a group of 16 European Universities, all providing degree courses in aquaculture. Through the activities of the Network, the composition, educational approach and degree requirements of European aquaculture courses were compared and an inventory of courses was firstly published, and then collated into the AQUA-TNET Database of Aquaculture Courses. This database underwent further updating in 2003 under the auspices of the Leonardo da Vinci funded, AquaTT-led, PISCES Project and can be found at www.piscestt.com.

At the 1997 Board meeting, in an attempt to intensify collaboration at European level, the network representatives decided to embark upon the implementation of a joint initiative namely, a series of intensive laboratory-based training courses. This value-added activity would address, in one way or another, methodological aspects of aquacultural research and development. The series was entitled **“AQUA-TNET Methodological Series of Courses”** and consisted of eight courses, each co-ordinated by a partner AQUA-TNET institution: “Biology of Fish Larvae Production”, “Applied Fish Nutrition”, “Design and Operation of Recirculation Systems”, “Fish Diseases Control”, “Molecular Biology and Ecology in Aquaculture”, “Fish Reproduction”, “Pathology, Physiology and Biotechnology in Aquaculture” and “Fish Vaccination”.

~~A number~~ Several of the AQUA-TNET Methodology Courses were further developed to form the basis of an AquaTT-led, Commission-funded project, entitled “AQUALABS - European Advanced Laboratory Courses in Aquaculture”. This series, focusing on four specific areas of aquaculture (i) Quality in Fish Products (ii) Biology of Fish Larvae Production (iii) Molecular Biology and Ecology in Aquaculture (iv) Design and Operation of Recirculation Systems, ran in 2000/01 under the High-Level Scientific Conferences Action of the Fifth Framework Human Potential Programme.

Building on the strength and resultant success of that AQUALABS series, a further series was devised and has received approval for funding for the years 2005/06, under the Marie Curie Action for Series of Events (SCF) in the Sixth Framework Programme. A series of six state-of-the-art training courses and one supporting student workshop, endorsed by the industry and fulfilling the following objectives:

- Provision of advanced practical laboratory training for early-stage researchers in the major topical themes of
 - Quality in Fish Products (Cork, IRELAND 2005)
 - Molecular Biology and Ecology (Kuopio, FINLAND 2005)
 - Design & Operation of Recirculation Technologies (Wageningen, THE NETHERLANDS 2006)
 - Freshwater Aquaculture and the Environment (Szarvas, HUNGARY 2005)
 - Aquatic Animal Disease Diagnostics (Stirling, UK 2006)
 - Fish Welfare (Varese, ITALY 2005)

- Provision for the acquisition of practical skills and critical field work experience in themes with specific tie into 6FP interest areas (environment, ethical production, food safety and traceability)
- Promotion of mobility of researchers from an early stage through key linkages and training programmes

The AquaTT-inspired AQUALAB Student Workshop is an integral part of the new series and has the following focal objectives:

- To examine scientific content relevant to course title; leading to prediction of future needs
- Review of current and potential future research issues
- Provision of multi-disciplinary training for the acquisition of non-research competencies (e.g. communicating science to non-scientists) through presentations, team work and networking events
- Provision of a forum for early-stage researchers to develop synergies, engage in collaboration and debate on issues of specific interest within the ERA

Each laboratory training course and the concomitant workshop consists of a 3-phase work programme:

1. Preparatory Phase – centralised internet-based system linking all the research participants prior to attendance at the individual events; providing background information and tasks through the online forum
2. Training Phase – five to seven days of intensive training consisting of lectures, practical work and field studies
3. Sustainability – post-event electronic forum for continued networking and collaboration of researchers

Each AQUALAB is a collaborative effort between six or more European Universities, the AQUA-TNET Partner Institutes, allowing for up to 30 participants to be trained by leading scientists in the latest practical and field techniques. Courses are hosted at European ‘recognised centres of excellence’ i.e., institutions with specific expertise in the subject area and possessing the current best available knowledge, generating key research findings and having fully-equipped facilities relating to the area.

4.1

Quality in Fish Products

Format		
Training course	Duration: 6 days	Host: UCC
Content		
The protocols for quality foodstuffs are relatively well described for many cultured animals, e.g. pork and beef, though relatively less work has been done on fish. Most of the fish work has been carried out on salmonids and this forms the core of this course with smaller inputs for other species including, e.g. turbot and halibut. It is known, from salmon and trout, that husbandry practices and pre-harvest conditions, e.g. diet, stress and starvation, all have a major impact on flesh quality and shelf-life. In relation to diet, in the past, special attention has been paid to the effect of both macro-nutrients, such as proteins and lipids, and micro-nutrients, such as vitamins and minerals, on growth, but this has not always been followed into their effects on product quality and ultimately human nutrition and health. This course explores our food in relation to safety, nutritional value and consumer acceptability of food i.e. organic fish. The course outlines the key issues that contribute to overall quality in Fish Products and describes key methodologies for investigation with practical training in techniques. To strengthen both the theoretical and laboratory aspects of this course, a Practical Quality Management (PQM) Module is introduced, focusing on practical management of fish product quality at the local-, industry-, and national-level.		
Speakers		
Name & Nationality	Institution	Presentation
Dr. Richard FitzGerald	Shorescape Ltd, Ireland	Concepts of Fish Quality in Relation to Human Health
Dr. Julie Maguire	University College Cork, Ireland	Concepts of Fish Quality in Relation to Human Health
Prof. John Sargent	University of Stirling, UK	Fish Composition
Ms. Catherine Morrison	Irish Sea Fisheries Board (BIM)	Sensory evaluation of fish products
Dr. Joe Kerry	University College Cork, Ireland	Fish Chemistry
Dr. Kirstin Hamre	University of Bergen, Norway	Slaughter methods
Mr. Dave Garforth	Trouw-Nutreco	HACCP, Organic Aquaculture, Quality Schemes and Traceability
Organiser		
Dr. Julie Maguire Aquaculture Development Centre University College Cork (UCC) Prospect Row, Lee Maltings Cork, Co. Cork IRELAND Tel: +353 (0)21 4904192		

Email: julie.maguire@ucc.ie

4.2

Molecular Biology and Ecology in Aquaculture

Format		
Training course	Duration: 8 days	Host: IAB-UKU
Content		
Provides state-of-the-art training in the key techniques of molecular biology used in fish research, breeding and farm stock management. Study topics include: mapping of fish genome, use of molecular markers in strain discrimination, gene isolation and cloning, transgenesis, and introduction to methods of gene expression profiling and proteomics.		
Speakers		
Name & Nationality	Institution	Presentation
Mr. Rolf Sara	University of Turku	Preparation and usage of micro-arrays in gene expression profiling
Dr. Joseph Planas	University of Barcelona	Applications of molecular biology in fish physiology and nutrition
Dr. Aleksei Krasnov	University of Kuopio	Gene transfer in fish; functional genomics: transcriptomics
Dr. Sam Martin	University of Aberdeen	Functional genomics: proteomics
Dr. Gary Wong	University of Kuopio	Use of oligochips in gene expression profiling
Dr. Craig Primmer	University of Helsinki	Molecular markers for discrimination of fish stocks
Dr. Tina Pitkanen-Arsiola	University of Kuopio	Gene transfer technologies
Res. Heikki Koskinen	University of Kuopio	Gene expression analysis
Organiser		
Professor Hannu Mölsä Institute of Applied Biotechnology University of Kuopio P.O. Box 1627, Kuopio FIN-70211 FINLAND Tel: +358 (17) 163742 Email: hannu.molsa@fishinnovationcentre.fi		

4.3 Design and Operation of Recirculation Systems

Format		
Training course	Duration: 5 days	Host: WU
Content		
The course examines and conveys aspects of engineering for recirculation systems, of importance to the design and evaluation of new and existing fish farm installations. Emphasis is placed on the provision of opportunities for gaining hands-on experience in the design, evaluation and operation of recirculation systems. Use of recirculation technology in farm management and routine farm operations is also studied. The ‘disciplines’ necessary for the content of this course are covered by the fields of expertise of the invited speakers. Most of the speakers are frequently invited as keynote speakers in international symposia, and work to present and discuss the state of art in literature in the field of recirculation system design and operation. Knowledge transfer is also guaranteed by the excellent didactical skills of the speakers.		
Speakers		
Name & Nationality	Institution	Presentation
Prof. Dr. Johan Verreth	Wageningen University	Developments in aquatic production systems; recirculation systems
Dr. Jean Paul Blancheton	IFREMER, Montpellier	Bio security and recirculation systems; water quality and fish requirements
Ing. Ep Eding	Wageningen University	Recirculation system carrying capacity; mass balances approach; biofiltration principles and design
Prof. Dr. Raul Piedrahita	University of California, Davis	Suspended solids characterisation and control; carbon dioxide and nitrogen gas control; oxygenation
Prof. Dr. Jaap van Rijn	Hebrew University, Jerusalem	Denitrification principles and design
Dr. Tom Losordo	North Carolina State University	Recirculation system design; recirculation system management and operation
Dr. Noam Mozes	National Center for Mariculture, Eilat, Israel	Seawater recirculation systems; recirculation system economics
Prof. Dr. Bot	Wageningen University	Energy control, heat balances
Dr. Neori	National Center for Mariculture, Eilat, Israel	Waste; Integrated recirculation systems
Organiser		

Prof. Dr. J. Verreth and Ing. E. Eding
 Fish Culture and Fisheries Group
 Wageningen University
 P.O.Box 338, 6700 AH Wageningen
 THE NETHERLANDS
 Tel: +31 (317) 48 3307
 Email: office@alg.venv.wau.nl

4.4 Aquatic Animal Disease Diagnostics

Format		
Training course	Duration: 6 days	Host: UoS
Content		
This course provides advanced training in the key techniques of disease diagnosis used in aquaculture management and fisheries research. Study topics include: Advanced histopathology and histochemistry, the use of biochemical and enzyme profiles for bacterial identification, immunological tests including latex agglutination, IFAT, immunohistochemistry (IHC) and ELISA techniques, molecular methods including PCR, rt-PCR and reverse cross dot blot PCR, methods for viral research and identification including cell culture and electron microscopy and the use of numerical techniques and modelling in parasite identification and epidemiological studies. The participants share their experience of different fish species and pathogens and have the opportunity to practice advanced diagnostic techniques and their interpretation. An additional session deals with the communication of science to the public, and in particular the communication of potentially sensitive and complex information on fish disease issues such as the diagnosis of a new disease in farmed stock. This will include a practical session in preparing suitable text.		
Speakers		
Name & Nationality	Institution	Presentation
Prof. Randolph Richards	University of Stirling	Introduction to aquatic animal disease diagnostics
Prof. Hugh Ferguson	University of Stirling	Histopathology and EM
Dr. Alexandra Adams	University of Stirling	Immunological and molecular techniques
Prof. Christina Sommerville	University of Stirling	Parasitology diagnostics
Dr. James Turnbull	University of Stirling	Epidemiological approaches to diagnostics
Dr. Guiseppe Bovo	The Istituto Zooprofilattico Sperimentale delle Venezie (IZS-VE)	Fish virological diagnosis
Dr. Franke Berthe	IFREMER, La Tremblade	Molluscan diagnosis
Dr. Inger Dalsgaard	Danish Institute for Fisheries Research	Microbiological methods
Ms. Lindsay Pollock	University of Stirling	Media relations and communications
Organiser		

John Bostock
 Institute of Aquaculture
 University of Stirling
 FK9 4LA, Stirling
 UNITED KINGDOM
 Tel: +44 (0) 1786 467878
 Email: j.c.bostock@stir.ac.uk

4.5 Freshwater Aquaculture and the Environment

Format		
Training course	Duration: 6 days	Host: HAKI
Content		
Provides advanced training on the key environmental issues of the sustainable freshwater aquaculture technologies. Study topics include: Aquaculture and environment interactions (environmental impacts on aquaculture, impact of aquaculture on the environment, minimizing the impact of aquaculture on the environment); Resource use and consumption of freshwater aquaculture; Technological research on water efficient and environment-friendly aquaculture systems. During the lectures, the participant will obtain advanced knowledge on the scientific background of the sustainable use of freshwater aquaculture resources and will participate in practicals related to practice of research methodology applied in the development of water efficient and environment-friendly operated aquaculture systems and in the application analytical techniques of the research of the aquaculture-environment interactions.		
Speakers		
Name & Nationality	Institution	Presentation
Dr. Maria B. Oncsik	HAKI	Environmental pollution by heavy metal; analysis of heavy metals by Atomic Absorption Spectrometry (AAS) techniques
Dr. Zsuzsanna Gy. Papp	HAKI	Environment related off-flavours; separation and determination of off-flavours by gas chromatography – mass spectrometry (GC/MS)
Dr. Istvan Csengeri	HAKI	Food resources, feeds and feeding in aquaculture; improvement of feed efficiency; pollution from various sources: agriculture, households, industry; GC/MS analysis of pesticides

Dr. Ferenc Pekar	HAKI	Water quality requirements of aquaculture production; aquafarm effluents; effluent treatment; the role of fishpond ecosystems in nutrient recycling
Dr. Laszlo Varadi	HAKI	Land and water use in aquaculture; water efficient pond systems and technologies; fish pond water recirculation system
Prof. Janos Olah	HAKI	The role of fishponds in providing ecosystem services
Prof. Hans Ackefors	Stockholm University	Aquaculture sustainability: code of conducts, best management systems and practices
Dr. Marc Verdegem	University of Wageningen	Minimal discharge systems; integrated aquaculture
Dr. Trevor Telfer	University of Stirling	Environmental impact assessment
Dr. Selena Stead	University of Newcastle	Socio-economic impact of aquaculture
Organiser		
Dr. László Váradi Research Institute for Fisheries, Aquaculture and Irrigation (HAKI) P.O.Box 47 5541 Szarvas HUNGARY Phone: +36 66 515 302 E-mail: varadil@haki.hu		

4.6 Fish Welfare

Format		
Training course	Duration: 7 days	Host: USI/DBSF
Content		
State-of-the-art training on the key techniques to monitor and to control fish welfare in intensive aquaculture in flow-through and water recirculation land-based systems, as well as in pen cages systems. Study topics include (1) a description of welfare and of its components in fish; (2) a survey on the environmental factors which may result in the constricting of fish, their sources, mechanism of action, monitoring protocols, control technologies; (3) a study of the available techniques for fish welfare monitoring, including behaviour, blood analyses, histological and histochemical tools,		

physiopathological approach, zootechnical performances, molecular approach. Theoretical presentations and practical modules will be included in the agenda. An exchange of information among researches and experts with knowledge and experience on different fish species will be a key to the course and hence, may provide opportunities to apply new techniques in the field.

Speakers

Name & Nationality	Institution	Presentation
Prof. Marco Saroglia	University of Insubria, Italy	Husbandry in intensive aquaculture, finalised to fish welfare improvement
Prof. Giovanni Bernardini	University of Insubria, Italy	Molecular approach (differential-display and real time RT PCR) on fish welfare studies, genes activation/deactivation and search for markers
Prof. Johan Verreth	Wageningen University, The Netherlands	Behavioural approach on fish welfare studies with practical applications
Dr. Hans Komen	Wageningen University, The Netherlands	Genetic basis of stress physiology
Dr. Lluís Tort	Universitat Autònoma de Barcelona, Spain	Current studies on the physiology of fish stress
Dr. Denis Cove	IFREMER, Palavas	Voluntary feed intake in fish as a tool to monitor welfare conditions
Prof. Felicity Huntingford	University of Glasgow, UK	Basics of fish welfare
Dr. Genciana Terova	University of Insubria, Italy	Labs with real time PCR applications
Prof. Magda De Eguileor	University of Insubria, Italy	Histological and histochemical methodologies applied to fish welfare studies
Dr. Monica Molteni	University of Insubria, Italy	ELISA and HPLC applications finalised to fish welfare studies
Dr. Rosalba Gornati	University of Insubria, Italy	Labs with Northern blot and differential display applications

Organiser

Prof. Marco Saroglia
 via Dunant 3
 Università dell'Insubria in Varese
 21100 Varese
 ITALY
 Tel: +39 (0332) 421332
 Email: marco.saroglia@uninsubria.it

4.7 AQUALAB Student Conference

Format		
Conference	Duration: 3 days	Host: AquaTT
Content		
The selected early-stage researchers from the training courses come together in the finale “Early-Stage Researchers Training Workshop” to participate in training and discussion on the following three interlinked themes: (1) Vertical - review of scientific content of courses; prediction/analysis of future needs, (2) Horizontal -review of current and potential future issues for researchers; ethical research, sustainability, role of science in society, socio- economic considerations, multidisciplinary research. (3) Complementary - acquisition of non-research competencies; communication skills, social & team building skills, financial planning and management, proposal writing, efficient time management, meeting skills.		
Speakers		
Solicitation of Keynote Speakers for the conference are primarily sourced by AquaTT, using its database of contacts, predominantly comprising individuals involved in some aspect of education and training in aquaculture. Speakers for the Vertical themes are sourced using the AQUA-TNET partner contacts at European centres of excellence; this category of speakers is experienced and recognised for research excellence. AquaTT sources speakers for horizontal themes and complementary themes with expertise in the listed areas; while many of these speakers may have extensive research experience, some will come from a different background and their presentation will lead to the transfer of complementary skills to researchers.		
Organiser		
David Murphy AquaTT P.O. Box 8989 Dublin 2 IRELAND Tel: +353 1 644 9008 Email: david@aquatt.ie		

Section 5

Aquaculture Career Opportunities

Compiled by:

Dr Ewen McLean
Aalborg University
Denmark

Summary outline

.....

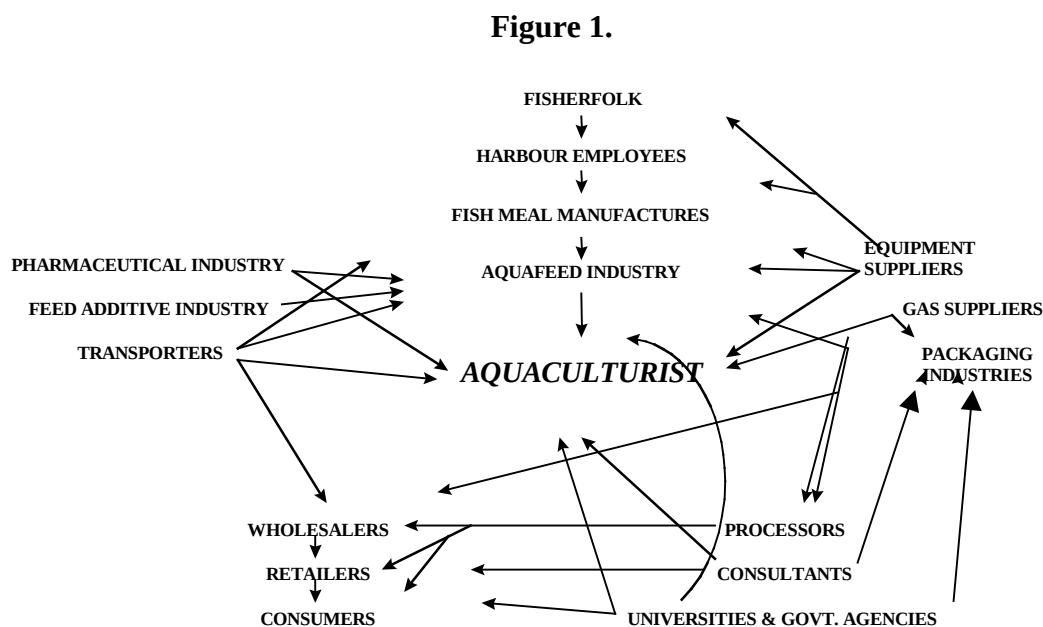
Section 6 provides an overview of the career opportunities in a series of inter-linked sectors which are open to graduates in Aquaculture

.....

Aquaculture Career Opportunities

Production methods in aquaculture are as assorted as the number of species cultured and include every variation between single operator, single pond production units, to involvement of multinational corporations in intensive rearing operations. During the last decade, harvests from global aquaculture have grown at 12% per annum. This industry, therefore, represents the fastest-growing component of the world food supply. Today, aquaculture, in all its variant forms, accounts for around 30% of total seafood wealth. It is manifest that the business will continue to increase at a dramatic rate well into the next millennium. As with other businesses, industry expansion has led to increased employment opportunities within the sector. The range of vocations on offer has also diversified over the last two decades, due to the development, and increasing involvement of, support and service industries (Figure 1). This, in turn, has broadened the type and level of vocational training necessary to service the various sectors, such that occupations within the aquaculture industry may be supported by secondary through to university level training.

Figure 1. *The range of vocations available to graduates in the aquaculture sector are not simply restricted to the production sector alone. The development of the business has stimulated growth in a variety of other service and support sectors, many of which provide employment opportunities. The figure provides a brief overview of some industry sectors which are directly or indirectly involved with the aquabusiness and their relationships in terms of service(s) provided. A noteworthy omission is the insurance and financial sectors.*



Career openings in the aquaculture sector include those directly related with production, as seen, for example, with general operatives responsible for inventory feeding, harvesting, site cleaning and general maintenance, through to hatchery and farm managers who possess significant management and operational experience. Often, smaller facilities may be maintained by a single entrepreneur, responsible for

all aspects of production. Many such units exist in Europe and elsewhere. A more recent trend has been the development of larger companies specialised in the management and operation of several aquaculture sites, as seen in Europe, the Americas and South and East Asia. This maturation process, which has impacted global fish, crustacean, shellfish and macrophyte production, has been accompanied by a subtle shift in the number and type of appointments offered within the industry. Frequently, such groups retain several highly trained specialists who are responsible for servicing all production holdings of the company. For example, M.Sc. and doctoral level employees may be involved in broodstock and genetic improvement programmes, nutritional management and similar operations. Within larger companies, veterinarians may be engaged in the organisation and oversight of disease management and diagnostic programmes and in Europe, significant activity has recently been seen in the hiring of individuals trained in logistics and project management. The larger commercial groups, together with their hatchery staff and farm managers, may retain the services of specialised personnel for heavy equipment handling, boating and seining operations, diving, net management and procurement functions for all their site holdings, together with financial advisers and similar, involved in accessing EU and similar funds for aquaculture-related enterprises. Opportunities are increasingly in evidence for highly trained aquacultural engineers, particularly to support recirculation-based operations; be these hatchery or on-growing based.

Clearly aquaculture is a multi-disciplinary business (Figure 1) and the industry trend is towards a higher level of sophistication allowing for improved efficiency in production and hence profitability. Latterly, the industry has experienced a certain level of horizontal, and to a lesser extent, vertical integration too. This organisational restructuring, particularly as it relates to processing, has broadened vocational opportunities in the industry even further. There exists an established tradition for European salmonid and oyster culture operators to undertake a certain degree of primary processing and end product marketing. Indeed, certain producers place a high degree of reliance upon local markets for income generation. However, the recent past has witnessed a certain level of refinement in the integration process, such that the complexity of producer-founded processing, marketing and exporting has increased. This trend, which is global, multi-species and multi-product in scope, has brought with it enhanced possibilities for employment, at the production and/or co-operative level, for those with skills in seafood processing, marketing, export, logistics, business economics and production management. Nevertheless, the vast majority of aquaculture product is delivered to the specialised processing sector for final preparation prior to marketing.

The seafood processing sector provides a wide variety of vocational opportunities for individuals possessing all levels of academic training in aquaculture-related fields. In the processing sector proper, staff requirements are diverse, ranging from those employed to work processing lines, through to personnel officers, plant managers, quality control specialists and product development scientists. As exemplified by the salmon business, there has been significant activity in end product diversification, with traditional fresh, chilled, frozen and smoked commodities being supplemented by marinated, terrine, pâté and mousse products. This development has also had the effect of strengthening the industry. Associated with the processing sector of

commerce are all those components which, together, form the product, or retail chain viz. marketing, packaging, transportation, storage, accountancy, public relations specialists etc. (Figure 1). With respect to the latter there is an increasing need for personnel who retain an in-depth knowledge of aquaculture production systems to support buying, export, marketing and product quality decisions. Product promotion is also undertaken on behalf of the aquaculture industry by co-operatives or associations and herein lie other vocational opportunities demanding of various levels of academic achievement in aquaculture and related specialisations.

The aquafeed industry has become increasingly refined in their research and development activities spurred on by the need for a greater range of species-specific diets, speciality products (pigmented, medicated), broodstock formulations and environmentally sound feeds. This has resulted in greater opportunities within the research and development area, with supportive needs from raw quality purchasing departments for production of least cost dietary formulations. Openings thus exist for personnel with an understanding of the requirements and limitations of the aquafeed industry. A trend in the aquafeed business has been co-opting of associated aquaculture services for buyers, including veterinary assistance. In line with this, the larger companies also employ specialist purchasers, in the chemical supply sense, for antibiotics, vaccines, pigments, vitamin premixes etc. Here too, therefore, exist possibilities for those with specialised training in aquaculture nutrition and economics. While there has been an overall increase in the use of vaccines, with a concomitant reduction in the employment of antibiotics in Europe, Canada and the US, there still exists a need to increase the product portfolio with respect to vaccines and a number of specialist companies continuously seek to improve their product lines with in-house research and development upon new adjuvants, alternative delivery systems, polyvalent vaccines and innovative treatment systems. Potential future markets exist with recently developed feed-based probiotics and immunostimulants expressing high potential. In these companies, there is a high demand for personnel in the R&D sector, sales and back-stopping and specifically for those familiar with fermentors and down-stream processing methods.

In attempts to enhance production efficiency and profitability, aquaculture producers have become increasingly sophisticated in terms of the equipment employed 'on-farm'. These range from automated grading systems through to piscators, on-line monitoring procedures, underwater video surveillance and measuring applications, automated feed delivery systems, recirculation configurations, water treatment components and processing and packaging lines. The vast majority of these components are derived from engineering development and supply companies, all of which require back-stopping in sales, service, installation and research and development (Table 1). Here, too, exist a wide range of vocational opportunities for aquaculture graduates and particularly for those with skills in engineering, marketing and research.

Since the 1980s a number of companies have provided specialist financial services to the aquaculture sector, although this area of specialisation has broadened considerably in the financial service sector. Knowledge of aquaculture production, in its widest sense, is highly beneficial in this area and it is not surprising to find that aquaculture graduates have found a niche in this industry. Also housed in the service sector are

companies and consultants who specialise in turn-key operations, designing, site selecting, constructing and backstopping aquaculture facilities. Here lie major opportunities for graduates with proficiency in a wide range of subjects from mechanical to electrical engineering through to hydrologists, surveyors, biologists, economists and others with critical knowledge and experience in aquaculture production.

Within the consultancy domain, a high level of competence in aquaculture and related disciplines is required (Table 1). Such employment may offer possibilities for recruitment to be engaged, at various levels, to service on-going international projects, of public and/or commercial interest, with respect to a wide variety of aquatic organisms and in the global setting. As well, an aquaculture education may be effectively employed in fields covering institutional and curriculum strengthening, project review and evaluation, environmental impact assessment, extension training, feasibility studies and field trials, proposal structuring, short-course design and execution, facility engineering and construction supervision, risk and facility take-over evaluations, site surveying and selection, topographic analyses and mapping, pond designs etc., with engineering details for water systems and research and facility support building plans, disease management assistance and training etc. Other fields in which consultancy companies may become involved in the aquaculture sense relate to product quality assurance, product development, and advisory roles for the development of HACCP systems for aquaculture processing plants and insurance in meeting EU, FDA and similar requirements as this regards importation restrictions for aquaculture produce.

The heightening of the public and scientific sector's understanding of issues surrounding water and environmental quality, has brought with it increasing attention to the methods employed in the licensing, inspection and monitoring procedures for aquaculture facilities on a global scale. In this respect possibilities exist for employment in the fields of water analyses, site evaluations, environmental impact assessments including disease transmission and soil, fauna and flora conservation. In this sector, which may be county, national or international in scope, lie opportunities for those with an academic training and demonstrated experience in the methods and limitations imposed during aquaculture production (Table 1). Finally, the academic and public sectors (*e.g.* Ministry of Agriculture and Fisheries etc.) offer career potential in terms of scientific and technical support for the industry. Research may be wide-ranging, and take into consideration new and cleaner technologies for production, better methods for harvesting and processing inventory, new techniques for utilising by-products from the industry or increasing yields and innovations in product development and marketing amongst a hundred others. Engagement in such work may be multi-level in terms of qualification, ranging from secondary through doctoral level (Table 1).

Table 1. Example employment opportunities and level of qualification deemed desirable for specific aquaculture-related vocations. It is noteworthy that in many instances qualification does not, necessarily, supplant experience and that different countries both within the European context and globally, might have lower expectations. The table should be used as it is intended - for guidance only.

Employment Sector	Example Functions	Desirable Qualification
Aquaculture production	General operatives: feeding/harvesting, etc.	Secondary-B.Sc. B.Sc./M.Sc.
	Farm/Hatchery manager	B.Sc./M.Sc.
	Logistics/Project management	M.Sc./Ph.D.
	Broodstock management/selection	DVM
	Programmes	M.Sc./Ph.D.
	Disease monitoring/treatment	
	Nutritional management	
Processing and marketing	Logistics/Project management	B.Sc./M.Sc.
	Public relations officer	B.Sc./M.Sc.
	Quality control specialist	M.Sc./Ph.D.
	Product development	M.Sc./Ph.D.
Service sector	Equipment sales	Secondary-B.Sc.
	Equipment installation/service	B.Sc./M.Sc.
	Facility and systems design	M.Sc./Ph.D.
	Facility and systems installation/service	B.Sc./M.Sc.
	Financial and insurance services	B.Sc./M.Sc.
Support sector	Feed sales and support	Secondary-B.Sc.
	Nutritionist	M.Sc./Ph.D.
	Vaccine development/manufacture	M.Sc./Ph.D.
	General consultancy operations	M.Sc./Ph.D.
	Aquaculture R&D	M.Sc./Ph.D.
	R&D support staff	B.Sc.
Legislative bodies	Water analyses	B.Sc.
	Site and product inspection	M.Sc./Ph.D.
	Environmental/Conservationist	M.Sc./Ph.D.

Section 6

Recommendations

**AQUA-TNET
Representatives**

7 Recommendations (grouped under Section headings)

7.1. Issues in the European aquaculture industry with implications for the university/research sector

In recognising that:

- ◆ Aquaculture is a complex industry, dependent on knowledge bases from a series of disparate disciplines (for instance, biology, engineering, marketing);
- ◆ Aquaculture is a dynamic, constantly evolving industry, drawing on new technologies, some industry-driven, some research-led, and benefiting from innovations and the outputs of a range of RTD activities;
- ◆ Aquaculture must absorb the changes brought about by the new technologies and seek further diversification in order to remain competitive on a world-wide scale;
- ◆ In this fast developing industry, education providers (mainly but not exclusively third-level educational institutions) must face the challenge of identifying changes, predicting trends and adjusting educational materials to match these emergent needs;
- ◆ It is neither practicable nor feasible for all universities to provide a full range of all courses and modules required for comprehensive coverage with state-of-the-art equipment.

The AQUA-TNET network recommends that:

- IV. Centres of Excellence in aquaculture education should be established, or recognised, where traditional specialisations or new developments following new technological breakthroughs are taught.
- V. Short courses such as the Methodology Series, AQUALABS, should continue to be run with appropriate funding to be raised.
- VI. Education institutions must improve their capacity to match course programme objectives with changing industry / employment requirements (biotechnology).
- VII. Quality concepts embracing environmental standards, BEP, Codes of Conduct, should be introduced into training packages or form part of new courses.
- VIII. Quality standards for educational provision should be introduced, to ensure:
 - ◆ technical relevance of course material presented
 - ◆ training methods and facilities to be up-to-date

- ◇ innovative and flexible delivery methods to be utilised where possible, in order to cut down costs

7.2. Issues directly concerning educational provision in aquaculture

a) curricular content

In recognising, from detailed analyses of European third-level aquaculture curricular provision that:

- ◆ Higher educational institutions offering B.Sc. courses provide a wide and varied range of degree courses with some going well beyond the minimum requirements, with no need to define a single "standard" common system (fixed content, common assessment practices and credit levels) for the European aquaculture under-graduate level;
- ◆ M.Sc. degrees in aquaculture exhibit sharp differences of quality and quantity of course content, with internal as well as external differences, with variability in length from 12 to 24 months, with structure, organisation and course content also very different from country to country

The AQUA-TNET network recommends that, in terms of curricular provision:

- I. A degree of harmonisation and interaction of existing aquaculture course provision should lead to the adoption of the flexible, ideal format for an undergraduate course, the framework of which is set out in Section 2 (2.2.3.2), (core elements, supported by further recommended modules, and finally, optional specialised elements which could be adapted for the specific geographic conditions and species mix in each country.)
- II. The M.Sc.degree likewise should not be specified in terms of curricular content (length of course, detailed curriculum requirements) but should harmonise the pre-entry conditions and adopt, in general, a coherent and consistent set of pre-entry requirements, as set out in Section 2 (2.2.4.3)
- III. Innovative delivery methods, such as the Internet, multimedia (CD-ROM) as in some of the Methodology Series should be utilised where suitable, to aid transparency and harmonisation of curricular content.

7.3 Accreditation & Recognition of European qualifications

In recognising, from detailed analyses of European third-level aquaculture assessment, certification and accreditation procedures that:

- ◆ The assessment practices and instruments used cover the whole available range (formal written exam, continuous assessment, laboratory exercises, oral assessment, dissertations, etc);
- ◆ The final grading schemes used in each country to record the final mark/score/grade are completely different, so that there is no easy way of establishing equivalence of standards;

- ◆ These disparities exist at both under-graduate and M.Sc. levels and do not imply differences in standards, but different methods of recording final results.
- ◆ The disparities hinder transparency to such an extent that objective comparisons cannot be made without some kind of external filtering procedure.

The AQUA-TNET network recommends that:

- I. All European under-graduate courses examine, with a view to using, the ECTS Accreditation system as a model, where all individual final assessment patterns can be accommodated, to provide a coherent, comprehensive and comparable standard, with credits based on student workload (lectures, practicals, laboratory work, work experience/ placements).
- II. Each university looks to the provision of a Diploma Supplement for its students.
- III. Student placements should be mutually recognised in Member States and incorporated into the curricula
- IV. There should be continued consideration of the most effective methods to increase the transparency in order to give equal opportunity for all to take part in training throughout the EU, by looking at the Europass initiative.

7.4 Mobility

In recognising that:

- ◆ Aquaculture is an important activity in Europe for socio-economic considerations and that therefore mobility procedures should be transparent, simple, efficient, and cost-effective.
- ◆ Mobility procedures need to address the needs of students, industry, the educational institutions and their administrative requirements.

The AQUA-TNET networks recommends that:

- I. Obstacles and barriers to mobility should be broken down through a number of specific measures
 - recognition between Member States of the value of placements through recognised accreditation procedures
 - Increased efforts should be made to encourage students and staff to take part in exchange schemes and practical training
- II. Basic requirements to include the following:
 - Clear information and promotion
 - Language and cultural preparation
 - Well-developed inter institutional linkages/contacts
 - Forward planning in terms of European funding
 - Convenient timing of the programme
 - Credit/recognition of placement/exchange
 - Ongoing supervision, monitoring, support
 - Dissemination of results
 - Sustained contacts between universities/ institutions and beneficiaries

7.5 Industry – University Linkages

In recognising that:

- ◆ It is important to stimulate new forms of industry-university partnerships
- ◆ The facilitation of exchanges of experience is one method leading to best practice
- ◆ The emergence of innovative learning approaches including the introduction of flexible learning can be of great benefit to industrial partners tied to remote and isolated workplaces

The AQUA-TNET networks recommends that:

- I. Companies should state clearly the broad competence needs of their workforce. They must indicate to training providers how staff profiles are changing and how education can meet new requirements.
- II. People should be encouraged to continuously improve skills, not necessarily by upgrading to higher degrees, but by updating qualifications and broadening competence.
- III. They should learn how to exploit all kinds of learning opportunities in professional life and outside.
- IV. Companies should contribute to the quality movement in education by sharing expertise and must collaborate in achieving high quality continuing training market.
- V. Company personnel should be offered a variety of learning opportunities.
- VI. Training approaches should be demand-driven rather than supply-led.
- VII. Education institutions should resist the tendency for longer study periods.

Concluding Remarks Richard, I think this needs very little work to finish it off. Just smooth off the edges here and there. I took the liberty of doing the last set of recommendations because of your Bank holiday.

Achieving greater synergy in the European Unions' R&D and education initiatives is required. In particular, AQUA-TNET has in mind harnessing the various mobility programmes as well as uncoordinated activities for advanced education and training (Human Capital and Mobility, LEONARDO, SOCRATES, ESPRIT). The linkage between R&D and advanced education initiatives should clearly address applied research in industry

Ensuring that European initiatives in aquaculture and fisheries meet goals that are relevant to the industry and economy. Greater use of EU structural policies for training actions with a strong European dimension. Areas where there is particular scope

- promotion of geographic and functional mobility
- transnational placements at various levels (post-grad and post-doc)
- exchanges of trainers between countries and organisations

- delivery of highly specialised and advanced education and training
- training aimed at technology transfer (comparability and analysis),
- joint development of advanced and specialised training materials
- joint development of specific specialised courses
- use of 'Centres of excellence' for the delivery of specialised courses
- transnational dissemination of training materials
- accreditation and mutual recognition of qualifications

