

**REGIONAL REVIEW ON AQUACULTURE DEVELOPMENT  
5. CENTRAL AND EASTERN EUROPEAN REGION – 2005**



Copies of FAO publications can be requested from:

Sales and Marketing Group

Communication Division

FAO

Viale delle Terme di Caracalla

00153 Rome, Italy

E-mail: [publications-sales@fao.org](mailto:publications-sales@fao.org)

Fax: (+39) 06 57053360

**REGIONAL REVIEW ON AQUACULTURE DEVELOPMENT  
5. CENTRAL AND EASTERN EUROPEAN REGION – 2005**

by

**FAO Fisheries and Aquaculture Department**

and

**Network of Aquaculture Centres of Central and Eastern Europe (NACEE)**

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

ISBN 978-92-5-105826-8

All rights reserved. Reproduction and dissemination of material in this information product for educational or other non-commercial purposes are authorized without any prior written permission from the copyright holders provided the source is fully acknowledged. Reproduction of material in this information product for resale or other commercial purposes is prohibited without written permission of the copyright holders. Applications for such permission should be addressed to the Chief, Electronic Publishing Policy and Support Branch, Communication Division, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy or by e-mail to [copyright@fao.org](mailto:copyright@fao.org)

© FAO 2007

## FOREWORD

The world population is on the rise, as is the demand for aquatic food products. Production from capture fisheries at the global level is levelling off and most of the main fishing areas have reached their maximum potential. Sustaining fish supplies from capture fisheries will, therefore, not be able to meet the growing global demand for aquatic food.

At present, the aquaculture sector contributes a little over 40 million tonnes (excluding aquatic plants) to the world aquatic food production. According to recent FAO predictions, in order to maintain the current level of per capita consumption at the minimum, global aquaculture production should reach 80 million tonnes by 2050. Aquaculture has great potential to meet this increasing demand for aquatic food in most regions of the world. However, in order to achieve this, the sector (and aqua-farmers) will face significant challenges.

A major task ahead for sustainable aquaculture production will be to develop approaches that will increase the contribution of aquaculture to the global food supply. These approaches must be realistic and achievable within the context of current social, economic, environmental and political circumstances. Accurate and timely information on the aquaculture sector is essential in order to evaluate the efficacy of these approaches and how they can be improved.

Under the FAO Fisheries and Aquaculture Department's current work programme, the Aquaculture Management and Conservation Service (FIMA) of the Fisheries and Aquaculture Management Division, using a wide-ranging consultative process, regularly conducts reviews on the status and trends in aquaculture development (FAO Fisheries Circular No. 886 – Review of the State of World Aquaculture and FAO Fisheries Circular No. 942 – Review of the State of World Inland Fisheries). The last review (both regional and global) was conducted in 1999/2000 and was published following the Global Conference on Aquaculture in the Third Millennium held in Bangkok, Thailand, in 2000 (NACA/FAO, 2001, Aquaculture in the Third Millennium). These reviews are seen as important milestones and the documents produced are recognized as significant reference materials for planning, implementing and managing responsible and sustainable aquaculture development worldwide.

As part of this continuing process and with the current objective of preparing a global aquaculture development status and trends review, FIMA had embarked on a series of activities. These are:

- National Aquaculture Sector Overviews (NASOs) and National Aquaculture Legal Overviews in selected countries;
- Prospective Analysis of Future Aquaculture Development – PAFADs in selected countries;
- five regional workshops to discuss the status and trends in aquaculture development in Asia and the Pacific, Central and Eastern Europe, Latin America and the Caribbean, Near East and North Africa, and sub-Saharan Africa; and
- seven regional aquaculture development status and trends reviews in Asia and the Pacific, Central and Eastern Europe, Latin America and the Caribbean, Near East and North Africa, North America, sub-Saharan Africa and Western-European region.

This document presents the regional synthesis for the Central and Eastern European region. This review is based on (i) NASO and PAFAD studies contributed by experts of the region; (ii) the Regional Aquaculture Review compiled by the Research Institute for Fisheries, Aquaculture and Irrigation (HAKI, Szarvas, Hungary); and (iii) the FAO Expert Workshop on Regional Aquaculture Review in Central and Eastern Europe, held in Astrakhan, Russian Federation, in September 2005. Both the preparation of the Regional Review as well as the discussions during the Astrakhan Workshop followed closely the terms of reference given by FIMA to all authors of the regional aquaculture reviews. The process of preparation of NASO-PAFADs, the Regional Review and the Astrakhan Workshop was undertaken within the framework of NACEE, the Network of Aquaculture Centres in Central-Eastern Europe, with technical and organizational support from HAKI and FIMA.

## ACKNOWLEDGEMENTS

FAO's Aquaculture Management and Conservation Service (FIMA) and the Network of Aquaculture Centres in Central-Eastern Europe (NACEE) greatly appreciate the contributions by all participating experts and institutes of the region and by all authors of the NASO-PAFAD studies. We are also grateful to L. Váradi and P. Lengyel of the HAKI team in Szarvas, Hungary, for coordination of the regional review process, for compilation and synthesis of data and resource materials for the review, and for the organization of the Regional Aquaculture Review Expert Workshop in Astrakhan held from 5 to 7 September 2005. Further, we thank especially A. Bogeruk of the Pedigree Fish Breeding Centre in Moscow as well as L. Vasilyeva and her team at the BIOS Research and Production Center for Sturgeon Breeding in Astrakhan for facilitating arrangements and support in the Russian Federation, and, in particular for hosting the Expert Workshop in Astrakhan. BIOS also hosted the Second Meeting of NACEE Directors held from 8 to 9 September 2005.

The finalization of the document required extensive work on presentation, layout and proofreading as well as technical editing and review, which was carried out respectively by Rine Sola, Anna Rita Colagrossi and Uwe Barg, all staff of FAO's Fisheries and Aquaculture Department.

Further information on NACEE can be found at: <http://www.agrowebcee.net/subnetwork/nacee/>

FAO NASO study reports for more than 80 countries are available at:  
<http://www.fao.org/fi/website/FISearch.do?dom=countrysector>

**FAO/Network of Aquaculture Centres in Central-Eastern Europe (NACEE).**  
*Regional review on aquaculture development. 5. Central and Eastern European region – 2005.*  
 FAO Fisheries Circular. No. 1017/5. Rome, FAO. 2007. 84pp.

### ABSTRACT

FAO regularly conducts global and regional reviews of aquaculture status and trends, most recently during 2005 and 2006. The present regional review and synthesis for Central and Eastern Europe (CEE) provides an overview of major issues and trends in the aquaculture sector. The dominant technology is carp-based polyculture production in ponds. Production declined significantly following the political and socio-economic changes in the early nineties. Since 1996, production is gradually increasing. Aquaculture is an important supplier of healthy food for local populations, and will continue to contribute to rural development. During the Astrakhan workshop in 2005, 13 NASO-PAFAD country review studies and the draft Regional Aquaculture Review were presented and discussed. A series of common issues, constraints and trends were recognized for the region covering: predominance of carp production, low production levels, inefficient farm management and marketing, lack of skilled staff, financial and legal problems. Four major thematic areas were analysed: (a) policy framework, legislation and institutional systems; (b) farming systems, species and technologies; (c) processing and marketing (consumers' demand, labelling, certification); and (d) social aspects (food supply, employment, income generation). The workshop highlighted the following points: (a) the significance of aquaculture development in CEE has to be emphasized; (b) governments and other policy-makers should be informed about the opportunities and need of developing a sustainable aquaculture sector; (c) producers should recognize consumer demands and the increased market competition with other commodities; and (d) NACEE can play an important role in facilitating the information exchange in the region. The regional review indicates that there are opportunities for integrating aquaculture with other activities, for enhancing exports, and for strengthening institutional capacity building. There is need for research, technology development and investment to improve sustainability of existing farming systems, to promote diversification using additional and high value species, and to expand marine production systems. There is significant scope for improved human resources development, for better collaboration among farmers, and between science and practice, and for international collaboration, within the region and with institutions and organizations outside the region.

## CONTENTS

Foreword.....	iii
Acknowledgements.....	iv
Abstract.....	iv
List of tables.....	vii
List of figures.....	viii
Acronyms and abbreviations.....	ix
<b>PART I – REGIONAL REVIEW ON AQUACULTURE DEVELOPMENT: CENTRAL AND EASTERN EUROPE – 2005.....</b>	<b>1</b>
<b>Executive Summary.....</b>	<b>3</b>
<b>1. CHARACTERISTICS AND STRUCTURE OF THE SECTOR.....</b>	<b>7</b>
1.1 Regional demographic and economic overview.....	7
1.2 Status of aquaculture in the region .....	10
1.2.1 History and traditions of aquaculture practices.....	10
1.2.2 Aquaculture production systems .....	13
1.2.3 Produced aquatic species .....	13
<b>2. PRODUCTION .....</b>	<b>14</b>
<b>3. ECONOMICS AND TRADE .....</b>	<b>20</b>
3.1 Role of the aquaculture sector .....	22
3.1.1 Contribution of the sector to national food security .....	22
3.1.2 Contribution of the sector to economic development .....	24
3.1.3 Role and impact of aquaculture as a component of the livelihood of poor rural households .....	25
3.2 Performance of the aquaculture sector .....	25
3.2.1 Trends in farming systems.....	25
3.2.2 Significant non-food aquatic species .....	26
3.2.3 Trends in diversification of aquatic species farmed .....	27
3.3 Regional markets for aquaculture products .....	27
3.3.1 Characteristics of export and import.....	27
3.3.2 General supply chains and distribution channels .....	28
3.3.3 Labelling and certification of aquaculture products .....	29
3.4 Expectations on economic gains through trading of aquatic products.....	30
3.4.1 Income generation through aquaculture production and export.....	30
3.4.2 Contribution to GDP of trade in fisheries and aquaculture products.....	30
3.4.3 Intraregional and interregional trade of aquaculture commodities.....	31
3.4.4 Production cost of aquatic species.....	32
<b>4. CONTRIBUTION TO FAMILY FOOD SECURITY, ACCESS TO FOOD, NUTRITION AND FOOD SAFETY .....</b>	<b>32</b>
4.1 The relative contribution of fish compared to other sources of protein to food production .....	32
4.2 Fish consumption trends .....	33
4.3 Comparing consumption of fish vs terrestrial meat in rural and urban societies.....	34
4.4 Market prices of aquatic species of different origins .....	34
4.5 Demographic data and trends relevant to aquaculture .....	36
<b>5. ENVIRONMENT AND RESOURCES .....</b>	<b>36</b>
5.1 Environment and land use.....	36
5.1.1 Overall use of land and water resources.....	36

5.1.2	Total area used for aquaculture production .....	39
5.1.3	Trend towards increasing mariculture development.....	40
5.1.4	Species introduced for aquaculture purposes.....	40
5.1.5	Indicative losses due to diseases in aquaculture.....	40
5.2	Feed and seed resources .....	40
5.2.1	Origin of feed resources and degree of their use.....	40
5.2.2	Status of commercial aqua-feed production .....	41
5.2.3	Levels of importation of aqua-feeds .....	41
5.2.4	Quality issues related to commercial aqua-feeds .....	41
5.2.5	Hatchery production of seed .....	41
5.3	Feeding fresh fish, trash fish and fishmeal usage.....	42
5.3.1	Production, export, import and use of fishmeal .....	42
5.3.2	Usage patterns for trash fish and raw fish in aquaculture.....	43
6.	<b>LEGAL, INSTITUTIONAL AND MANAGEMENT ASPECTS OF THE AQUACULTURE SECTOR.....</b>	<b>43</b>
6.1	Description of the sector.....	43
6.1.1	Parts of the sector .....	43
6.1.2	Management of the sector.....	43
6.1.3	Country efforts to develop sustainable aquaculture.....	44
6.2	Institutional support and legal and policy frameworks in the sector .....	44
6.2.1	Farmer societies and organizations.....	44
6.2.2	National resource allocations for agricultural, livestock and fisheries (aquaculture) production .....	45
6.2.3	Measures of authorities for ensuring quality and safety of aquaculture products .....	46
6.2.4	International trading standards and related strategies to safeguard small-scale producers .....	47
7.	<b>SOCIAL IMPACTS, EMPLOYMENT AND POVERTY REDUCTION.....</b>	<b>47</b>
7.1	Trends in shifting from small-scale operations to larger commercial operations in aquaculture.....	48
7.2	Ownership of aquaculture operations.....	48
7.3	Contribution of aquaculture to employment in rural and coastal areas.....	49
7.4	Distribution of benefits from aquaculture.....	50
7.5	Involvement of women and children in aquaculture.....	50
8.	<b>TRENDS, ISSUES AND DEVELOPMENT.....</b>	<b>51</b>
8.1	External and internal driving forces and reasons of main development trends in the sector.....	51
8.2	Main development trends in the sector.....	52
8.2.1	Growth of aquaculture production.....	52
8.2.2	Utilization of water resources .....	53
8.2.3	Production systems .....	54
8.2.4	Market .....	54
8.2.5	The role of aquaculture in the rural economy .....	54
8.2.6	Contribution of aquaculture to the better fish supply of local population.....	55
8.2.7	Development of aquaculture technologies.....	56
9.	<b>REFERENCES.....</b>	<b>58</b>
	<b>PART II – REPORT OF THE FAO EXPERT WORKSHOP ON REGIONAL AQUACULTURE REVIEW IN CENTRAL AND EASTERN EUROPE.....</b>	<b>63</b>



**LIST OF TABLES**

Table 1. Area and population of Central and Eastern European countries in 2003 .....	8
Table 2. Demographic and economic data of Central and Eastern European countries .....	9
Table 3. Gross Domestic Product (using Purchasing Power Parity method) of CEE countries in 2003.....	10
Table 4. Volume of total aquaculture production in Central and Eastern European countries between 1990 and 2003 .....	17
Table 5. Value of aquaculture production in Central and Eastern European countries in 2003, with and without data of the Russian Federation .....	18
Table 6. Volume of top 24 fish species cultivated in Central and Eastern Europe between 1990 and 2003 .....	19
Table 7. Volume, value and unit value of top 24 species by value produced in the countries of Central and Eastern Europe in 2003 .....	21
Table 8. Volume, value and unit value of most cultivated ISSCAAP species in Central and Eastern European region in 2003 .....	22
Table 9. Fish and seafood supply in Central and Eastern European countries between 2000 and 2004 .....	23
Table 10. Relative contributions of aquaculture production of CEE countries to the total value of GDP, agriculture and livestock production in 2003.....	24
Table 11. Data on export earnings from aquaculture in 2003 as available for four CEE countries ....	31
Table 12. Fish and meat supply in CEE countries in 2002 .....	33
Table 13. Predicted fish consumption for EUR-28 countries from 1989 to 2030.....	35
Table 14. Area and volumes of inland water resources of Central and Eastern European countries ..	37
Table 15. Area of marine and brackish water resources of Central and Eastern European countries .	38
Table 16. Total area used for aquaculture production in CEE countries in 2003 .....	39
Table 17. Aqua-feed production and imports in some Central and Eastern European countries .....	42
Table 18. Fish producer's associations in Central and Eastern Europe .....	45
Table 19. Number of employees in aquaculture and their level of education in some Central and Eastern European countries .....	50
Table 20. Comparison of some relative aquaculture production indicators in Western and in Central and Eastern Europe in 2003 .....	54

**LIST OF FIGURES**

Figure 1. Quantity of aquaculture production in Europe by regions and environments in 2003 .....	15
Figure 2. Quantity of aquaculture production in Europe between 1990 and 2003 .....	15
Figure 3. Total aquaculture production by culture environment in Central and Eastern Europe in 2003.....	16
Figure 4. Main species farmed in freshwater aquaculture in Western and in Central and Eastern Europe in 2003 .....	16
Figure 5. Aquaculture production in CEE countries, 1983–2005.....	53
Figure 6. Fish consumption in Western and Eastern Europe during 1993–2003 .....	55

**ACRONYMS AND ABBREVIATIONS**

AQUASTAT	Information System on Water and Agriculture of FAO
ARWR	Annual Renewable Water Resources
Avg.	Average
CEE	Central and Eastern Europe
CEE 18s	Abbreviation used in tables and figures indicating the group of CEE countries not including the Russian Federation (CEE countries excluding Russian Federation)
CEE 19s	Abbreviation used in tables and figures indicating all the 19 CEE countries (CEE countries including Russian Federation)
COMECON	Council for Mutual Economical Assistance/Aid
EMAS	Eco Management and Auditing Scheme
EU	European Union
EUROSTAT	Statistical Office of the European Communities
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO Statistical Databases
FCR	Feed Conversion Ratio
FIFG	Financial Instrument for Fisheries Guidance
Fish Stat Plus	Universal software for fishery statistical time series of FAO
FMO	Fisheries management organization
FVO	Food and Veterinary Office (Commission of EU)
GDP	gross domestic product
GDP PPP	GDP based on Purchasing Power Parity
HACCP	Hazard Analysis and Critical Control Point
HRD	human resources development
ISO	International Organization for Standardization
ISSCAAP	FAO International Standard Statistical Classification of Aquatic Animals and Plants
KHV	Koi Herpes Virus
Ltd.	Limited Company
NA	Data not available
NACEE	Network of Aquaculture Centres in Central and Eastern Europe
NASO	National Aquaculture Sector Overview
OECD	Organisation for Economic Co-operation and Development
PAFAD	Prospective Analysis of Future Aquaculture Development
POs	Producers' Organizations
R&D	Research and Development
RAS	Recirculation Aquaculture Systems
RF	Russian Federation
SAPARD	Special Accession Programme for Agriculture and Rural Development
sq.	square
TRWR	Total Renewable Water Resources
UN	United Nations
US\$	United States Dollar
vs	versus

**CURRENCIES**

	<b>Name of currency</b>	<b>Abbreviation of currency</b>	<b>Exchange Rate of 1 Euro</b>	<b>Exchange rate of 1 US\$</b>
<b>Albania</b>	Lek	ALL	122,47	102,62
<b>Belarus</b>	Ruble	BYB	2566,56	2150
<b>Bosnia and Herzegovina</b>	Marka	BAM	1,95	1,639
<b>Bulgaria</b>	Leva	BGN	1,95	1,63
<b>Croatia</b>	Kuna	HRK	7,31	6,13
<b>Czech Rep.</b>	Koruny	CZK	28,4	23,79
<b>Estonia</b>	Krooni	EEK	15,64	13,1
<b>Hungary</b>	Forint	HUF	253,28	212,15
<b>Latvia</b>	Lat	LVL	0,69	0,58
<b>Lithuania</b>	Lita	LTL	3,45	2,88
<b>Moldova</b>	Leu	MDL	15,43	12,97
<b>Poland</b>	Zlotych	PLN	3,78	3,16
<b>Romania</b>	Leu	RON	3,47	2,90
<b>Russian Federation</b>	Ruble	RUB	33,48	28,02
<b>Serbia and Montenegro</b>	Dinar	CSD	87,46	73,5
<b>Slovakia</b>	Koruny	SKK	36,99	30,96
<b>Slovenia</b>	Tolar	SIT	239,48	200,44
<b>The former Yugoslav Republic of Macedonia</b>	Denar	MKO	61,76	51,9
<b>Ukraine</b>	Hryvna	UAH	6,04	5,06

(www.pleven.net; www.xe.com/ict; www.nbrb.by; www.abdicat.net - 02/03/2006)



**PART I**

**REGIONAL REVIEW ON AQUACULTURE  
DEVELOPMENT:  
CENTRAL AND EASTERN EUROPE – 2005**

Compiled by

Research Institute for Fisheries, Aquaculture and Irrigation  
(HAKI)  
Szarvas, Hungary

With contributions from experts of the  
Network of Aquaculture Centres in Central and Eastern Europe  
(NACEE)



## **EXECUTIVE SUMMARY**

### **CHARACTERISTICS AND STRUCTURE OF THE SECTOR IN THE CEE REGION**

#### **Freshwater aquaculture**

In Central and Eastern Europe (CEE) there is a long history of freshwater aquaculture production which is still based on the use of traditional methods and gears.

The dominant technology is carp-based polyculture production in ponds. The various cyprinids make up about 80 percent of the total aquaculture production both in freshwater and marine environment. However there are regions where other species play a dominant role in aquaculture (e.g. sturgeon, salmonids and whitefish).

There was a significant decline in production after the changes in Central and Eastern Europe in the early nineties, which was followed by a slow but steady growth.

Aquaculture is important not only for food supply but also for purposes of restocking (including endangered species) and recreational fisheries.

The fish processing industry is relatively undeveloped, though there have been positive changes recently.

There are very few intensive systems in the region. The sector continues to be highly dependent on supply of good quality seeds and feeds. Economic efficiency in the use of these resources must be considered for all systems, including intensive and “organic” farming.

#### **Marine and brackishwater aquaculture**

Marine and brackish water production is very limited. It was about 6 331 tonnes in 2003. About 70 percent of total production is coming from Croatia, where tuna production shows significant growth.

### **PRODUCTION, SPECIES AND VALUES**

Freshwater aquaculture production was 246 763 tonnes with a total value of US\$591.6 million in 2003, which represented 51 percent and 45 percent of the volume and value of European production. Cyprinids, mainly common carp, silver- and bighead carps are dominant species in freshwater aquaculture, which amount to about 81 percent of the total freshwater aquaculture production. The share of salmonids is about 13 percent of the total freshwater aquaculture production. Although there is significant R&D experience in sturgeon farming in the region, especially in the Russian Federation, the production of sturgeons is less than 3 000 tonnes. It was 1 percent and 4 percent of the total freshwater aquaculture production in terms of volume and value respectively.

The volume and value of marine aquaculture production was 6 331 tonnes and US\$21.9 million in 2003, which represented only 0.3 percent and 0.5 percent of the European production respectively. In Central and Eastern Europe marine aquaculture is only about 2.5 percent of the total aquaculture production in volume. The main cultivated species are Mediterranean mussel (38 percent), European seabass (31 percent) and gilthead seabream (14 percent). There is a spectacular growth of tuna production in Croatia, which increased from 39 tonnes in 1996 up to 3 971 tonnes in 2002.

### **ECONOMICS AND TRADE**

Generally, the contribution of aquaculture to national economies of CEE countries is rather low in terms of value (i.e. on average only 0.02 percent of GDP). However aquaculture can be very significant in the development of some rural areas. Hence rural, traditional and cultural characteristics of aquaculture should be emphasized.

There are efforts to develop aquaculture through initiatives of introducing new laws and regulations, training of fish farmers, establishing and upgrading production and processing facilities, implementing new marketing strategies, joining international organizations, improving product quality and widening species diversity.

Among non-food species only ornamental fish production has significance.

The export of fish commodities is limited in the region. The total export was around US\$2.4 billion in 2003, which is about 10 percent of the total European export value.

Supply chains show great varieties. The role of supermarkets is increasing. The increasing dominance of supermarkets in the trade of fish and fish products lead to the decrease of profits of producers. Production must address market demand. Marketing strategies should mainly focus on local and regional opportunities. New markets should be created.

Labelling and certification systems are new but developing. Organic standards for aquaculture are available only in one country.

Cost of production shows great variety however seems to be high and not competitive with some import products.

There is a trend towards species diversification, but the process is slow.

#### **CONTRIBUTION TO FOOD SECURITY, ACCESS TO FOOD, NUTRITION AND FOOD SAFETY**

When compared with other sources of protein the relative contribution of fish production to food production is varying from region to region but is generally low. Many people can not afford buying fish because it is too expensive and unaffordable in some areas because of the low incomes of the people. Fish consumption shows a slow but steady increase. Even though data are not available on fish consumption in rural versus urban areas, it seems that fish consumption is affected mainly by tradition. No significant competition has been identified between farmed and wild fish, as different species are sold on the market from farms and from the wild.

There is a need to identify market needs and consumers' expectations.

#### **ENVIRONMENT AND RESOURCES**

There are almost 500 000 ha areas of ponds in the CEE region. Fish ponds were built on areas with poor soil conditions therefore competition with agriculture is not a main issue, especially not in new member states of the EU, where land areas will be withdrawn from cultivation. The positive functions of pond ecosystems and stocking in support of biodiversity conservation including protection of species and habitats should be recognized.

There are opportunities for the integration of aquaculture with other human activities, which are based on the utilization of water resources such as irrigation and recreation.

During the past 10 years, only few (about 4–5) species have been introduced into the region for use in aquaculture.

The potential in mariculture is largely unexploited. There is however a slow development concerning mussel, seabream, seabass and tuna production.

Disease is not a main issue in pond aquaculture due to the relatively low intensity level. However the appearance of Koi Herpes Virus (KHV) and the risk of it spreading to neighbouring countries are of major concern. In intensive systems the prevention and treatment of diseases remains an important issue.



Feed resources, cereals and organic manures, as used in pond aquaculture, are available. However, aqua-feed production is limited in the region. It is about 150 000 tonnes per year. Good quality feed for intensive fish culture is mainly imported. Reasons of limited national production of high quality aqua-feed are the low quality fishmeal, lack of advanced production technology, unsatisfactory control of available raw materials and lack of equipment (e.g. for lipid enrichment). Efforts are required to develop local fish feed production and the use of locally available feed ingredients.

There is relatively large number of hatcheries in the region. Still there is a need for significant upgrading in order to meet the demand for good quality seed both in freshwater and marine aquaculture production.

Ecosystem approaches should include the use of different water bodies for culture-based fisheries.

### **LEGAL, INSTITUTIONAL AND MANAGEMENT ASPECTS OF THE AQUACULTURE SECTOR**

Laws and regulations for aquaculture are in place in some countries, while they are under elaboration in others. There is a continuous need for the development of an appropriate legal and regulatory framework for aquaculture.

Farmer societies and organizations have been established recently in almost all countries of the region, but their operation is still not very efficient.

In most countries aquaculture is recognized as contributor to rural development and the sector receives government support in the form of allocation of resources. Specific characteristics of aquaculture should be recognized by different institutions and public authorities, including agencies with mandate over fisheries, agriculture, water management, environmental protection and assurance of food safety. In some countries aquaculture is considered to be an “industry” which then is not eligible for agricultural subsidies.

Steps have been taken by authorities towards ensuring quality and safety of aquatic products for export. However the degree of assistance and support is varying and not satisfactory in some countries. Small-scale farmers are especially vulnerable when their products are affected by issues associated with international trade.

Investment needs and opportunities, including loans, credits and grants, should be defined in support of aquaculture development. Financial institutions and insurance companies are often not aware of the specific characteristics of the different aquaculture farming systems.

There are governmental and international efforts aiming to promote the establishment of producers’ organizations and to develop good networking but farmers often are reluctant to cooperate.

### **SOCIAL IMPACTS, EMPLOYMENT AND POVERTY REDUCTION**

The patterns of ownership of production units show great variability in the different countries. There is no clear trend in shifting from small-scale operation to larger commercial operations. Still there is an unsettled situation due to effects of the transition into market economy.

The contribution of aquaculture to employment is relatively low, but in some rural regions aquaculture is the only source of employment. Data on employment in upstream and downstream industries and in some special farms with angling services are incomplete. Involvement of women in aquaculture is high in some countries, but no gender related problems can be identified.

There are needs and opportunities for human resources development including training and education for farm operators and managers.

The crisis in capture fisheries and related unemployment lead to poaching, whereas fishermen could find new jobs in aquaculture.

#### **TRENDS, ISSUES AND DEVELOPMENT**

There has been a gradual increase in aquaculture production since 1996, which is likely to continue.

Aquaculture will remain an important supplier of healthy food for local populations. However, enhancing export activities especially those targeting niche market segments will offer new opportunities. It is a great challenge to satisfy the increasing demand for fish and seafood by local products.

Aquaculture will continue to be a significant contributor to rural development, particularly through various forms of pond fish farming.

Aquaculture is important for recovery of species diversity in natural water bodies.

There is a scope for marine aquaculture development in some countries where good conditions are available.

There is a need for research, technology development and investment to improve sustainability of farming systems.

Human resources management, including language training is a vital component of aquaculture development in CEE region. There is a need for better collaboration among farmers, and between science and practice. There is also a need for international collaboration, within the region and with institutions and organizations outside the region.

## 1. CHARACTERISTICS AND STRUCTURE OF THE SECTOR

There are 19 countries which belong to the reviewed region of Central and Eastern Europe (CEE). These countries are: Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, Russian Federation, Serbia and Montenegro, Slovakia, Slovenia, The former Yugoslav Republic of Macedonia and Ukraine.

When aquaculture development in Central and Eastern Europe is discussed, the terms “Central” and “Eastern” are associated with socio-economic or historical meanings rather than with the geographic coverage. This is because the nineteen countries of the CEE region had different political and economic administrations, especially in contrast to Western Europe, before the political changes took place in these countries in the early nineties.

### 1.1 Regional demographic and economic overview

In 2003, the total population of the nineteen CEE countries was about 333.2 million (UNDP, 2005). This also includes the population of 144.6 million of the Russian Federation (RF), which itself represents nearly 43 percent of the total population of the region. The population of CEE countries without<sup>1</sup> the Russian Federation is about 188.6 million (Table 1).

Although the average population of CEE states is more than 17.5 million with and 10.6 million without the Russian Federation, only ten of them have population figures higher than five million. These CEE countries are: Belarus, Bulgaria, Czech Republic, Hungary, Poland, Romania, Russian Federation, Serbia and Montenegro, Slovakia and Ukraine. The other countries have just a few million inhabitants as presented in Table 1. These CEE countries are: Albania, Bosnia and Herzegovina, Croatia, Estonia, Latvia, Lithuania, Moldova, Slovenia and The former Yugoslav Republic of Macedonia.

The average population density of CEE countries is rather different with 17.3 persons/km<sup>2</sup>, when including the Russian Federation, and 87.0 persons/km<sup>2</sup> without the RF, because the RF is a huge but very scarcely populated (8.4 persons/km<sup>2</sup>) country. According to the statistics even the least populated countries, such as Estonia (28.7 persons/km<sup>2</sup>), Latvia (34.0 persons/km<sup>2</sup>) and Belarus (47.69 persons/km<sup>2</sup>) are 3.5–6 folds, while Albania (107.8 persons/km<sup>2</sup>), Moldova (124.1 persons/sq. km) and Czech Republic (129.3 persons/km<sup>2</sup>) are 14.5–15.5 folds more densely populated than the RF (Table 1).

Latest estimates show that the majority of the countries in the region have a negative population growth rate, which is -0.2 percent on an average. The population in only three states Albania (0.6 percent), Slovakia (0.1 percent) and The former Yugoslav Republic of Macedonia (0.1 percent) is expected to show a growing tendency in the next 10–15 years (Table 2).

The proportion of the sexes shows more uniformity. Generally, in most CEE countries there are more women than men, approximately 0.9 male per one female on average (UN, 2006).

---

<sup>1</sup> The Russian Federation (RF) is by far the largest country of the CEE region. Therefore it is necessary to present and analyze data not only with but also without the relevant figures of the RF. In this way of presentation the same set of data may provide additional and more detailed information (see Tables 1-3). In the following sections reference will often be made to data from all 19 CEE countries (i.e. including data from RF) as well as to data from 18 CEE countries (i.e. excluding data from RF) and to their relative shares with and without respective data from the RF.

**Table 1. Area and population of Central and Eastern European countries in 2003** (adapted from UNDP Human Development Report 2005)

Country	Total Area (km <sup>2</sup> )			Population (million)			Density of Population		
	km <sup>2</sup>	% of CEE 19	% of CEE 18	Persons	% of CEE 19	% of CEE 18	person per km <sup>2</sup>	% of CEE 19	% of CEE 18
Albania	28 748	0.15	1.31	3.1	0.93	1.64	107.83	622.24	123.83
Belarus	207 600	1.08	9.50	9.9	2.97	5.25	47.69	275.18	54.76
Bosnia and Herzegovina	51 129	0.27	2.34	3.9	1.17	2.07	76.28	440.15	87.59
Bulgaria	110 910	0.58	5.07	7.8	2.31	4.08	69.43	400.61	79.73
Croatia	56 542	0.29	2.59	4.5	1.35	2.39	79.59	459.24	91.40
Czech Republic	78 866	0.41	3.61	10.2	3.06	5.41	129.33	746.30	148.52
Estonia	45 226	0.23	2.07	1.3	0.39	0.69	28.74	165.87	33.01
Hungary	93 030	0.48	4.25	10.2	3.06	5.41	109.64	632.67	125.91
Latvia	64 589	0.34	2.95	2.2	0.66	1.17	34.06	196.55	39.12
Lithuania	65 200	0.34	2.98	3.5	1.05	1.86	53.68	309.76	61.65
Moldova	33 843	0.18	1.55	4.2	1.26	2.23	124.10	716.11	142.52
Poland	312 685	1.62	14.30	38.6	11.58	20.47	123.45	712.33	141.76
Romania	237 500	1.23	10.86	21.9	6.57	11.61	92.21	532.09	105.89
Russian Federation	17 075 200	88.65	780.98	144.6	43.40	76.67	8.47	48.87	9.72
Serbia and Montenegro	102 350	0.53	4.68	10.5	3.15	5.57	102.59	591.97	117.81
Slovakia	48 845	0.25	2.23	5.4	1.62	2.86	110.55	637.93	126.96
Slovenia	20 273	0.11	0.93	2.0	0.60	1.06	98.65	569.26	113.29
The former Yugoslav Republic of Macedonia	25 333	0.13	1.16	2.0	0.60	1.06	78.95	455.56	90.66
Ukraine	603 700	3.13	27.61	47.5	14.26	25.19	78.68	454.02	90.36
<b>Total of CEE 19</b>	<b>19 261 569</b>	<b>100.00</b>		<b>333.2</b>	<b>100.00</b>		<b>17.30</b>	<b>100.00</b>	
<b>Total of CEE 18</b>	<b>2 186 369</b>	<b>11.35</b>	<b>100.00</b>	<b>188.6</b>	<b>56.6</b>	<b>100.00</b>	<b>87.08</b>		<b>100.00</b>

The average of the agricultural labor force in the region is more than 15 percent of the population. It is much higher than the 4.5 percent average of the European Union (EU). Only Croatia with 2.7 percent and the Czech Republic with 4 percent are below the EU average and three more states Hungary (6.2 percent), Slovakia (5.8 percent) and Slovenia (6 percent) are relatively close to this figure (CIA, 2006).

The contribution of the agricultural sector to the GDP (gross domestic product) is also varying (see Table 2). In all countries it is higher than the 2.2 percent EU average and there are only eight states where it is under 5 percent. These are: the Czech Republic (3.4 percent), Estonia (4.1 percent), Hungary (3.3 percent), Latvia (4.4 percent), Poland (2.9 percent), Russian Federation (4.9 percent), Slovakia (3.5 percent) and Slovenia (3 percent). In Albania, almost half of the GDP (46.2 percent) is coming from agricultural activities (Table 2).

**Table 2. Demographic and economic data of Central and Eastern European countries** (adapted from World Bank: World Development Indicators 2005; UNDP: Human Development Report 2005; CIA: The World Factbook 2005)

Country	Population (2003)					GDP (2004)					
	Persons (million)	Age Structure (%)			Growth 2003-2015 (%)	Amount (billion US\$)	Growth Rate (%)	Per Capita (US\$)	Composition (%)		
		Under 15	15-64	Above 65					Agriculture	Industry	Services
Albania	3.1	28.3	65,4	6.3	0.6	7.59	6.2	<b>2080</b>	46.2	25.4	28.4
Belarus	9.9	16.4	71,1	12.5	-0.6	22.84	11	<b>2120</b>	11.0	36.4	52.6
Bosnia and Herzegovina	3.9	17.4	72,3	10.3	-0.1	8.12	4.7	<b>2040</b>	14.2	30.8	55.0
Bulgaria	7.8	14.4	71,3	14.3	-0.8	24.13	5.5	<b>2740</b>	11.5	30.1	58.4
Croatia	4.5	16.1	69,7	14.2	-0.1	34.19	3.7	<b>6590</b>	8.2	30.1	61.7
Czech Republic	10.2	15.3	72,5	12.2	-0.1	107.04	4.0	<b>9150</b>	3.4	39.3	57.3
Estonia	1.3	16.2	69,9	13.9	-0.3	10.8	6.1	<b>7010</b>	4.1	28.9	67.0
Hungary	10.2	16.2	70,7	13.1	-0.3	99.71	4.0	<b>8270</b>	3.3	31.4	65.3
Latvia	2.2	15.9	69,9	14.2	-0.5	13.68	8.5	<b>5460</b>	4.4	24.8	70.8
Lithuania	3.5	18.0	69	13.0	-0.4	22.62	6.7	<b>5740</b>	6.1	33.4	60.5
Moldova	4.2	20.0	71,6	8.4	-0.2	2.59	7.3	<b>710</b>	22.4	24.8	52.8
Poland	38.6	17.3	71,8	10.9	-0.1	241.83	5.3	<b>6090</b>	2.9	31.3	65.9
Romania	21.9	16.5	71,4	12.1	-0.4	73.16	8.3	<b>2920</b>	13.1	33.7	53.2
Russian Federation	144.6	16.2	72,3	11.5	-0.5	589.39	7.2	<b>3410</b>	4.9	33.9	61.2
Serbia and Montenegro	10.5	18.9	69,5	11.6	-0.1	23.99	7.2	<b>2620</b>	15.5	27.6	56.8
Slovakia	5.4	17.8	72,1	10.1	0.1	41.09	5.5	<b>6480</b>	3.5	30.1	66.4
Slovenia	2.0	14.5	72,6	12.9	-0.1	32.18	4.6	<b>14810</b>	3.0	36.0	60.0
The former Yugoslav Republic of Macedonia	2.0	20.6	70,6	8.8	0.1	5.24	2.5	<b>2350</b>	11.2	26.0	62.8
Ukraine	47.5	16.0	70,9	13.1	-1.1	65.14	12.1	<b>1260</b>	18.0	45.1	36.9
Total/Avg. of CEE 19	<b>333.2</b>	<b>16.80</b>	<b>69.20</b>	<b>14.00</b>	<b>- 0.2</b>	<b>3 139.77</b>	<b>5.78</b>	<b>9 406</b>	<b>10.8</b>	<b>31.5</b>	<b>57.5</b>
Total/Avg. of CEE 18	<b>188,6</b>				<b>NA</b>	<b>1 739.77</b>	<b>NA</b>	<b>9 138</b>	<b>8.5</b>	<b>34.6</b>	<b>56.9</b>
Total/Avg. of EU 25	<b>456.95</b>	<b>16.00</b>	<b>67.20</b>	<b>16.80</b>	<b>0.15</b>	<b>11 650.00</b>	<b>2.40</b>	<b>26 900</b>	<b>2.2</b>	<b>28.4</b>	<b>69.4</b>

There is a significant difference in the per capita GDP values within CEE states as well. The three highest GDP per capita values are in Slovenia (US\$14 810), Czech Republic (US\$9 150) and in Hungary (US\$8 270), while the lowest are in Moldova (US\$700) and the Ukraine (US\$1 260) as shown in Table 2.

In order to compare more accurately the differences between the CEE countries values of GDP based on purchasing power parities (GDP PPP) were also considered. According to the comparison of GDP and GDP PPP there is no difference in their list, regarding the poorest

and the richest CEE countries. In relation to GDP per capita (PPP) the ranking of CEE countries both with and without the Russian Federation demonstrate an almost identical average as there is only about 3 percent deviation between them. In view of the world average of GDP per capita PPP the relevant figures of CEE countries are better with about 4–7 percent (Table 3).

**Table 3: Gross domestic product (using Purchasing Power Parity method) of CEE countries in 2003** (adapted from UNDP: Human Development Report 2005)

Country	GDP (Purchasing Power Parity) – Absolute				GDP (Purchasing Power Parity) – Relative			
	US\$	% of World	% of CEE 19	% of CEE 18	US\$/Capita	% of World	% of CEE 19	% of CEE 18
Albania	14 500 000 000	0.028	0.49	0.90	4584	55.7	51.9	53.4
Belarus	59 800 000 000	0.117	2.03	3.69	6052	73.5	68.5	70.5
Bosnia and Herzegovina	24 700 000 000	0.048	0.84	1.53	5967	72.5	67.6	69.5
Bulgaria	60 500 000 000	0.118	2.06	3.74	7731	93.9	87.5	90.1
Croatia	49 200 000 000	0.096	1.67	3.04	11080	134.6	125.4	129.1
Czech Republic	166 900 000 000	0.326	5.67	10.31	16357	198.8	185.2	190.5
Estonia	18 300 000 000	0.036	0.62	1.13	13539	164.5	153.3	157.7
Hungary	147 700 000 000	0.289	5.02	9.12	14584	177.2	165.1	169.9
Latvia	23 800 000 000	0.047	0.81	1.47	10270	124.8	116.3	119.6
Lithuania	40 400 000 000	0.079	1.37	2.50	11702	142.2	132.5	136.3
Moldova	6 400 000 000	0.013	0.22	0.40	1510	18.3	17.1	17.6
Poland	434 600 000 000	0.850	14.77	26.84	11379	138.3	128.8	132.5
Romania	158 200 000 000	0.309	5.38	9.77	7277	88.4	82.4	84.8
Russian Federation	1 323 800 000 000	2.588	44.98	81.76	9230	112.2	104.5	107.5
Serbia and Montenegro	23 900 000 000	0.047	0.81	1.48	2622	31.9	29.7	30.5
Slovakia	72 700 000 000	0.142	2.47	4.49	14494	176.1	164.1	168.8
Slovenia	38 200 000 000	0.075	1.30	2.36	19150	232.7	216.8	223.1
The former Yugoslav Republic of Macedonia	13 900 000 000	0.027	0.47	0.86	6794	82.6	76.9	79.1
Ukraine	265 500 000 000	0.519	9.02	16.40	5491	66.7	62.2	64.0
<b>World</b>	<b>51 150 000 000 000</b>	<b>100</b>	<b>-</b>	<b>-</b>	<b>8229</b>	<b>100</b>	<b>93.2</b>	<b>95.9</b>
<b>Total/Avg. of 19s</b>	<b>2 943 000 000 000</b>	<b>5.754</b>	<b>100</b>	<b>181.76</b>	<b>8833</b>	<b>107.3</b>	<b>100.0</b>	<b>102.9</b>
<b>Total/Avg. of 18s</b>	<b>1 619 200 000 000</b>	<b>3.166</b>	<b>55.02</b>	<b>100</b>	<b>8585</b>	<b>104.3</b>	<b>97.2</b>	<b>100.0</b>

## 1.2 Status of aquaculture in the region

### 1.2.1 History and traditions of aquaculture practices

Fish rearing in ponds was well known already in the time of ancient Rome (Huet, 1972). From the Romans the other regions of the continent took over the practice of aquaculture, which is consequently one of the oldest agricultural activities in Europe. Due to the wide range of climatic conditions and many suitable species of the European fish fauna, aquaculture practices of both cold and warm water fish species have developed in the countries of Central and Eastern Europe.

### *Freshwater aquaculture*

In the middle ages, in Central and Eastern Europe, fish culture developed along with the monasteries. Therefore there are many Central and Eastern European countries, where aquaculture is based on very old traditions. These countries are: the Czech Republic, Hungary, Poland or Russian Federation, where fish culture activities started during the eleventh and twelfth centuries. This early form of aquaculture was mainly practiced by priests and monks, who kept and reared fish in small ponds in order to supply fish to the monasteries.

The growth of commercial fish culture started a few centuries later, when techniques of controlled spawning and artificial incubation of eggs of the most important cold and warm water species were elaborated and widely introduced. By the eighteenth–nineteenth centuries, commercial aquaculture became rather widespread in Europe. At the beginning it was limited to the production of fish for food, carp in particular, but it has been profoundly modified since the nineteenth century.

Changes of consumers' preferences and better food supply conditions in some regions of Europe lead to the reduction in consumption of pond grown cyprinids, while in other regions, especially in Central and Eastern Europe the improvement of fish production capacity of pond and the introduction of supplementary feeding gave pond fish culture new directions. Accordingly, cold and warm water fish culture practices developed simultaneously: cold water aquaculture mainly in Western Europe and warm water aquaculture mainly in Central and Eastern Europe. Consequently pond fish culture was the most dominant fish production system in the CEE region at the beginning of the twentieth century.

During the two world wars the number of operating fishponds declined because of the resulting destruction. In recent years the Balkan-crisis had the same effect in Bosnia and Herzegovina, Croatia as well as in Serbia and Montenegro.

Under the communist regimes following World War II, fish farms became state-owned in all CEE countries. During this period significant technical developments started, since governments financed all the investments and in some of the states (Albania, Moldova, etc.) that was the period when modern aquaculture was introduced. In addition to technical investments, such as establishment of large-scale farms and hatcheries, construction of large water reservoirs, etc.), research programmes were also initiated in newly established aquaculture research institutes (for example, in Bosnia and Herzegovina, Hungary, Moldova, Poland, Russian Federation, etc.).

In the late seventies and early eighties some CEE countries, especially Hungary, exported propagation and production technologies of warm water fish species to many countries of Europe, Latin America, Africa and Asia, while advanced, super-intensive production technologies of high value fish species were adapted or imported mainly from Western Europe into the CEE region.

After the political changes in the region in the early nineties, privatization of the large state and cooperative-owned farms started, and the majority of them became property of the private sector. In most CEE states production declined during the difficult transition from state financed central planning economy to the mainly private entrepreneurship based market economy. The key reasons of the decline were the cessation of state subsidies and the collapse of the huge Soviet market. In some rare cases, however, like in Slovenia, the economic

development even accelerated after the political and economic change. In 1991 the Slovenian Government decided to invest in aquaculture. Therefore the farming capacity expanded, which along with the newly established organized extension services doubled the Slovenian production of cold water fish species, mainly rainbow trout, within five years (Podgornik, 2005).

At present most CEE countries produce fish primarily to cover the domestic demand. Export is limited, although some major carp producing countries as Czech Republic, Hungary and Poland export mainly live common carp to the very limited and often only seasonal Western European markets, especially to Germany. Though the majority of the traded products are live fish, the increasing number of established fish processing plants indicates that significant changes are occurring, and that efforts are underway of adding value to aquaculture products (NASO and PAFAD country studies, 2005).

In addition to the production of fish for food, aquaculture is also important for producing fish seed for stocking in the frame of sustainable fisheries management of natural water bodies. The need for supplementing the fish stocks in the natural waters had been realized first when and where the rivers had been regulated, wetlands drained and power stations constructed. These engineering interventions resulted in the alarming reduction of natural spawning grounds of most valuable fish species. Considering the ever increasing environmental awareness in the management of inland water resources, the role of maintaining gene banks, as well as breeding and propagation of a wide range of native fish species is becoming an increasingly important part of freshwater aquaculture (Váradi, 2000).

#### *Brackish and marine water aquaculture*

Even though nearly two thirds of the CEE states have seashores, not all of these countries have developed marine or brackish water aquaculture operations. In the northern states, like Estonia or Lithuania, where the coastal seas are shallow, open to storms and covered by ice for a long period of time, there are only very few sites suitable for large cage farms or other types of mariculture.

There are some countries, like Poland or Ukraine, where they do not breed or produce fish in marine water and aquaculture is based on freshwater species. Some other states have such a short coastline, like Bosnia and Herzegovina (its coastline is only 20 km), that the importance of marine aquaculture is negligible. In contrast, even though the Slovenian coastline is also very short, about 46.6 km (see Table 15); their marine aquaculture production is quite remarkable amounting to around 115.5 tonnes, which reflects 12 percent of the total aquaculture production of the country.

Bulgaria, Romania, Albania, Croatia, Serbia and Montenegro and the Russian Federation are those countries, where marine and brackishwater aquaculture has a more prominent economic role. However, in most cases its contribution to the total aquaculture production is still very low, rarely exceeding 5 percent.

In Bulgaria the only marine species produced until recently in aquaculture was the black sea mussel (Hubenova, 2005). In Albania shrimp, seabream and seabass are produced in marine aquaculture, but as they have to import the seed and suitable feeds, the cost of production is relatively high (Cobani, 2005). In Serbia and Montenegro the same problem of seed supply exists, and, as a result, their marine production is negligible as they produce only 20 tonnes of seabream and seabass and 40 tonnes of mussels annually (Markovic and Poleksic, 2005).



The biggest variety of marine species is produced in Croatia and the Russian Federation, also because these two countries have the longest seashore among CEE countries. In Croatia they breed seabass, seabream, mussels and oysters. Beside these species they rear tuna by intensive feeding (fattening) of captured 2-4 year old wild fish in order to increase their size hence their market value. Generally they use inshore cages for marine aquaculture, but recently they started to switch to semi-offshore cage systems (Piria, 2005). In Russian Federation the total output of marine and brackishwater aquaculture is more than 11 000 tonnes, however, this amount to only 6.5 percent of their total aquaculture production (Bogeruk, 2005).

Most marine aquaculture producers in the CEE region have to import almost 100 percent of their fry and fingerlings from other countries, mainly from Italy, France or Spain, which makes production rather expensive (Cobani, 2005; Piria, 2005).

### ***1.2.2 Aquaculture production systems***

The most important traditional aquaculture production system in the CEE region is the natural food based pond culture of carps and of high market value indigenous fish species, such as European catfish, pike and pike perch as complementary species. Although no data are available on aquaculture production by system it can be assumed that at least 80 percent of the total aquaculture production comes from fish ponds in the region. In order to improve the economical sustainability of the traditional fish pond production, promising semi-commercial experiments with new type of fish pond systems have been conducted in Hungary with the combination of extensive and intensive production of traditional and high market value species (Váradi, 2002). Another direction of the development of traditional fish pond system is towards multi-functionality, where various additional services are incorporated into the farming activities.

The other main aquaculture production system in the CEE region is the cold water flow through system for trout production. These types of systems are mainly used in countries where good quality water is available and environmental regulations are not overly strict. The warm water flow through systems can also be mentioned, which are using geothermal water for the production of tropical species (e.g. African catfish and tilapia). The proper disposal of the used water is one of the main constraints of these systems, and, therefore efforts have been made in order to treat the effluent (e.g. on wetland) or to recirculate the water.

The use of recirculation aquaculture systems (RAS), marine cage and pen culture systems is very limited in the CEE region. The aquaculture production, which comes from these types of systems, is only few percent of the total production. There is however a trend towards the development of such systems due to the limited availability of freshwater resources.

### ***1.2.3 Produced aquatic species***

There are numerous indigenous and exotic aquatic species which are cultivated in the CEE region. Based on NASO and PAFAD country reports the most frequently produced species are listed below:

- Common carp (*Cyprinus carpio*) is produced in all CEE countries.
- Grass carp (*Ctenopharingodon idella*) and Silver carp (*Hypophthalmichthys molitrix*) is produced in 76 percent of CEE countries.
- Brown trout (*Salmo trutta*), European catfish (*Silurus glanis*) and pike perch (*Stizosteidon lucioperca*) are produced in 71 percent of CEE countries.

- Bighead carp (*Aristichthys nobilis*) is produced in 65 percent of CEE countries.
- Pike (*Esox lucius*) is produced in 59 percent of CEE countries.
- Rainbow trout (*Oncorhynchus mykiss*) is produced in 53 percent of CEE countries.
- Mussels (*Mytilus galloprovincialis*) are produced in 41 percent of CEE countries.
- Brook trout (*Salvelinus fontinalis*) is produced in 29 percent of CEE countries.
- Seabream (*Sparus auratus*) and seabass (*Dicentrarchus labrax*) are produced in 29 percent of CEE countries.
- African catfish (*Clarias gariepinus*), Atlantic salmon (*Salmo salar*), Prussian carp (*Carassius auratus gibelio*), sea trout (*Salmo trutta trutta*), tench (*Tinca tinca*) and whitefish (*Coregonus spp.*) are produced in 24 percent of CEE countries.
- Carp bream (*Abramis brama*), Channel catfish (*Ictalurus punctatus*), crayfish (*Astacus astacus*), eel (*Anguilla anguilla L.*), grayling (*Prototroctes maranea*), shrimp (*Penaeus japonicus*), Soiu y mullet (*Mugil soiu y*) and sturgeon (*Acipenser spp.*) are produced in 18 percent of CEE countries.
- Crucian Carp (*Carassius auratus*), European flat oyster (*Ostrea edulis*), Ohrid trout (*Salmo letnica*) and roach (*Rutilus spp.*) are produced in 12 percent of CEE countries.
- Black grass carp (*Mylopharyngodon piceus*), burbot (*Lota lota*), huchen (*Hucho hucho*), Nile tilapia (*Oreochromis niloticus*), perch (*Perca fluviatilis*), sneep (*Chondrostoma nasus*) and
- tuna (*Thunnus spp.*) are produced in 6 percent of CEE countries.

NASO and PAFAD country reports also prove that the contribution of the different aquatic species to the total volume of production in the years 2003 and 2004 was very similar. Accordingly, on an average common carp (54 percent) has the biggest share within the total production, which was followed by brown trout (9 percent), rainbow trout (7 percent), silver carp (5 percent), bighead carp (5 percent), African catfish (3 percent), mussels (3 percent), brook trout (2 percent), grass carp (2 percent), seabass (2 percent), Prussian carp (2 percent), European catfish (1 percent) and seabream (1 percent). The proportions of all the other species to the total volume of production were below 1 percent.

There was a drop in common carp production after the 1990s, however the consolidation of the production can be observed in the past years and common carp still provides about half of total aquaculture production in the region. The total proportion of Chinese major carps remains constant around the 20 percent but the contribution of the different trouts increased and slowly exceeds 10 percent of the total production of the region (Tables 6 and 7).

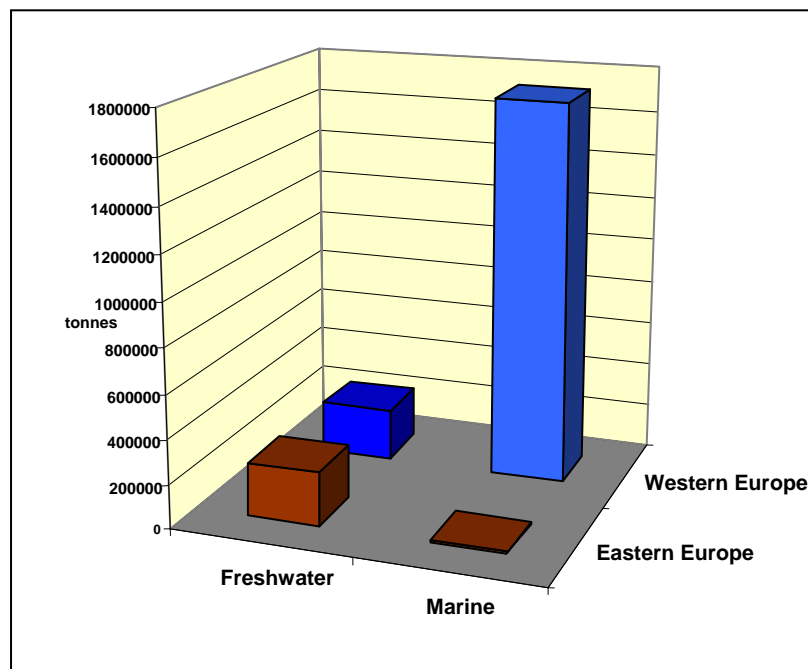
## **2. PRODUCTION**

The total volume of aquaculture production in Europe was 2 446 227 tonnes in 2003, of which about 80 percent was produced in marine and about 20 percent in freshwater environments (FAO Fishstat Plus, 2005).

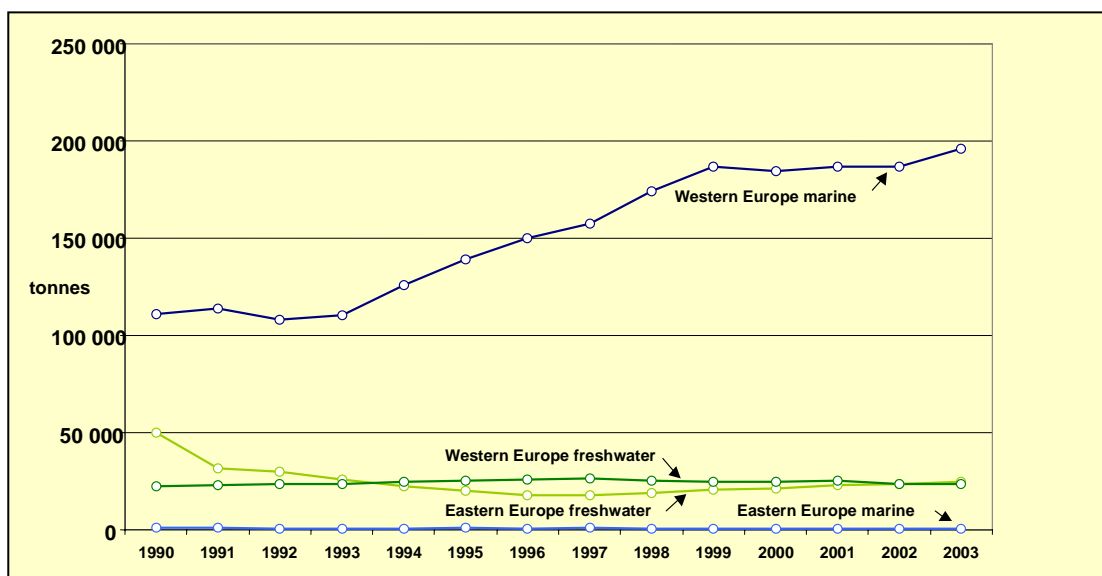
In 2003, the total value of European aquaculture production was US\$5 150 million. Data also show that the majority of aquaculture products, about 78 percent, derived from marine aquaculture (EUROSTAT, 2005). The share of Central and Eastern European aquaculture production relative to the total European aquaculture production was about 20 percent in volume and 12 percent in value.

Marine aquaculture production in the CEE region was only 6 331 tonnes in 2003, which is negligible when compared to the marine aquaculture production of 1 960 000 tonnes in Western Europe. However, freshwater aquaculture production was 240 763 tonnes in CEE countries in 2003, which is about 51 percent of the total freshwater aquaculture production in Europe (Figure 1).

Production trends in Western Europe and in Central and Eastern Europe both in marine and freshwater environments are shown in Figure 2. Both figures 1 and 2 clearly illustrate that marine aquaculture in Western Europe is the dominant aquaculture industry, which showed a gradual increase in the past ten years, although the rate of development slowed down and production stagnated in the past few years. Further, it can be seen clearly in Figure 2 that freshwater aquaculture is leveling off both in Western as well as in Central and Eastern Europe.



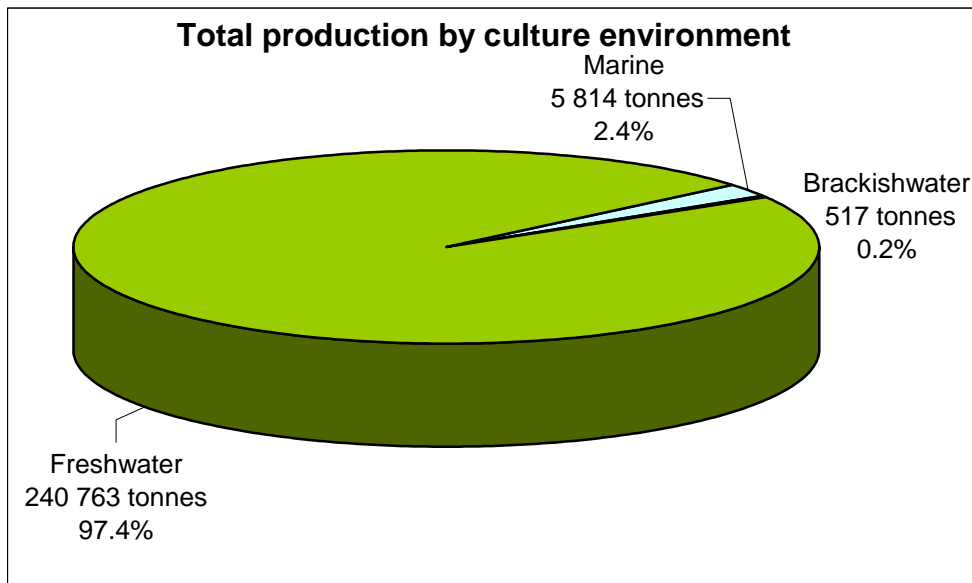
**Figure 1. Quantity of aquaculture production in Europe by regions and environments in 2003** (tonnes; adapted from FAO Fishstat Plus, 2005; last accessed October 2005)



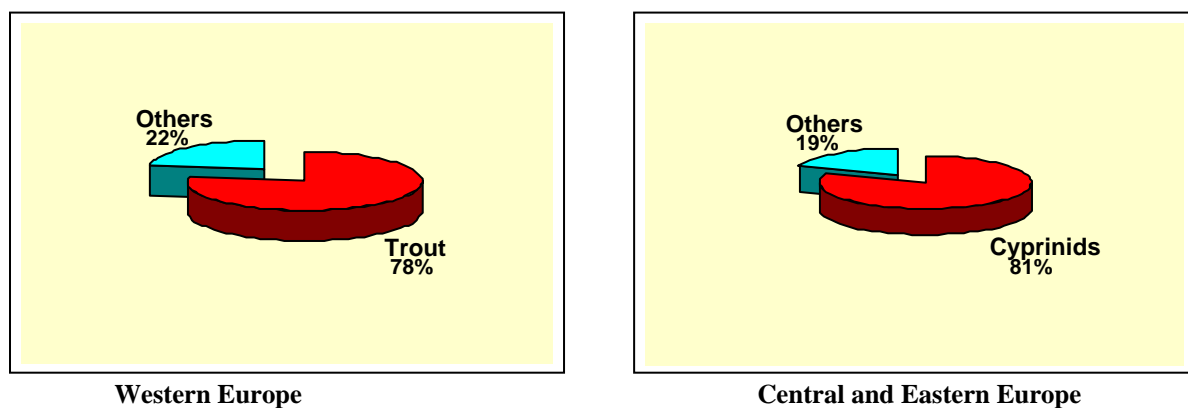
**Figure 2. Quantity of aquaculture production in Europe between 1990 and 2003** (tonnes; adapted from FAO Fishstat Plus, 2005; last accessed October 2005)

Even if there is a scope for marine aquaculture development in the CEE region, the main type of aquaculture is still freshwater fish production (Figure 3).

Although the volume of freshwater fish production is almost equal in Western Europe (234 224 tonnes) and Central and Eastern Europe (246 763 tonnes), cyprinids are the dominant species in the CEE region contributing 81 percent of the total freshwater aquaculture production, while the share of trout is 78 percent of the total freshwater aquaculture production in Western Europe (Figure 4).



**Figure 3. Total aquaculture production by culture environment in Central and Eastern Europe in 2003** (after Tacon, 2005; adapted from FAO FishStat Plus 2005. Tonnes and relative shares)



**Figure 4. Main species farmed in freshwater aquaculture in Western and in Central and Eastern Europe in 2003** (after Tacon, 2005; adapted from FAO FishStat Plus 2005. Relative shares)

While world aquaculture production has been gradually increasing since 1970, this has not been the case in Central and Eastern Europe, where the trends in volumes of aquaculture production have shown a fluctuation because of the political and economical changes in the region. Even if in the CEE countries there was a significant production before 1990, between 1990 and 2000 the total aquaculture production decreased more than two folds (HAKI, 1999;

HAKI, 2000; Váradi *et al.*, 2001a; Váradi *et al.*, 2001b). This dramatic drop in production between 1990 and 2000 was the result of the collapse of the centrally planned socialist economy in the region. In this period the total aquaculture production in this region decreased by 53 percent, when including respective data of the Russian Federation, and by 67 percent, when excluding data of the Russian Federation. A gradual increase in the production can be observed after the stabilization of the national economies (Table 4). The increase in the total aquaculture production was 14 percent between 2000 and 2003 and continuous further growth of aquaculture production is expected in the years to come.

The Russian Federation is the largest aquaculture producer in the CEE region. Its highest contribution to the regional total aquaculture production was in 1990 (259 735 tonnes; 56 percent) whereas it was 108 751 tonnes (44 percent) in 2003; this latter figure represented the value of US\$289 million in 2003 (Tables 4 and 5).

**Table 4. Volume of total aquaculture production (tonnes) in Central and Eastern European countries between 1990 and 2003** (after Tacon, 2005; adapted from FAO FishStat Plus, 2005)

Country	1990	2000	2001	2002	2003
Russian Federation	259 735	77 132	90 449	101 483	108 751
Poland	26 400	35 795	35 460	32 709	34 526
Ukraine	81 639	30 969	31 037	30 819	25 616
Czech Republic		19 475	20 098	19 210	19 670
Hungary	17 600	12 886	13 056	11 574	11 870
Romania	34 950	9 727	10 818	9 248	9 042
Croatia		6 674	10 166	8 416	7 605
Bosnia and Herzegovina				4 685	6 635
Belarus	16 638	6 716	4 666	6 523	5 393
Bulgaria	7 849	3 654	2 938	2 308	4 465
Moldova	7 141	990	1 189	1 765	2 638
Serbia and Montenegro		2 844	2 688	2 450	2 607
Lithuania	4 666	1 996	2 001	1 750	2 356
The former Yugoslav Republic of Macedonia		1 626	1 053	1 215	1 486
Slovenia		1 181	1 262	1 289	1 353
Slovakia		887	999	829	881
Albania	4 961	307	286	860	860
Latvia	2 235	325	463	430	637
Estonia	936	225	467	257	372
<b>Total of CEE 19</b>	<b>464 750</b>	<b>213 409</b>	<b>229 096</b>	<b>237 820</b>	<b>246 763</b>
<b>Total of CEE 18</b>	<b>205 015</b>	<b>136 277</b>	<b>138 647</b>	<b>136 337</b>	<b>138 012</b>
<b>% of RF of CEE 19</b>	<b>56</b>	<b>36</b>	<b>39</b>	<b>43</b>	<b>44</b>

The aquaculture production of the 18 CEE countries (i.e. excluding data from the Russian Federation) shows however an opposite trend of contribution to total aquaculture production

of the region. Accordingly, while their contribution in 1990 was only 44 percent this figure increased up to 56 percent by 2003, which represented the total value of US\$324.6 million (Tables 4 and 5).

In terms of volume, the main aquaculture producers of the region are the Russian Federation, Poland, Ukraine, Czech Republic, Hungary and Romania. The share of these six countries from the total aquaculture production was close to 85 percent in 2003. On the other hand, the total production volume of the six “least producer” countries (The former Yugoslav Republic of Macedonia, Slovakia, Slovenia, Albania, Latvia and Estonia) is less than 6 000 tonnes (Table 4). In terms of production value there is a similar ranking among CEE countries, although some countries get higher rankings where the production of high value species has a significant share in their total aquaculture production, e.g. Croatia (European seabass), Bosnia and Herzegovina (rainbow trout) and The former Yugoslav Republic of Macedonia (trout) as shown in Table 5.

**Table 5. Value of aquaculture production in Central and Eastern European countries in 2003, with and without data of the Russian Federation** (after Tacon, 2005; adapted from FAO FishStat Plus, 2005)

Country	1'000 US\$	% CEE 19	% CEE 18
<b>Russian Federation</b>	289 035.7	47.1	89.1
<b>Poland</b>	77 066.7	12.6	23.7
<b>Ukraine</b>	66 576.0	10.9	20.5
<b>Czech Republic</b>	39 050.5	6.4	12.0
<b>Hungary</b>	32 884.4	5.4	10.1
<b>Croatia</b>	24 095.9	3.9	7.4
<b>Bosnia and Herzegovina</b>	17 155.5	2.8	5.3
<b>Romania</b>	16 239.7	2.6	5.0
<b>Belarus</b>	14 095.6	2.3	4.3
<b>Bulgaria</b>	8 023.3	1.3	2.5
<b>The former Yugoslav Republic of Macedonia</b>	6 650.8	1.1	2.0
<b>Serbia and Montenegro</b>	6 079.4	1.0	1.9
<b>Slovenia</b>	3 939.3	0.6	1.2
<b>Lithuania</b>	3 887.8	0.6	1.2
<b>Moldova</b>	2 779.0	0.5	0.9
<b>Slovakia</b>	1 943.0	0.3	0.6
<b>Albania</b>	1 860.6	0.3	0.6
<b>Estonia</b>	1 394.5	0.2	0.4
<b>Latvia</b>	833.6	0.1	0.3
<b>Total of CEE 19</b>	<b>613 591.3</b>	<b>100</b>	<b>189.1</b>
<b>Total of CEE 18</b>	<b>324 555.6</b>	<b>52.9</b>	<b>100</b>

The top 24 aquatic species, which were cultivated in CEE countries between 1990 and 2003, are listed in Table 6. In this context, a significant pattern of aquaculture production of this period is the increasing diversity of species farmed. At the same time, the contribution of conventional species to total production decreased. Common carp, for example, contributed with 75.5 percent (346 432 tonnes) to the total fish production of CEE countries in 1990 but this figure decreased to 50 percent (122 479 tonnes) by 2003.

**Table 6. Volume (tonnes) of top 24 fish species cultivated in Central and Eastern Europe between 1990 and 2003** (after Tacon, 2005; adapted from FAO FishStat Plus, 2005)

Species	1990	2000	2001	2002	2003
Common carp	346 432	119 679	125 398	126 524	122 479
Silver carp	82 918	37 713	46 130	44 684	46 620
Rainbow trout	6 433	15 524	16 394	17 260	19 750
Cyprinids nei	1 160	7 059	7 744	11 366	16 178
Sea trout	1 056	4 125	4 502	5 390	6 221
Freshwater fishes nei	346	4 771	3 131	4 882	5 942
Bighead carp	6 265	6 022	6 382	5 773	4 881
Whitefishes nei	1 321	2 231	2 914	4 215	4 546
Grass carp	5 820	2 107	2 063	1 884	2 613
Sturgeons nei	68	2 300	2 103	2 413	2 520
Mediterranean mussel	4 443	1 563	3 195	2 910	2 432
Goldfish	2 500	1 557	1 957	1 719	2 182
European seabass		1 346	1 579	1 910	1 953
Crucian carp	5	553	297	1 629	1 666
North African catfish			889	878	989
Gilthead seabream		827	1 047	997	911
Trouts nei	17	717	470	591	898
Brook trout		144	125	211	562
European catfish	90	329	223	285	364
Yesso scallop	124	197	162	41	334
Pike-perch	28	121	100	162	330
Atlantic salmon					300
Torpedo-shaped catfishes nei			160	300	300
Freshwater bream	100	189	136	178	240
<b>Total</b>	<b>459 126</b>	<b>209 074</b>	<b>227 101</b>	<b>236 202</b>	<b>245 211</b>

The annual production volume of some species grew many folds between 1990 and 2003. For example the yearly production of rainbow trout, sea trout, sturgeons, European catfish and pike-perch grew about 3, 6, 37, 4 and 12 folds, respectively. In addition, in 1990, there was almost no aquaculture production of fish species, such as European seabass, gilthead seabream, Yesso scallops and Atlantic salmon. However, their contribution to the total aquaculture production of the region had grown to 3 percent by 2003 (Tables 6 and 7).

The proportion of the production of Chinese major carps to other species remained practically the same, but their annual production decreased with 47 percent from 1990 to 2003 (Table 6).

Regarding the value of aquaculture production in CEE countries also common carp has the highest share, which was 48.7 percent, valued at about US\$297 million, in 2003, while the remaining 23 top species contributed with 51.3 percent (US\$313 million) to the total value of production in the same year (Table 7).

The average unit value of aquatic species was about US\$2.5/kg in 2003. Species with unit value above the average were sturgeons, sea trout, European seabass, trouts, gilthead seabream, Yesso scallop, torpedo-shaped catfishes, European catfish, brook trout, Atlantic salmon, North African catfish, pike-perch and Crucian carp, which represented a total of 17 300 tonnes (7.1 percent) and some US\$104 million (17.1 percent) of total regional production in 2003.

Species with unit value below the average US\$2.5/kg were the various cyprinids, whitefishes, Chinese major carps, rainbow trout, goldfish and mussels.

In 2003 the total volume and value of these species were 227 600 tonnes (92.9 percent) and (US\$506 million) (82.9 percent) respectively (Tables 7 and 8).

The above figures prove that the farming of low market value species contributes significantly to the total aquaculture production in the CEE region. The presented list of species and the relevant figures also demonstrate clearly that freshwater aquaculture in general and carp polyculture in particular have a dominant role in the CEE region.

### **3. ECONOMICS AND TRADE**

The present characteristics of the economics and trade patterns of the nineteen CEE countries are determined by their common political and economic history between 1945 and 1990. Most of CEE countries were tied together with the COMECON (Council for Mutual Economical Assistance) treaty in this period, which provided the frame of common economic and trade cooperation.

After 1990, there have been significant political and economical changes in the region, which resulted in the division of some countries such as Czechoslovakia (Czech Republic and Slovakia), Yugoslavia (Bosnia and Herzegovina, Croatia, The former Yugoslav Republic of Macedonia, Serbia, Montenegro, and Slovenia) and the Soviet Union (with its European states Belarus, Estonia, Latvia, Lithuania, Moldova, Russian Federation and Ukraine).

After a transition period which lasted more than one decade, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia, joined the European Union in the year 2004.



Although CEE countries have a common background regarding their economics and trade, they still have different relationships with the EU, which determines significantly the trade (import and export) and marketing of their aquaculture related products.

**Table 7. Volume, value and unit value of top 24 species by value produced in the countries of Central and Eastern Europe in 2003** (after Tacon, 2005; adapted from FAO FishStat Plus, 2005)

Species	Volume		Value		Unit Value US\$/kg
	tonnes	%	1'000 US\$	%	
Common carp	122 479	50.0	296 988.3	48.7	2.4
Silver carp	46 620	19.0	85 812.6	14.1	1.8
Rainbow trout	19 750	8.1	44 009.0	7.2	2.2
Sea trout	6 221	2.5	43 018.9	7.1	6.9
Cyprinids nei	16 178	6.6	37 306.2	6.1	2.3
Sturgeons nei	2 520	1.0	24 454.0	4.0	9.7
European seabass	1 953	0.8	11 821.3	1.9	6.1
Whitefishes nei	4 546	1.9	10 454.4	1.7	2.3
Freshwater fishes nei	5 942	2.4	10 105.2	1.7	1.7
Bighead carp	4 881	2.0	9 463.6	1.6	1.9
Grass carp	2 613	1.1	6 344.4	1.0	2.4
Trouts nei	898	0.4	4 968.9	0.8	5.5
Gilthead seabream	911	0.4	4 843.1	0.8	5.3
Crucian carp	1 666	0.7	4 409.6	0.7	2.6
Goldfish	2 182	0.9	2 971.8	0.5	1.4
North African catfish	989	0.4	2 741.5	0.4	2.8
Yesso scallop	334	0.1	1 736.8	0.3	5.2
Brook trout	562	0.2	1 710.4	0.3	3.0
Mediterranean mussel	2 432	1.0	1 517.8	0.2	0.6
European catfish	364	0.1	1 236.7	0.2	3.4
Torpedo-shaped catfishes nei	300	0.1	1 234.8	0.2	4.1
Atlantic salmon	300	0.1	900.0	0.1	3.0
Pike-perch	330	0.1	897.0	0.1	2.7
Northern pike	-	-	652.3	0.1	-
<b>Total</b>	<b>244 971</b>	<b>100</b>	<b>609 598.6</b>	<b>100</b>	<b>2.5</b>

**Table 8. Volume, value and unit value of most cultivated ISSCAAP species in Central and Eastern European region in 2003** (after Tacon, 2005; adapted from FAO FishStat Plus 2005)

ISSCAAP Species Group	Volume		Value		Unit Value US\$/kg
	tonnes	%	1'000 US\$	%	
Carps, barbels and other cyprinids	197 300	80.0	444 914.2	72.5	2.3
Salmons, trouts, smelts	32 433	13.1	105 461.0	17.2	3.3
Miscellaneous freshwater fishes	8 404	3.4	17 364.1	2.8	2.1
Miscellaneous coastal fishes	3 080	1.2	17 319.6	2.8	5.6
Sturgeons, paddlefishes	2 523	1.0	24 463.5	4.0	9.7
Mussels	2 466	1.0	1 562.0	0.3	0.6
Scallops, pectens	334	0.1	1 736.8	0.3	5.2
River eels	73	0.0	332.8	0.1	4.6
Brown seaweeds	67	0.0	100.5	0.0	1.5
Oysters	57	0.0	171.0	0.0	3.0
Miscellaneous pelagic fishes	14	0.0	56.0	0.0	4.0
Freshwater crustaceans	11	0.0	105.7	0.0	9.6
Shrimps, prawns	1	0.0	4.0	0.0	4.0
<b>Total/Average</b>	<b>246 763</b>	<b>100</b>	<b>613 591.2</b>	<b>100</b>	<b>2.5</b>

### 3.1 Role of the aquaculture sector

#### 3.1.1 Contribution of the sector to national food security

Although fish and fishery products are among the main sources for a healthy diet, the trend of consumption shows a relatively slow increase throughout Central and Eastern Europe. One of the main factors, which limit the consumption of fish and fish products, is their relatively high price and the low income of the people, especially in rural areas. On the other hand, a large amount of chicken, pork, veal, beef and other meat products are imported to these countries.

Statistics on fish and seafood consumption have been collected from various sources and presented in Table 9. The knowledge on fish and seafood consumption, not only quantitative but also qualitative, is very important since the main objective of the aquaculture industry is to satisfy the consumers' demand. Unfortunately very few surveys have been conducted in the region in order to understand better consumers' demands and trends in fish consumption.

The average fish consumption in the CEE region is about 12 kg/capita/year, which is less than half of the average fish and seafood consumption in Western European countries. However the actual values in different CEE countries show considerable variation from this average consumption.

It can be observed that there are significant differences in fish consumption between CEE countries. Fish consumption is higher in those countries and regions where fish is a traditional

food. Accordingly in Lithuania (59.8 kg), Estonia (21.2 kg), Russian Federation (18.6 kg), Ukraine (15.4 kg), Belarus (14.3 kg), Czech Republic (13.6 kg) and Poland 13.1 kg) the per capita fish and seafood consumption was above the regional average in 2002, while in Serbia and Montenegro (2.0 kg), Bulgaria (2.9 kg), Romania (3.4 kg), Albania (4.1 kg), The former Yugoslav Republic of Macedonia (4.1 kg), Bosnia and Herzegovina (4.4 kg), Hungary (5.1 kg), Moldova (7.2 kg), Slovakia 7.3 kg), Slovenia (7.7 kg), Latvia (11.1 kg) and Croatia (11.9 kg) per capita consumption was below the average of the region (Table 9). The significant differences in fish consumption may derive from the different traditions in the various regions of CEE.

There are also some indications which show that fish and seafood consumption is higher in the cities than in rural areas, unless these rural areas are located in the vicinity of major natural water bodies, because in these locations fish consumption is much higher than in the other regions of the countries. The available data on per capita consumption of fish and seafood however do not provide for accurate information regarding the contribution of the aquaculture sector to the fish supply, because the estimated apparent per capita consumption of fish and seafood includes not only aquaculture products but also products from both capture fisheries as well as the balance of exports and imports.

**Table 9. Fish and seafood supply in Central and Eastern European countries (kg/cap/year) between 2000 and 2004** (data in columns are from FAO: FAOSTAT – 2005; from EU: EUROSTAT – 2005; and from CR: NASO-PAFAD country reports – 2005)

Countries	2000			2001			2002			2003			2004		
	FAO	EU	CR	FAO	EU	CR	FAO	EU	CR	FAO	EU	CR	FAO	EU	CR
Albania	4.0	NA	NA	4.1	NA	NA	4.1	NA	NA	NA	NA	3.0	NA	NA	4.0
Belarus	10.1	NA	NA	14.3	NA	NA	14.3	NA	NA	NA	NA	NA	NA	NA	NA
Bosnia and Herzegovina	3.5	NA	NA	4.4	NA	NA	4.4	NA	NA	NA	NA	NA	NA	NA	1.5
Bulgaria	3.1	3.1	3.3	2.9	2.8	3.3	2.9	NA	3.5	NA	NA	3.8	NA	NA	4.3
Croatia	8.4	NA	NA	11.9	NA	NA	11.9	NA	NA	NA	NA	NA	NA	NA	7.0
Czech Republic	13.5	10.6	NA	13.6	10.4	NA	13.6	NA	NA	NA	NA	NA	NA	NA	6.0
Estonia	17.4	17.1	NA	21.0	20.5	NA	21.2	NA	NA	NA	NA	NA	NA	NA	16.7
Hungary	4.9	4.2	NA	5.0	4.4	NA	5.1	NA	NA	NA	NA	NA	NA	NA	3.0
Latvia	14.7	13.2	NA	11.0	9.6	NA	11.1	NA	NA	NA	NA	NA	NA	NA	NA
Lithuania	42.6	36.7	NA	59.4	54.5	NA	59.8	NA	NA	NA	NA	NA	NA	NA	NA
Moldova	4.4	NA	NA	7.2	NA	NA	7.2	NA	NA	NA	NA	NA	NA	NA	NA
Poland	13.2	9.6	NA	13.0	9.9	NA	13.1	NA	NA	NA	NA	NA	NA	NA	10.5
Romania	2.8	2.6	NA	3.4	3.1	NA	3.4	NA	NA	NA	NA	NA	NA	NA	NA
Russian Federation	19.4	NA	NA	18.5	NA	NA	18.6	NA	NA	NA	NA	NA	NA	NA	11.3
Serbia and Montenegro	1.7	NA	NA	2.0	NA	NA	2.0	NA	NA	NA	NA	NA	NA	NA	3.6
Slovakia	7.6	6.9	NA	7.3	6.5	NA	7.3	NA	NA	NA	NA	NA	NA	NA	4.2
Slovenia	6.7	6.5	NA	7.7	7.5	NA	7.7	NA	NA	NA	NA	NA	NA	NA	NA
The former Yugoslav Republic of Macedonia	4.9	NA	NA	4.1	NA	NA	4.1	NA	NA	NA	NA	NA	NA	NA	NA
Ukraine	13.0	NA	NA	15.3	NA	NA	15.4	NA	NA	NA	NA	NA	NA	NA	11.0

NA: not available

### 3.1.2 Contribution of the sector to economic development

Although the contribution of agriculture to GDP is relatively high compared to that of Western European countries, the share of the production value of aquaculture within agriculture is rather low. According to 2003 data (Table 10) the contribution of the aquaculture sector to the total GDP of CEE countries varies between 0.002 percent and 0.065 percent (average 0.02 percent). Belarus (0.020 percent), Russian Federation (0.021 percent) and Poland (0.017 percent) are the three countries which are the nearer to these averages. The proportion of aquaculture within the GDP was the smallest in Slovakia (0.002 percent), Latvia (0.003 percent) and in Estonia (0.007 percent), while it was highest in The former Yugoslav Republic of Macedonia (0.046 percent), Croatia (0.048 percent) and in Bosnia and Herzegovina (0.065 percent).

**Table 10. Relative contributions of aquaculture production of CEE countries to the total value of GDP, agriculture and livestock production in 2003 (computed from Tables 2 and 5)**

Country	Contribution of Aquaculture Production			Contribution of Agriculture to GDP (%)
	% of Total GDP	% of Agricultural Production	% of Livestock Production	
Albania	0.011	0.02	NA	46.2
Belarus	0.020	0.18	NA	11.0
Bosnia and Herzegovina	0.065	0.46	NA	14.2
Bulgaria	0.013	0.11	NA	11.5
Croatia	0.048	0.58	NA	8.2
Czech Rep.	0.023	0.67	NA	3.4
Estonia	0.007	0.18	NA	4.1
Hungary	0.022	0.67	NA	3.3
Latvia	0.003	0.07	NA	4.4
Lithuania	0.009	0.14	NA	6.1
Moldova	0.032	0.14	NA	22.4
Poland	0.017	0.57	NA	2.9
Romania	0.009	0.07	NA	13.1
Russia Federation	0.021	0.42	NA	4.9
Serbia and Montenegro	0.023	0.15	NA	15.5
Slovakia	0.002	0.07	NA	3.5
Slovenia	0.010	0.33	NA	3.0
The former Yugoslav Republic of Macedonia	0.046	0.41	NA	11.2
Ukraine	0.022	0.12	NA	18.0
<b>Average of CEE 19</b>	<b>0.020</b>	<b>0.28</b>	NA	<b>10.8</b>
<b>Average of CEE 18</b>	<b>0.019</b>	<b>0.22</b>	NA	

The same data also show that aquaculture production in CEE region accounted for 0.28 percent and 0.22 percent of the total agriculture production with and without the Russian Federation<sup>2</sup>. Estonia, Belarus, Slovenia and The former Yugoslav Republic of Macedonia are the nearest to these averages. The contribution to the agriculture production was the least in Albania (0.02 percent), Slovakia (0.07 percent) and Latvia (0.07 percent) and the most in Hungary and Czech Republic (0.67 percent in both countries) and Croatia (0.58 percent).

In the Russian Federation, despite increasing aquaculture production, its share in the national gross domestic product has decreased from 0.16 percent in 2000 to 0.09 percent in 2004 (Bogeruk, 2005).

### ***3.1.3 Role and impact of aquaculture as a component of the livelihood of poor rural households***

The increasing fish production of fish farms in the past few years has also increased the role of the aquaculture sector in the rural economy by providing the population with food products of animal origin (Table 4).

Practically all production facilities of freshwater and marine farms are located in rural areas of CEE countries. In several locations, fish farms are the only industrial enterprises providing occupation and enhancing the level of employment and incomes of rural people.

The dominant pond fish farming in Central and Eastern Europe is a relatively labour intensive fish production method. It therefore can offer considerable opportunities of permanent and seasonal employment for the poorest segments of the rural population. The development of the fish processing industry is expected in many CEE regions, which in turn will also provide employment opportunities for the rural population.

Furthermore, extended fish pond systems contribute to the maintenance of biodiversity and to the improvement of water management and satisfy the needs of various water related recreational activities including fee fishing. The development of such multi-functional fish farms in rural areas will also create job opportunities.

It can be predicted, on the basis of earlier EU experiences that in countries like Albania, Croatia, Serbia and Montenegro, where marine mollusc farming is increasingly practiced, the employment opportunities of local population will also increase (Cobani, 2005; Piria, 2005; Markovic and Poleksic, 2005).

Aquaculture has contributed to the improvement of rural life in some countries, although food security and poverty alleviation issues are different when compared to non-European developing countries. While the main thrust of aquaculture is the production of food fish for income generation, the importance of the various services provided for recreation, rural tourism, nature conservation and water management will increase in the future and this will provide further employment and business opportunities for rural populations.

## **3.2 Performance of the aquaculture sector**

### ***3.2.1 Trends in farming systems***

In CEE countries the majority of fish farms became private property after the political change in the early nineties. New owners had to face problems such as neglected fish farms, low

---

<sup>2</sup> These figures do not include the value of aqua-feed production.

productivity, old working habits, disused or obsolete equipment and lack of mechanization. Given that credits are disadvantageous or difficult to obtain, new owners only gradually try to provide better farming conditions and to enlarge production.

At present, the most widespread table fish production technologies in CEE countries are the extensive and semi-intensive warm water pond systems, which according to the actual climatic conditions, follow three-year (Hungary, Lithuania and Estonia) or four-year (Czech Republic and Poland) production cycles.

However, since the political and economic changes in the region a gradual diversification of the pond fish farming systems can be observed.

One direction of the development is switching to organic fish farming, which may be an option for small-scale fish farmers, who lack both the capital for modernization and the production loans to cover the seasonal production expenses, such as fertilizers and feeds.

Another development direction is to incorporate various services into farm activities. Angling service is the most typical secondary activity besides fish production in many fish farms in CEE countries. There are, however, growing number of farms where various services are offered to individuals and organizations (eco-tourist programs, restaurant and hotel services, various shows and exhibitions, etc.). The application of the idea of multi-functionality is a new option for many pond fish farms in the CEE region.

A possible development direction is available when the conventional pond fish farms are modernized in order to facilitate intensification of the production. Such development, however, requires investment, therefore only very few pond fish farmers in CEE countries follow this line of development for the time being. Even in the New EU Member States, where the EU Financial Instrument for Fisheries Guidance (FIFG) is available, many farmers can not afford to provide the necessary own contribution for the desired construction and reconstruction works.

The role of the super-intensive tank culture systems and the cage culture systems for the production of high value cold and warm water fish species is low in aquaculture production in Central and Eastern Europe. The development of intensive aquaculture can also be observed in some more advanced regions, where investment capital is more readily available. Trout production shows a gradual increase in the region and the share of various high market value species is also increasing even though the growth rate is still low (Tables 6, 7 and 8).

Because of the specific social and economic conditions of CEE states the desirable trends of sustainable development are envisaged to be supported with new laws and regulations, efficient overall training fish farmers, modernizing the already existing processing facilities and establishing new ones, stimulating marketing strategies, joining international organizations, strengthening competitiveness, improving product quality and introducing new high value species.

### ***3.2.2 Significant non-food aquatic species***

The production of non-food aquatic species is very limited or non-existent in CEE countries, except ornamental fish, which is produced in few food fish production farms as secondary species. However, there are also some smaller family farms, which are specialized in production of ornamental fish, especially in the Czech Republic and Hungary.

In general, no statistical data are available on the production of ornamental fish, as its relative contribution to the national economy is negligible in most of the CEE countries. However, in the Czech Republic ornamental and aquarium fish production is an integral part of the aquaculture production, and the total value of exported aquarium and ornamental fish was estimated at US\$120 million in 2003 (Adámek, 2005).

### ***3.2.3 Trends in diversification of aquatic species farmed***

There is an overall trend towards species diversification in aquaculture, however, no significant changes can be observed for the time being in CEE region. Based on the country reports some notable changes may be summarized.

The most significant aquatic food species in the region are the common carp and silver carp, which during the period of 2000–2003 contributed 57.2–49.9 percent and 18–19 percent respectively to the total fish production of top 24 aquatic species. The other lower and higher value fish species of carp polyculture contributed an additional 8.0–10.7 percent within the same period (Table 6). The volume and proportion of the different trouts within the top 24 aquatic species increased from 7 500 tonnes (3.4 percent) to 27 430 tonnes (11.2 percent) between 1990 and 2003.

In Bosnia and Herzegovina, there is an increasing trend in the production of brown trout as food fish and it is very likely that during 2005 the production will have reached 60 tonnes (Hamzic, 2005). In Bulgaria, there is a clear tendency for increasing the production of rainbow trout. Between 2002 and 2004 the production of this species increased by 68.5 percent and reached 1 175 tonnes (Hubenova, 2005). In Estonia, there is also interest in new species like freshwater crayfish, eel and sturgeon (Paaver, 2005). Presently, no significant changes can be observed in Hungarian pond aquaculture, which is still based on the production of conventional species (mainly carps). However, in intensive fish production there has been a spectacular growth in African catfish production. Some special aquaculture activity for caviar production also appeared in the country (Békefi, 2005). In the Russian Federation, there was a tendency for widening the species diversity of cultured fishes in the past few years in favour of indigenous species, such as tench, Crucian carp, pike and catfish (Bogeruk, 2005).

## **3.3 Regional markets for aquaculture products**

### ***3.3.1 Characteristics of export and import***

Export-oriented aquaculture has an important role in the economies of several Western European countries, while the main purpose of aquaculture production in CEE is to satisfy local market demand in the own region.

The patterns of export and import of aquatic products are determined by regulations applicable within and outside the different CEE countries. The situation is more complicated when the differences between EU and non EU member countries of the region are also considered.

Fish produced in the CEE region is generally exported live, frozen, quick-frozen, canned, salted, and as smoked fish. Exported fish are traded mostly within CEE countries and only limited amounts in other European countries.

The Czech Republic, as the largest carp exporter of Europe, exports mainly live fish, basically to the German market (about 40–50 percent) and to Slovakia (about 20 percent). However, its total volume of annual carp export is below 10 000 tonnes. Most of their processing plants are not up to EU standards consequently the proportion of processed fish in the exported volumes is quite low (Adámek, 2005).

Hungarian live carp export has gradually declined mainly due to the dominance of Czech carp production. In the beginning of the nineties, carp export from Hungary reached nearly 3 000 tonnes per year, which dropped to 300–400 tonnes per year in recent years. The most competitive Hungarian carp product is high quality brood stock for the European carp market and silver carp is the main commodity in the field of live fish export which is marketed in Poland for processing (Zakeš, 2005).

In Poland, the main exported aquaculture product is rainbow trout. Around 25 percent of their domestic trout production is exported, mainly to the German market. The quantity of this exceeds 3 000 tonnes per year, and most of this amount is processed (smoked). The Polish carp export is presently stagnating at a low level (Zakeš, 2005).

Despite its huge aquaculture production, sturgeon and trout roe (caviar) are the only Russian aquaculture products which are exported. The main importers of Russian sturgeon caviar are China, Greece, Germany, the USA and Bulgaria, while trout roe are exported to Armenia, Belarus, Georgia and Ukraine (Bogeruk, 2005).

Bulgaria also exports substantial amounts of aquaculture products (more than 5 600 tonnes annually), mainly molluscs (46 percent) and frozen fish (54 percent), above all to Romania, Serbia and Montenegro, Germany, Greece, Turkey and Japan (Hubenova, 2005).

Croatian aquaculture production is focusing on export markets, which has resulted in a foreign trade surplus for several years by now. Tuna itself accounts for more than 74 percent of the total fish exports of the year 2003. The most important markets for canned fish are Bosnia and Herzegovina, The former Yugoslav Republic of Macedonia, Serbia and Montenegro and Austria. Fresh and chilled fish is exported to Japan and Italy. In view of its export orientation, Croatian fishery places strong emphasis on further trade liberalization, primarily with EU countries, and on increased export quotas (Piria, 2005).

Imports of aquaculture products are growing in many CEE countries, especially in Hungary, Bulgaria and Romania, where the gap between domestically produced and consumed fish and seafood is filled in with products of import origin (NASO and PAFAD country reports, 2005).

### ***3.3.2 General supply chains and distribution channels***

Supply chains and distribution channels show great diversity in the region from direct sales at the farm site to large supermarkets.

In Poland, the sale of fish from aquaculture is handled directly by farms. Around 90–95 percent of the production is sold wholesale, while 5–10 percent is sold retail through small outlets owned by the fish farms. Retail prices are approximately 20 percent higher than wholesale prices. In Hungary and in Serbia and Montenegro, domestic production is mainly sold to the consumers in the form of live fish, through special fish shops, and supermarket chains. Because of limited numbers of such outlets, many consumers do not have access to live fish. Sales in Croatia are made directly from the fishing boats or fish farms to distribution



wholesale markets that place the products later in the retail shops. In the Czech Republic, most of sales of live and processed freshwater fish are provided by subsidiary companies. The wholesale market for fish is very small in Romania, with the consequence that there are many short-link marketing chains, resulting in high transport and distribution costs.

In the Russian Federation, fish farms sell some 30 percent of their production themselves through their own shops and mobile aquarium booths. The rest of the production is supplied to the trading network at wholesale prices, the level of which is determined by the purchasing capacity of the population, the value of fish species and the season. The markets for fish products have a three tier system, such as local, regional and federal. Local markets are limited to the territories where producers are located. As a rule, these are rural settlements with population up to 10 000 people. The regional markets serve one or two administrative units of the Russian Federation, and are located within a distance of 200–250 km from the producers. The population of the territory served by a regional market is within 1-1.5 million people. Federal markets are in large and medium cities with a population of not less than 1 million people. At federal markets, the species assortment, distribution volumes and cost characteristics of aquaculture products are mostly determined by the purchasing capacity of the inhabitants, not their numbers. The markets of the Moscow and Saint Petersburg regions are very significant, selling more than 25 percent of the Russian aquaculture production in recent years (Bogeruk, 2005).

The role of super- and hypermarkets are not as pronounced in CEE countries as in Western Europe, but their importance is gradually increasing. In some of the CEE states like in Estonia, the large supermarket chains have already become the most important channels of distribution of aquaculture products (Paaver, 2005).

### ***3.3.3 Labelling and certification of aquaculture products***

At the end of the nineties, consumers in the EU called for government measures to ensure consumer protection through improved legislation for public health and quality assurance, and against food fraud. Today all food producing industries need to comply and to accept the responsibility for the production of safe food. In order to enter profitable European markets both domestic production and imports from third countries must be produced with production records in order to assure consumers about product safety and, increasingly that production is from sustainable resources. As a result, a growing number of aquaculture and fisheries codes of conduct and certification programmes have been developed or are under development in Western Europe. These take many forms from advisory, voluntary to mandatory and are led by government, private sector or joint initiatives. There are also numerous private label schemes established by producers and retailers. These vary in nature but usually try to convince consumers via an attached logo or label that the product meets certain standards (EIFAC,2001).

There are different labelling programmes in Europe, which provide guaranty for selected quality criteria of the products. The most significant labeling programmes operate in countries of the OECD (Organisation for Economic Co-operation and Development), of which only some countries of CEE region are members, including Czech Republic, Hungary, Poland and Slovakia. Among different labelling initiatives the most advanced ones are the ecolabelling schemes, which aim to promote and market products with a reduced environmental impact. These labelling programmes include the EU Eco-label Award Scheme, the Nordic Swan, the Swedish Environmental Choice Programme, the Canadian Environmental Choice Programme, the Blue Angel, the Green Seal, the Japanese Eco-Mark and the French NF Environnement.

When comparing the labelling programmes of CEE countries to similar programmes of European OECD countries, it can be concluded that there still is considerable scope for their development. Standards for the production of organic fish have not been elaborated in these countries except for Hungary, where the certifying body is “Biokontrol Hungaria”, which is a non-profit organization, belonging to the Ministry of Agriculture and Rural Development.

Major international standards (i.e. ISO 9001, HACCP) have already been established in almost all countries of CEE region. Processing factories and also some fish farms apply these basic standards, however specific labelling and certification schemes for aquaculture products practically do not exist or are rather undeveloped in the region.

Much more efforts can be observed in establishing traceability standards and processes in those countries of the CEE region, which are members of the European Union. Producers give preference to those systems when the name of producing farms appears on the product label. Efforts were made in the Czech Republic to promote their common carp with trademarks like “Cesky Carp”, which is targeting local consumers.

It may be concluded that certification and labelling programmes are in their infancy in most of the countries of the CEE region. Even if there is a growing interest in such programmes, no significant initiatives have been taken so far in CEE region.

Most fish products are sold on local markets, where a large segment of the consumers are looking for cheap products and are concerned less about quality and traceability. Although various quality schemes are already available in most CEE countries like EMAS (Eco Management and Auditing Scheme), fish farmers are either not familiar with such systems or refuse to pay for the certification which may not pay off for them.

### **3.4 Expectations on economic gains through trading of aquatic products**

#### ***3.4.1 Income generation through aquaculture production and export***

Although no specific data and reliable information are available on income generation through aquaculture, based on experience and information available it can be stated that aquaculture is not a major source of income in the region.

When the role of aquaculture in the economy is evaluated, new opportunities of pond fish farms, such as recreation services for tourism, which may generate significant income, should also be taken into account. Most of the fish produced through aquaculture (especially the low market value species) are sold on local markets. Therefore the income from export of fish and fish products is low in the region.

#### ***3.4.2 Contribution to GDP of trade in fisheries and aquaculture products***

Although no or very few specific data are available in the available NASO-PAFAD country reports on export earnings of aquatic products in comparison with other terrestrial animal commodities, based on information above it can be concluded that the contribution to GDP of aquatic products is much less significant than that of terrestrial animal commodities.

Even the Russian Federation, which is the leading aquaculture producing country in the region, exports only sturgeon caviar (to China, Greece, Germany, USA and Bulgaria) and trout roe (to former USSR countries). In Croatia, however, the export earning from aquatic products (from capture fisheries and aquaculture both) was US\$81 million in 2003, which was

40 percent of the total export earning from agriculture, forestry, game, and fisheries products and is approximately 0.18 percent of the GDP. The relatively insignificant role of aquaculture in export earnings is also supported by the available figures summarized in Table 11, which have been drawn from the available NASO-PAFAD country reports and relevant tables of EUROSTAT and FAOSTAT.

**Table 11: Data on export earnings from aquaculture in 2003 as available for four CEE countries** (values in US\$1 000. NA = not available)

Country	Values in 2003 US\$1 000
Albania	NA
Belarus	NA
Bosnia and Herzegovina	NA
Bulgaria	NA
Croatia	81 000
Czech Republic	20 000
Estonia	NA
Hungary	4 926
Latvia	NA
Lithuania	NA
The former Yugoslav Republic of Macedonia	NA
Moldova	NA
Poland	NA
Romania	NA
Russian Federation	NA
Serbia and Montenegro	4 100
Slovakia	NA
Slovenia	NA
Ukraine	NA

Sources: NASO and PAFAD country reports, 2005; Adámek, 2005; Bekefi, 2005; Markovic and Poleksic, 2005; Piria, 2005.

### ***3.4.3 Intraregional and interregional trade of aquaculture commodities***

Based on the data available in the NASO-PAFAD country reports, only a few country authors provided specific information on exports and imports of aquaculture commodities in their countries, however there was no indication on the source and target countries.

On the basis of the available data no specific trend of exports and imports of aquaculture commodities can be observed for the CEE region. However, given that often mainly those types of aquaculture products are imported, which are neither produced nor could be produced in the different CEE countries, it may be assumed that the imports of aquaculture products will continue to grow in the future.

### **3.4.4 Production cost of aquatic species**

It is a difficult task to determine the production costs of the different agriculture products in general and that of the different aquatic species in particular. This is especially true when they are produced in ponds, because there are a wide range of technological variables, which determine fundamentally the production costs. Moreover, reliable information on financial efforts and results are considered private matter/business, hence would rarely be shared publicly. For these reasons information is not readily available on production costs of the different aquatic species.

In the case of intensive systems, where factory made aqua-feeds are used the calculation of production costs must be easier, but still the actual figures may vary significantly from farm to farm, not mentioning the variations between the different regions.

According to the list of 2003 unit prices of the top 24 aquatic species, calculated from their total volume and value, the production costs should be around 25–50 percent less than the indicated unit prices (Tables 7 and 8).

Based on the available NASO and PAFAD country study reports it can be stated, that the production cost of carp is fluctuating between US\$0.8 and US\$1.5 per kg depending on the country. Accordingly the computed price of US\$2.4/kg may provide reasonable profit for carp farmers (Tables 7 and 8). The production cost of trouts is varying between US\$2 and 5 per kg. Sea bass and sea bream have the highest production costs, which is about US\$4.5 per kg.

Regarding the nature of the profit it is very typical that the difference between production and retail price of common carp (dominant species of the region), is often two folds (Russian Federation) or even five folds (Bosnia and Herzegovina and Croatia) higher. Still, as a common phenomenon, the majority of the profit goes to the retail sector (NASO and PAFAD country reports, 2005).

## **4. CONTRIBUTION TO FAMILY FOOD SECURITY, ACCESS TO FOOD, NUTRITION AND FOOD SAFETY**

### **4.1 The relative contribution of fish compared to other sources of protein to food production**

In many countries, like in Lithuania, Bosnia and Herzegovina, Ukraine, Croatia, Romania and Slovakia, due to the lack of reliable information and data, it is very difficult to estimate the contribution of fishery products to overall food production compared to other sources of animal protein. However, FAO statistical data demonstrate that the contribution of fish to the animal protein supply of the people is less than that of different meats (poultry, pig, beef, mutton and goat) in most CEE countries (Table 12).

Lithuania is the leading country in the CEE region as far as relative fish consumption is concerned, because it is very high both in absolute (59.8 kg fish/capita/year) and relative terms (54 percent of total animal meat consumption).

The contribution of fish to the total animal protein supply is over 20 percent in Croatia, Estonia, Russian Federation and Ukraine, while it is between 10 and 20 percent in Belarus, Bosnia and Herzegovina, Czech Republic, Latvia and Poland (Table 12).

The proportion of per capita fish and seafood consumption within the total per capita meat consumption was the lowest in Bulgaria (4 percent), Hungary (5.4 percent), Romania (5.9 percent) and Serbia and Montenegro (2.5 percent) in 2003 (Table 12). Meat consumption in these countries is traditionally high, but the rather low share of fish in the diet in Bulgaria and Romania is difficult to explain because these countries have seashores and a well-developed fishing industry.

**Table 12. Fish and meat supply in CEE countries in 2002** (FAOSTAT Nutritional data on food supply, 2005)

Country	Supply in 2002 (kg/capita/yr)	
	Fish and Seafood	Terrestrial Meat
Albania	4.1	39.3
Belarus	14.3	57.7
Bosnia and Herzegovina	4.4	22.6
Bulgaria	2.9	69.7
Croatia	11.9	31.5
Czech Republic	13.6	86.1
Estonia	21.2	64.7
Hungary	5.1	88.9
Latvia	11.1	45.9
Lithuania	59.8	50.9
The former Yugoslav Republic of Macedonia	4.1	40.7
Moldova		
Poland	13.1	73.3
Romania	3.4	54.1
Russian Federation	18.6	49.8
Serbia and Montenegro	2.0	77.9
Slovakia	7.3	66.3
Slovenia	7.7	88.3
Ukraine	15.4	32.0

## 4.2 Fish consumption trends

No detailed data are available on fish consumption trends in the NASO-PAFAD country study reports. In addition, data in the reports and data from other sources such as FAOSTAT and EUROSTAT are often conflicting. Available data and estimates indicate that there was a considerable decrease in fish consumption in most CEE countries after the early nineties, when their fisheries and aquaculture production decreased significantly. This proves the importance of local production in the fish supply. There has been a gradual increase in fish

consumption in recent years however there were countries where fish consumption increased rapidly. For instance in Albania the 2 kg/capita fish consumption of 2002 doubled by 2004.

A recent study (Failler 2003; Failler and Lecrivain, 2003) estimated the future trends of fish consumption in Europe and estimated fish consumption levels up to the year 2030 (Table 13). According to this study, there will be significant increases in fish consumption in Central and Eastern Europe. The predicted fish consumption in Lithuania, Bulgaria, Romania and Slovakia, for example, will be significantly higher with 81 percent, 60 percent, 58 percent and 55 percent, respectively, in 2030 compared to the fish consumption in 1998.

#### **4.3 Comparing consumption of fish vs terrestrial meat in rural and urban societies**

In many countries there is no reliable information concerning the consumption of fish vs terrestrial meat in rural and urban societies. However, one can find some important indications in the following examples of different countries in the region.

Ranking highest in most CEE countries, pig and poultry meat are dominant on the meat market. Fish and fish products rank third or fourth in the total consumption of meat in these countries.

In some regions of Central and Eastern Europe, fish is mainly consumed at religious holidays such as Christmas, while in some other regions fish is an everyday food. There are significant differences in consumption patterns from region to region even within a country. In Hungary for example the annual per capita fish consumption differences may vary with 10–20 kg from one region to another. A recently completed study proved that fish consumption is higher in those areas where fisheries and aquaculture have long traditions irrespectively whether the market is in rural or urban areas (Szücs, 2002).

Even though in Albania the proportion of fish consumption is 9.4 percent within the total meat production, fish consumption in Albania shows also regional diversity, because it is higher in coastal areas and also in urban areas than consumption of the terrestrial meat (Cobani, 2005).

On the other hand, in Latvia, Estonia and Croatia fishery products rank second or even lead the meat market (NASO and PAFAD country reports, 2005).

#### **4.4 Market prices of aquatic species of different origins**

Many NASO-PAFAD study reports provide no information on the price differences between the products from capture and culture fisheries. Therefore there are only very few presentable examples, such as Albania, where the market price of wild fish may be about US\$10/kg while farmed fish is approximately US\$5/kg. To compare the prices for wild fish and farmed fish in most cases is very difficult, because different species are sold from the wild than from the farms. For instance, in Estonia there is practically no “overlap” of cultured and wild fish species on the domestic market. There is competition only between groups of fish of similar consumption profile. Cyprinids caught from the lakes are cheaper than the farmed common carp, because it is consumed the same way as freshwater bream or roach.

**Table 13. Predicted fish consumption for EUR-28 countries<sup>3</sup> from 1989 to 2030** (after Failler, 2003; Failler and Lecrivain, 2003)

Country	Consumption (kg/cap/yr)								
	1989	1994	1998	2005	2010	2015	2020	2025	2030
Austria	9	12	11	11	11	12	12	12	13
Belgium-Luxembourg	21	23	22	22	22	23	23	23	24
Denmark	20	25	23	24	25	26	27	28	29
Finland	33	34	34	34	35	35	36	36	37
France	30	30	32	32	32	32	32	33	33
Germany	11	13	15	15	15	16	16	17	18
Greece	20	26	26	26	26	26	27	27	27
Ireland	22	19	21	21	21	21	21	21	20
Italy	21	22	23	24	25	26	27	28	29
Netherlands	14	16	15	15	15	15	15	16	16
Portugal	59	60	61	60	59	59	58	58	57
Spain	39	40	41	40	39	39	39	39	39
Sweden	22	27	29	28	28	27	27	27	27
United Kingdom	22	20	24	24	24	25	25	25	25
<b>EU-15 Average</b>	<b>23</b>	<b>24</b>	<b>25</b>	<b>26</b>	<b>26</b>	<b>26</b>	<b>26</b>	<b>27</b>	<b>27</b>
Cyprus	18	20	25	25	24	24	23	23	23
Czech Republic	-	9	9	10	10	11	11	12	13
Estonia	-	37	15	14	14	14	14	14	14
Hungary	-	4	4	5	5	5	5	6	6
Poland	15	13	11	12	13	13	14	15	16
Slovenia	-	6	7	7	7	8	8	8	9
<b>EUR-6 NC Average</b>	<b>15</b>	<b>11</b>	<b>10</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>12</b>	<b>13</b>	<b>14</b>
Bulgaria	-	2	4	5	5	6	6	7	7
Latvia	-	43	37	37	37	38	38	38	39
Lithuania	-	21	15	17	19	21	23	25	27
Malta	23	22	29	30	31	32	33	34	36
Norway	45	47	46	46	45	45	45	45	45
Romania	9	3	3	3	4	4	4	5	5
Slovakia	-	7	5	6	6	7	7	8	8
<b>EUR-7 NC Average</b>	<b>42</b>	<b>37</b>	<b>40</b>	<b>11</b>	<b>11</b>	<b>12</b>	<b>12</b>	<b>13</b>	<b>13</b>
<b>EUR-28 Average</b>	<b>22</b>	<b>21</b>	<b>22</b>	<b>22</b>	<b>22</b>	<b>23</b>	<b>23</b>	<b>24</b>	<b>24</b>

<sup>3</sup> The enlargement of the European Union is taken into account in the study by Failler (2003). The first six countries (EUR-7 NC) are most likely to be part of the EU before 2005 are Cyprus, the Czech Republic, Estonia, Hungary, Poland and Slovenia. The second group of countries (EUR-6 NC) that could reasonably join the EU before 2010 is Bulgaria, Latvia, Lithuania, Malta, Romania and Slovakia. In addition to these countries, it seemed appropriate to consider Norway becoming a member state before 2010 even if this Scandinavian country has not currently initiated a process of adhesion. Within the framework of the Failler study the size of the EU is thus: 15 Member States in 2000 (EU-15), 21 in 2005 (EUR-21) and 28 in 2010 (EUR-28).

On the basis of available information, it can be stated that people with low income prefer cheaper fish, for example, herring or cyprinids, instead of the more expensive local trout or the imported Norwegian salmon and large trout which in CEE countries are still relatively expensive.

#### **4.5 Demographic data and trends relevant to aquaculture**

Although no data are available in the NASO-PAFAD country study reports regarding the demographic trends relevant to aquaculture, it is felt that the known demographic trends, such as ageing of the population, low birth rates, etc. do not have a significant effect on the development of the aquaculture industry. Even if the production volume is relatively low, and low market value species are dominant in the production, the social sustainability of the aquaculture industry (especially the traditional pond aquaculture) can not be questioned.

### **5. ENVIRONMENT AND RESOURCES**

The Commission of the European Communities emphasizes the importance of ensuring the development of an environmentally sound aquaculture industry. Therefore already in 2002 the most important relevant strategic aspects were elaborated. Accordingly, it is very important to reduce the negative environmental impacts of aquaculture by developing a set of norms and/or voluntary measures and agreements which prevent environment degradation. On the other hand, those aquaculture developments, which have positive contribution to the environment, must be recognized and encouraged (Commission of the European Communities, 2002).

It is especially crucial to consider EU norms and voluntary agreements in CEE countries for three main reasons. First, some of the CEE countries are EU member states, and therefore, they must comply with relevant rules and regulations. Other countries, which do not belong to the EU, should also consider their own regulations, because EU is a very interesting potential market for their products, especially for the high value aquatic species, which may have the most adverse effects on the environment if they are produced with traditional technologies. Therefore the eco-labelling of these products cannot be pursued unless relevant norms and regulations are observed and followed. The second reason for considering environmental aspects in aquaculture production is the own interest of all countries, because there is no sustainable development without protection of their environments. The third and probably one of the most important reasons is the ever increasing scarcity of good quality water resources, therefore the environmental aspects and considerations in aquaculture production increasingly influence the present and future management of the aquaculture sector.

#### **5.1 Environment and land use**

##### ***5.1.1 Overall use of land and water resources***

In Central and Eastern Europe, most of the pond fish farms were built on areas, which were not appropriate for efficient agricultural production due to the low quality of the soil of the sites. There are also some regions where large inland areas are inundated regularly. In some of these areas either fish ponds or reservoirs have been constructed. In the reservoirs floodwater is stored in some critical periods, but the reservoirs are also used for aquaculture where suitable conditions are available. There is commercial fishing on the bigger lakes and rivers as well, such as Lake Balaton (Hungary), Lake Prespa (Albania), River Neretva (Bosnia and Herzegovina), etc.

The inland water resources of Central and Eastern European countries are considerable. The total renewable water resources (TRWR) of CEE countries, with and without the Russian



Federation, are 5 437 million and 0.930 million km<sup>3</sup>/year respectively (Table 14). Accordingly about 83 percent of TRWR of the CEE region belong to the Russian Federation and only 17 percent belong to the other 18 CEE countries.

**Table 14. Area and volumes of inland water resources of Central and Eastern European countries** (sources: adapted from CIA, 2006; FAO AQUASTAT, 2006)

Country	Total Area (km <sup>2</sup> )	Land (km <sup>2</sup> )	Inland Waters (km <sup>2</sup> )	Total renewable water resources (TRWR; km <sup>3</sup> )
<b>Russian Federation</b>	17 075 200	16 995 800	79 400	4 507 250
Albania	28 748	27 398	1 350	41 700
Belarus	207 600	207 600	-	58 000
Bosnia and Herzegovina	51 129	51 129	-	-
Bulgaria	110 910	110 550	360	21 300
Croatia	56 542	56 414	128	105 500
Czech Rep.	78 866	77 276	1 590	13 150
Estonia	45 226	43 211	2 015	12 808
Hungary	93 030	92 340	690	104 000
Latvia	64 589	63 589	1 000	35 449
Lithuania	65 200	65 200	-	24 900
Moldova	33 843	33 371	472	11 650
Poland	312 685	304 465	8 220	61 600
Romania	237 500	230 340	7 160	211 930
Serbia and Montenegro	102 350	102 136	214	-
Slovakia	48 845	48 800	45	50 100
Slovenia	20 273	20 151	122	31 870
The former Yugoslav Republic of Macedonia	25 333	24 856	477	6 400
Ukraine	603 700	603 700	-	139 550
<b>Total of CEE 19</b>	<b>19 261 569</b>	<b>19 158 326</b>	<b>103 243</b>	<b>5 437 157</b>
<b>Total of CEE 18</b>	<b>2 186 369</b>	<b>2 162 526</b>	<b>23 843</b>	<b>929 907</b>

Annual TRWR per unit area of the countries were also calculated in order to compare more reliably the inland water resources available in the CEE region. Out of the 19 CEE countries, Czech Republic (0.17 km<sup>3</sup>/km<sup>2</sup>), Bulgaria (0.19 km<sup>3</sup>/km<sup>2</sup>), Poland (0.20 km<sup>3</sup>/km<sup>2</sup>), Ukraine (0.23 km<sup>3</sup>/km<sup>2</sup>), The former Yugoslav Republic of Macedonia (0.25 km<sup>3</sup>/km<sup>2</sup>) and Russian Federation (0.26 km<sup>3</sup>/km<sup>2</sup>) have the least and Croatia (1.87 km<sup>3</sup>/km<sup>2</sup>), Slovenia (1.57 km<sup>3</sup>/km<sup>2</sup>), Albania (1.45 km<sup>3</sup>/km<sup>2</sup>), Hungary (1.12 km<sup>3</sup>/km<sup>2</sup>) and Slovakia (1.03 km<sup>3</sup>/km<sup>2</sup>) have the most TRWR, while the averages of CEE countries are 0.28 km<sup>3</sup>/km<sup>2</sup> with and 0.43 km<sup>3</sup>/km<sup>2</sup> without the Russian Federation.

The unit TRWR, however, includes the water inflow from upstream countries. Therefore, even if the TRWR value is relatively high for some countries, there are significant water conflicts between upstream and downstream countries both in terms of quantity and quality (e.g. conflict of Hungary with Slovakia and Romania).

Out of the 19 countries of the CEE region, six are landlocked countries, in which only freshwater aquaculture can be practiced. Other 13 countries have coastal and marine waters. The total length of coastlines of CEE countries is about 52 400 km and 14 700 km with and without the Russian Federation, therefore, approximately 72 percent of the coastlines of the region, about 37 700 km belong to the Russian Federation (Table 15). Some of the countries with suitable seashore do not have significant marine aquaculture and in some Baltic countries (Estonia and Lithuania), the environmental conditions are not suitable to utilize coastal areas for aquaculture production (Paaver, 2006; Poviliunas, 2006; HAKI, 2000; Váradi *et al.*, 2001a).

**Table 15. Area of marine and brackish water resources of Central and Eastern European countries** (sources: adapted from CIA, 2005; WRI Earthtrends, 2006; Cobani, 2005)

Country	Total Area (km <sup>2</sup> )	Marine Waters (km <sup>2</sup> )	Lagoons (km <sup>2</sup> )	Coast Line (km)
Albania	28 748	6 210	100	362
Belarus	207 600	-	-	-
Bosnia and Herzegovina	51 129	-	NA	20
Bulgaria	110 910	6 506	NA	354
Croatia	56 542	31 067	NA	5 835
Czech Rep.	78 866	-	-	-
Estonia	45 226	24 279	NA	3 794
Hungary	93 030	-	-	-
Latvia	64 589	12 584	NA	531
Lithuania	65 200	2 018	NA	99
Moldova	33 843	-	-	-
Poland	312 685	10 632	NA	491
Romania	237 500	5 343	NA	225
Russian Federation	17 075 200	1 318 100	NA	37 653
Serbia and Montenegro	102 350	-	-	199
Slovakia	48 845	-	-	-
Slovenia	20 273	171	NA	47
The former Yugoslav Republic of Macedonia	25 333	-	-	-
Ukraine	603 700	53 930	NA	2 782
<b>Total of CEE 19</b>	<b>19 261 569</b>	<b>1 470 840</b>	<b>100</b>	<b>52 392</b>
<b>Total of CEE 18</b>	<b>2 186 369</b>	<b>152 740</b>	<b>100</b>	<b>14 739</b>

Still, it can be concluded that there are extensive water resources, hence future potential to develop both freshwater as well as brackishwater and marine aquaculture activities in CEE countries. Yet, many complaints against aquaculture development reflect competition for space therefore land and water for aquaculture will be more and more expensive in the future (EIFAC, 2001; CEC, 2002).

### **5.1.2 Total area used for aquaculture production**

The total fishpond area in the region is about 448 000 ha, which represents a valuable aquatic resource in Europe not only for fish production but also for the maintenance of biodiversity, and for the improvement of water management in the watersheds involved (Table 16). Unfortunately most of the existing fish farms in CEE regions are very old, hence they should be rehabilitated. For this reason EU support is provided to its member countries in the CEE region. Regarding other countries there is no information available about similarly organized programmes.

**Table 16. Total area used for aquaculture production in CEE countries in 2003** (Source: NASO and PAFAD country reports, 2005)

Country	2003		
	Fishponds (ha)	Intensive fish farms (ha)	Coastal and marine farms (ha)
Albania	10 000	NA	10 000
Belarus	341	2	-
Bosnia and Herzegovina	3 276	16.6	3.6
Bulgaria	3 071	NA	5 92.8
Croatia	6 276	5.84	NA
Czech Republic	41 000	NA	-
Estonia	530	1.8	2.6
Hungary	26 813	NA	-
Latvia	5 000	NA	NA
Lithuania	3 825	NA	-
Moldova	27 000	NA	-
Poland	50 000	NA	NA
Romania	84 500	20.9	NA
Russian Federation	101 000	59	70 000
Serbia and Montenegro	12 000	16.5	-
Slovakia	2 000	NA	-
Slovenia	316	5.89	1.7
The former Yugoslav Republic of Macedonia	700	NA	-
Ukraine	70 000	NA	NA
<b>Total of CEE 19</b>	<b>447 648</b>	<b>129</b>	<b>80 008</b>
<b>Total of CEE 18</b>	<b>346 648</b>	<b>70</b>	<b>10 008</b>

N.B. Data for intensive, coastal and marine fish farms include the area/volume of cages, raceways and tanks.

Available data show that the total area of intensive fish farms is at least 129 ha, while the total area of coastal and marine farms is estimated at some 80 000 ha (Table 16).

### ***5.1.3 Trend towards increasing mariculture development***

One third of CEE countries do not have access to the sea (Table 15). Countries with coastlines have started to develop their marine aquaculture in the past few years, except Lithuania and Estonia, because of their long winters and unfavorable environmental conditions and Bosnia and Herzegovina because of market constraints. In other countries with shorelines, producers started to construct fish farms and increase the amount of mariculture production with special regard to cage culture. The target species are mainly mussels, salmon, sea bream, sea bass and tuna.

The most significant constraint of marine aquaculture development is the lack of high quality seed. Almost all CEE countries have to import the seed of marine species from other European countries, like Italy, Spain or France, which makes marine aquaculture production very expensive. On the other hand, mariculture can be an important management tool to limit pressure on wild fish stocks, which are heavily stressed due to overfishing and pollution in coastal areas, i.e. problems which are generating a gradually increasing public concern.

The case is different in Croatia where there are good perspectives for mariculture development. Tuna production showed a significant increase in Croatia targeting high demands of markets in Japan. However, since tuna production is based on fattening of wild-caught juveniles this type of fish culture is being criticized by some environmentalists.

There is a general need in the region to modernize production, to reinforce mariculture infrastructure and logistics, in addition to systematic support to research and developments.

### ***5.1.4 Species introduced for aquaculture purposes***

Only a few fish species have been introduced to the region during the past ten years. Some countries have imported the Black grass carp (Czech Republic, Bulgaria) and the African catfish (Hungary, Russian Federation and Ukraine). Some other species, like the European catfish, the paddlefish and the Soiyu mullet were also introduced into some countries, but these later introductions so far have had no significant commercial scale developments, because their production data were not yet registered in the NASO and PAFAD country reports.

### ***5.1.5 Indicative losses due to diseases in aquaculture***

Since both the production volume and intensity level decreased in the past years in the region, disease occurrence is not a main issue in Central and Eastern European pond aquaculture.

The appearance of the KHV (Koi Herpes Virus) in Poland, however, is an alarming incident for other carp producing countries in the region. Although the volume of intensive aquaculture production is relatively low in the region, diseases impose a threat to the viable operation of such systems. Fish health management has a priority in intensive production, even if no serious losses have been reported to date.

## **5.2 Feed and seed resources**

### ***5.2.1 Origin of feed resources and degree of their use***

In pond fish culture of the CEE region the main fish species are the various carps. Their production is based on the utilization of natural fish food in ponds, which is the principal

protein source in the diet of growing fish in extensive and semi-intensive pond systems. Farmers provide supplementary feed, such as wheat, corn or barley, to the fish in order to supplement carbohydrates into the diet. Sometimes and in certain seasons of production cycle, when there is not enough protein of natural origin, oil cakes, like sunflower or soybean, are used in fish feeding. The same is done in case of intensification of the production of the pond systems.

In intensive farms, where the main fish species are rainbow trout, African catfish or sturgeon, fully balanced diet are used in the form of artificial pellets. However some countries apply trash fish for the production of carnivorous species. Unfortunately there is no available information neither on the degree of use of feed resources or on the related trends.

### ***5.2.2 Status of commercial aqua-feed production***

Specialized aqua-feed production capacity is rather limited in the CEE region. Feed for intensive aquaculture is sometimes produced in feed mills, which manufacture feeds for terrestrial animals. Data from NASO-PAFAD country study reports were summarized in Table 17. Data show that there is no significant aqua-feed production in Albania, Croatia, Estonia, Lithuania, Moldova, Slovenia and Ukraine.

### ***5.2.3 Levels of importation of aqua-feeds***

Aqua-feeds for intensive production are imported mainly from Western European feed manufacturers. Even if there are countries, where they have their own fish feed mills, if high quality feed is required, it is imported from Western Europe (Table 17).

### ***5.2.4 Quality issues related to commercial aqua-feeds***

There is an increasing need for high quality aqua-feeds in the region. National feed standards are available in most of the countries but local quality feed production has not been well developed due to a range of reasons, which include: low quality fishmeal, low-level production technology, unsatisfactory control of available raw materials, low lipid content of the feed and lack of equipment for lipid enrichment of pellets. Therefore, the quality of fish feeds produced in CEE countries is lower but is also less expensive than similar products from Western Europe. Furthermore, prices of fish feeds of CEE countries are also lower than those manufactured in Western Europe. For these reasons, CEE countries produce cheaper fish feed with higher FCR (feed conversion ratio) and Western Europe countries produce more expensive fish feed with lower FCR. These differences offer the choice of using larger quantities of cheaper feeds or lower quantities of more expensive fish feed. However, the impact of using increased amounts of fish feed on the environment may be more significant, when fish feed with higher FCR is used.

### ***5.2.5 Hatchery production of seed***

Relatively many of usually very large fish hatcheries were built in the period of centrally planned economies in CEE countries. Some of them were designed to provide fish seed for entire regions. Most of these hatcheries are still in operation having significant capacity theoretically. However, most of them are in poor condition, using obsolete equipment and are only suitable for the propagation of conventional species. Therefore, there is a need to upgrade the existing hatcheries and to build new ones for the efficient and safe propagation of various species, including non-conventional species.

**Table 17. Aqua-feed production and imports in some Central and Eastern European countries**  
(source: NASO and PAFAD country reports, 2005)

Country	Production		Imports	
	1 000 t/year	Used for Species	1 000 t/year	Imported from
Albania	NA	NA	0.5	Greece, Italy
Belarus	NA	NA	NA	NA
Bosnia and Herzegovina	2.2	common carp, trout	3.2	Denmark, Italy, Germany
Bulgaria	12.0	common carp	2.0 – 3.0	NA
Croatia	NA	NA	6.0 – 8.0	NA
Czech Republic	2.6	common carp, tilapia, trout	0.5 – 0.6	NA
Estonia	NA	NA	0.4 – 0.5	NA
Hungary	2.0	common carp, tilapia, African catfish	0.1	Western Europe
Latvia	NA	NA	NA	NA
Lithuania	NA	NA	NA	NA
Moldova	NA	NA	0.01	Ukraine, Romania
Poland	NA	NA	NA	NA
Romania	NA	NA	NA	NA
Russian Federation	115.0	NA	13.2	Denmark, Finland, Germany
Serbia and Montenegro	5.0	NA	2.0	NA
Slovakia	NA	NA	NA	NA
Slovenia	NA	NA	NA	Western Europe
The former Yugoslav Republic of Macedonia	NA	NA	NA	NA
Ukraine	NA	NA	0.04 – 0.05	NA

NASO and PAFAD country reports suggest that there is a need for hatchery improvement both in freshwater and marine aquaculture. It is especially important because fish hatcheries also produce stocking material for natural waters, which includes a large variety of often endangered species. The services which these hatcheries provide to various environment agencies stimulate only the development of aquaculture but also contribute to the commercial viability and sustainability of fish hatcheries and breeding centers.

### 5.3 Feeding fresh fish, trash fish and fishmeal usage

#### 5.3.1 Production, export, import and use of fishmeal

According to international statistics the aquaculture sector took the largest share (46 percent) from the total world production of fishmeal in 2002 and 2003. The other sectors such as pig breeding, poultry and ruminants took only 24 percent, 22 percent and 1 percent respectively, while the remaining 7 percent was consumed by different other sectors (FIN, 2006).

Only the Russian Federation and Ukraine have significant fishmeal production in the CEE region. There are no statistics available on the production of Ukraine, because it is not within the top 16 producers. Regarding the Russian Federation it is about the 13<sup>th</sup> largest producer of the world even if its annual fishmeal production decreased from 126 000 to 70 000 tonnes between 2000 and 2004 (FIN, 2006). In addition to the domestic production the Russian Federation imported almost the same annual quantities, which were 167 000 in 2001 and 55 000 in 2004 (FIN, 2006).

All the other CEE countries import fishmeal for the production of formulated feeds, although no detailed data are available on the imported volume.

In most of the countries of Central and Eastern Europe the main user of fishmeal is the livestock industry, but no data are readily available on the use of fishmeal for the various sub-sectors including aquaculture.

### ***5.3.2 Usage patterns for trash fish and raw fish in aquaculture***

Usage of unprocessed trash and raw fish in aquaculture as feed is prohibited in the EU. Therefore, no trash fish or raw fish is used in EU member countries of the CEE region.

However, farmers not always comply with the regulations. On the other hand even in those countries where the use of trash fish is permitted for aquaculture production, their use is rather limited. The use of trash fish has been reported from Croatia for feeding tuna in mariculture and from Albania for feeding trout.

In the Czech Republic and also in Hungary the situation is somewhat different. Advanced fry and fingerlings of some low-value fish species are produced in large quantities and stocked together with growing pike-perch and perch or with other high value predators in order to provide natural food for them. Of course, these practices are entirely different ones, and therefore, are not contradictory to relevant EU regulations.

## **6. LEGAL, INSTITUTIONAL AND MANAGEMENT ASPECTS OF THE AQUACULTURE SECTOR**

### **6.1 Description of the sector**

#### ***6.1.1 Parts of the sector***

In all Central and Eastern European countries freshwater pond fish farming is the dominant sub-sector (mainly for the production of carps), which is followed by the sub-sector of cold water fish farming in flow-through systems (mainly for the production of trout). Other sub-sectors such as intensive tank and cage farming of warm and cold water species are representing only a smaller part of the aquaculture sector.

#### ***6.1.2 Management of the sector***

There have been substantial changes in the structure of the aquaculture sector in Central and Eastern Europe since the early nineties as a result of political and economic changes in the region.

In the centrally planned economy, fish farms were integral parts of well organized state-farm and mandatory cooperative systems, which also provided a level of protection to them. However, after privatization of individual fish farms they have been exposed to market conditions and to the sometimes difficult economic environment. In this new situation fish

farmers gradually realized that they need a new type of cooperation, which would allow them to protect their interests and also to act jointly in order to achieve their common objectives.

Although the need for the participation of representatives of the production sector in the elaboration of relevant policies, legislature, and regulatory frameworks has been recognized, efficient industry representation in policy-making has not been achieved in many Central and Eastern European countries.

Responsibilities and mandates for sector management within the government administration are often unclear. The status of the aquaculture sector has been and still is uncertain in some countries. The need for the establishment of a specialized agency for aquaculture as well as for specific legislation on aquaculture issues has also been emphasized in order to get aquaculture recognized as a legitimate and equal-right user of resources which is eligible for institutional and financial support.

There have been various responses to the above issues in different countries both in the EU member countries such as Hungary, Slovakia, Czech Republic and Poland and in other CEE countries which are not member of the EU. The actual responses depended on the relevant political and economic situation. However, the importance of producers' participation and the creation of producers' associations have been recognized. Such organizations are increasing thereby strengthening industry representation.

### ***6.1.3 Country efforts to develop sustainable aquaculture***

In those CEE countries, which belong to the EU various programmes support the sustainable development of the aquaculture sector, which offer grants (in the case of significant own contributions) on renovation, modernization of production units, elaboration of new viable production systems and identification of promotion programmes for aquaculture products.

In those countries which do not belong to the EU, there are also national efforts for the development of sustainable aquaculture, like in Albania, Croatia or in Bosnia and Herzegovina. According to NASO and PAFAD country reports there are similar efforts also in the Russian Federation and Ukraine.

## **6.2 Institutional support and legal and policy frameworks in the sector**

### ***6.2.1 Farmer societies and organizations***

The Czech Republic, Hungary and Poland were the first countries, where producers' organizations have been established. It should also be mentioned that cooperation among producers had a long tradition in these countries, and the new types of associations were built on the traditional values and experiences.

In many cases new producers' associations have been developed out of the previous cooperatives or state-owned associations. However, there have been significant changes in the structure and function of the old-type organizations while they have been converted into "real" producers' associations, which also resulted in conflicts in many cases. An account of Central and Eastern European fish producers associations is given in Table 18.



**Table 18. Fish producer's associations in Central and Eastern Europe** (NASO and PAFAD country reports, 2005; Bekefi et al. 2004; 2006)

Country	Name of the Fish Producers Association	Remarks
Albania	No information	
Belarus	None. Contact: Department of Melioration and Water Management, Ministry of Agriculture and Food of Belarus	
Bosnia and Herzegovina	1. Foreign Trade Chamber of Bosnia and Herzegovina 2. NGO Association of Agriculture Producers in Bosnia and Herzegovina Fishery Section	
Bulgaria	1. National Association of Fishery and Aquaculture in Bulgaria 2. The Fish Producer Association 3. Bulgarian Fish Association	
Croatia	Croatian Chamber of Commerce. Aquaculture Section	130 members; 3 Affiliations (Agriculture, Fishing and Fish Processing)
Czech Republic	Czech Fish Farmers' Association	60 members; members cover about 80 % of total fish production in the country; member of FEAP
Estonia	Estonian Fish Farmers Association	76 members
Hungary	Hungarian Fish Producers Association	108 members; members cover about 80% of the total fish production in the country; member of FEAP
Latvia	Latvian Crayfish and Fish Farmers Association	
Lithuania	Association of National Aquaculture and Fish Product Producers	
Moldova	"Piscicola" Association	
Poland	Polish Fishery Association (Polish Trout Breeders Association)	
Romania	1. State Fisheries Organization 2. 'ROMPESCARIA' Association of private fish producers	
Russian Federation	1. State Cooperative Association for Fisheries "Rosrybkhoz" 2. Association of Inland Water Fish Culture Enterprises and Aquaculture "Rybkhozassotsiatsiya"	
Serbia and Montenegro	Serbian Chamber of Commerce. Fisheries Group	64 private farms and 5 under privatization
Slovakia	No information.	
Slovenia	No information.	
The former Yugoslav Republic of Macedonia	No information.	
Ukraine	Association of Fish Farmers of Inland Waters of Ukraine "Ukrribhoz"	

### **6.2.2 National resource allocations for agricultural, livestock and fisheries (aquaculture) production**

Aquaculture is only a minor segment of the agricultural sector in most of Central and Eastern European countries. Therefore relatively limited resources are available for aquaculture development.

However, in those countries, where the importance of aquaculture in rural development has been recognized, more resources are allocated for the aquaculture sector in the frame of agricultural and rural development policies. In many countries of the region there is a continuous need for the development of appropriate legal and regulatory frameworks for aquaculture. Specific characteristics of aquaculture should be recognized by different institutions and public authorities, including agencies with mandate over fisheries, agriculture, water management, environmental protection and food safety.

It should be noted that governments provide support for aquaculture research institutions and also for fisheries and aquaculture faculties at various universities even in those countries where aquaculture is not an important part of the national economy.

Due to its multidisciplinary nature, aquaculture with special regard to pond fish farming contributes to the improvement of rural livelihood, as well as to the maintenance and development of biodiversity and to better water management.

Before joining the European Union, the Special Accession Programme for Agriculture and Rural Development (SAPARD) in several CEE countries (for instance Bulgaria, Estonia and Hungary) provided significant contributions to the fisheries and aquaculture sector, since the programme supported this sector by financing projects.

The existence of a separate Common Fisheries Policy and the FIFG (Financial Instrument for Fisheries Guidance) structural fund in EU member countries of the CEE region helps to distinguish aquaculture from agriculture, which may have a positive effect regarding the recognition of special values of aquaculture.

In countries, where the status of the aquaculture sector is uncertain further efforts are needed to ensure this sector is accepted as an equal-right user of resources.

The elaboration of National Development Strategies has a great importance with a view to providing enabling policy frameworks, including institutional recognition and adequate financial measures in support of aquaculture development.

### ***6.2.3 Measures of authorities for ensuring quality and safety of aquaculture products***

The importance of product quality and safety of export products has been well recognized in all countries in Central and Eastern Europe, although most of the aquatic products are destined to local markets, especially the conventional and relatively low market value species, which are produced in ponds.

The use of the HACCP system is becoming common practice even in countries with low export volume. The number of enterprises with ISO certification is also growing, especially in the service sector. There is a growing number of fish processing plants in the region, even in non-EU CEE countries, applying EU regulations.

In Estonia, for example, 100 fish processing enterprises obtained EU certificates having one of the most important preconditions to export their products to EU countries. In Bosnia and Herzegovina, five larger fish farms have introduced EU standards, but they are still waiting for FVO (Food and Veterinary Office – Commission of EU) approval. An inspection team was expected to arrive in the country in August 2005 in order to evaluate possibilities for exporting fish and fish products.

It should be noted, however, that significant further development and investments are required in order to strengthen the aquaculture sector in the region in terms of its competitiveness in the international market. Adequate policies and institutional frameworks for inspection and monitoring of fish health and product quality are in place in most of the countries, although their operation is not always efficient due to understaffing, under-financing and sometimes poor infrastructural conditions.

#### ***6.2.4 International trading standards and related strategies to safeguard small-scale producers***

Although a significant amount of aquaculture production comes from small enterprises in Central and Eastern Europe, these small-scale farms are much bigger than those in developing countries of other regions. Small enterprises sometimes operate relatively large fishpond systems, which used to be a part of a state enterprise in the past before privatization. Although it is argued that very small (micro) enterprises would be viable on the long run, the development of such enterprises is not encouraged in some countries of CEE region (e.g. in Estonia).

There are, however, initiatives to assist the networking of small enterprises and the establishment of producers' organizations in order to meet new market challenges in several countries. Unfortunately, the process is slow and sometimes unsuccessful (e.g. in Hungary) due to the reluctance of individual farmers to collaborate and share market information. Some small farms could be victims of such a situation because bargaining power of individual farms (especially the smaller ones) is very weak against the domineering supermarkets.

In EU member countries of CEE region FIG provides support for the improvement of marketing activities and for the establishment of producers' organizations.

However, there are also other forms of international assistance to promote small-scale aquaculture enterprises, for example in Albania, where the World Bank assisted the development of eleven so-called Fishery Management Organizations (FMO), seven of which operate in inland waters.

There are also some specific actions taken by certain governments (i.e. in Moldova) which aim to train small-scale producers in business management and in the rational use of natural resources.

One specific constraint of aquaculture development in Central and Eastern Europe should be mentioned, namely the significant weakening of the R&D (Research and Development) sector during the transition to market economy and the lack of efficient collaboration between fisheries and aquaculture institutions in the region. Parallel with the consolidation and growing economic stability in the region efforts of promoting institutional collaboration have been restarted. Such processes are greatly helped by the activity of the recently established Network of Aquaculture Centers in Central and Eastern Europe (NACEE). Still, further efforts are needed to improve international collaboration among institutions within the region and also on European and inter-regional levels, which is considered crucial in view of the limited resources for research and development in the region.

### **7. SOCIAL IMPACTS, EMPLOYMENT AND POVERTY REDUCTION**

It is expected that this section of the review will facilitate better understanding of the aquaculture sector's contribution to livelihoods of people, employment and income generation especially as regards its support to rural communities. This section aims also to assist in better understanding the benefits provided by the sector to communities and vulnerable groups of people.

## **7.1 Trends in shifting from small-scale operations to larger commercial operations in aquaculture**

The scale of production remained commercial after the privatization, even if not the entire but only the divided parts of big fish farms were privatized. Therefore no small-scale fish farming is practiced in CEE region, especially not in the sense used this term in Africa and Asia. Consequently, no clear trend in shifting from small-scale operation to larger commercial operations could be observed in Central and Eastern European aquaculture. This is mainly due to the fact that pond fish farming has never been really small-scale in most of CEE countries.

However, one can observe an opposite tendency in the region, namely the shift towards small scale operations. In Hungary, farm sizes range from 6 to 130 hectares for family farms, from 30 to 850 hectares for cooperatives and from 45 to 4 070 hectares for companies. Eleven larger ventures operate 59 percent of the pond fish farms (13 353 hectares) while the rest, about 41 percent is managed by 119 ventures. In Serbia and Montenegro, the number of small-scale farms increased by 10–15 percent during the past five years. There is another notable trend in Central and Eastern Europe, namely the establishment of small, usually family-owned pond systems specifically providing services for anglers.

It can be concluded that the main issue in this region is how the individual producers can develop networking and organize jointly their production and marketing in order to meet new market challenges.

## **7.2 Ownership of aquaculture operations**

There is a wide range of different ownership patterns in CEE countries. In the countries of Central and Eastern Europe mostly those professionals became owners of fish farms, who worked there before as managers or were powerful enough to represent their interests during the race of privatization. Consequently, a well defined segment of the societies became the new owners and, therefore, no very different wealth groups can be distinguished within the circle of the present fish farm owners.

A large number of fish farms were privatized during the past 10–15 years in the CEE region. For example, the percentage of farms which are owned by the state can be quite low now, approximately 5 percent in Bosnia and Herzegovina and Ukraine, compared to the total number of farms. Generally, numerous relatively small pond fish farms have been established throughout the region after the division and privatization of fairly large state-owned pond fish farms in the past ten years.

Nevertheless, other types of ownership were also established, and the form of the ownership has a wide range, such as joint-stock companies (Ukraine and Bulgaria), mixed ownership, cooperatives, and limited companies. In addition, several farms were given to concession in Hungary, Croatia, Slovakia and Poland. In the Czech Republic a relatively large holding was established, which includes several pond fish farms. This holding controls approximately one third of marketable fish production in the country.

Most of commercial fish in the Russian Federation is produced by the enterprises of the State Cooperative Union (ROSRBYBKHOZ) and by fish farms of the agricultural type, operating within the system of the Ministry of Agriculture of the Russian Federation (Bogeruk, 2005). In 2002, there were about 600 aquaculture enterprises in ROSRYBKHOZ, including 33 enterprises of federal state ownership, 35 joint stock companies, 26 regional associations, unions and societies and a lot of country farms. The federal state enterprises dealing with

reproduction of high-value fish species and creation and maintenance of pedigree stocks of fish breeds are practically fully financed from the federal budget (Bogeruk, 2005).

Practically, all (90 percent) specialized fish farm facilities of the Ukraine are open joint-stock companies. About 5 percent of the facilities are in state ownership and 5 percent more are cooperative societies. There are a number of agricultural enterprises of various patterns of ownership in which aquaculture is not the main component of production. Their contribution to the total amount of fish produced in Ukraine is estimated as 5-6 percent (Bekh, 2006).

In Albania, most of the fish farms are now family operated small-scale enterprises, just like in Bosnia and Herzegovina, Estonia or Bulgaria, where more than 70 percent of the farms operate on less than 10 hectares. Similarly in Croatia, a lot of small farms do operate, but only in the sector of cold water production, whereas the majority of carp production is carried out by big joint-stock companies. In Moldova, more than 70 percent of the total production comes from large-scale farms.

### **7.3 Contribution of aquaculture to employment in rural and coastal areas**

The contribution of aquaculture to employment in Central and Eastern European region varies greatly among the countries. Although aquaculture does not have a significant role in the overall economy in several countries, fish farms and processing plants provide employment in some rural regions, where otherwise work opportunities are very limited or do not exist. Data and information derived from the available NASO and PAFAD country reports on these topics are shown in Table 19.

As can be seen in Table 19, the number of people who are involved in aquaculture production in Central and Eastern Europe is relatively low. Most employees have primary or secondary school education and some of them completed only a few years in the elementary school. The percentage of employees with higher education is low. The relatively well trained people are usually the farm managers. A key issue in the development of aquaculture in Central and Eastern Europe is human resources development.

Fisheries is still of significant social, cultural and economic importance for Estonia. In Poland, fishing plays an important part in rural development and in certain regions of the country it is the only source of income. Next to fish farming, there are approximately 1 500 companies that provide angling-related services, where the number of active anglers reached one million (Zakes, 2005). The number of people who work in aquaculture farms today in Serbia and Montenegro is about 1 200, of which 85 percent work in Serbia and 15 percent in Montenegro.

Aquaculture and fisheries offer many job opportunities for fishermen in Romania too. Besides the primary industry, upstream and downstream industries offer jobs in several countries, especially where marine fisheries and aquaculture has importance in the economy, thus processing plants, various suppliers, engineering companies and also transport and trade companies provide employment for local people (Cristea and Patriche, 2005).

In general capture fisheries production drastically decreased since 1988, which lead to unemployment and poaching. A part of the redundant fishermen, however, could find new jobs in marine aquaculture in countries like Albania or Ukraine (Cobani, 2005 and Bekh, 2006).

**Table 19. Number of employees in aquaculture and their level of education in some Central and Eastern European countries (NASO and PAFAD country reports, 2005)**

Country	Number of employees			Education	
	Total	Full time	Part time	Higher	Secondary and/or lower
Bulgaria		141			
Lithuania	10 – 49				
Bosnia and Herzegovina		562	100	Managers- university degree	Working staff- elementary or higher education
Albania	~1 600				
Estonia	~5 400				
Moldova	1 282				
Poland		4 500	Seasonal during spring etc.		
Czech Republic		2 600	Several hundred people per year	Majority- fisheries-related education, college/university level	
Russian Federation	Staff of fish farming enterprises of state and joint-stock ownership included 22 190 persons Staff of farms is ~5 000			Aquaculture specialists-trained in 9 institutes of higher education (110 - 130 persons)	4 institutions specialized secondary education (colleges, technical school)
Serbia and Montenegro		1 200	200 - 300	about 50 persons (4 percent of the total) - higher education	~120 person (10 percent) - secondary education (mainly agriculture, economics and machinery); other employees - primary education.
Slovakia		1 200	900 seasonal, contract workers, family members		
Ukraine	8 000				
Croatia	1 669			The lowest number - university education (1.65 percent ), educated professionals (college degree) 8.25 percent	Total numbers of employees- underqualified workers (33 percent)
Romania	16 807; 46 percent subsistence fishers, 18 percent involved in fish farming, 27 percent active inland fisheries, 9 percent marine fisheries				

#### 7.4 Distribution of benefits from aquaculture

There is no specific information in the NASO and PAFAD country studies on how benefits from aquaculture are distributed.

#### 7.5 Involvement of women and children in aquaculture

Only 5–10 percent of all workers on fish farms are women. They work mainly in administration and as cooks or cleaning ladies in Bosnia and Herzegovina, Czech Republic, Serbia and Montenegro. The involvement of women in aquaculture is higher in Ukraine, where the share of women in the total employment in aquaculture is about 20 percent. In Moldavia, women work as accountants and as experts in various disciplines.

Estonia, as well as Russian Federation is somewhat different from other above mentioned CEE countries as far as the employment of women is concerned. In Estonia, for example, the

gender proportions in aquaculture are practically in equilibrium. In Russian Federation, women also play an important role in aquaculture production. Their ratio in some fish farms is up to 70 percent of the total staff. It is common that the owner or manager of a fish farm is a woman.

If the fish farm is a family enterprise, young family members eagerly participate in aquaculture operations. Because of their better knowledge of foreign languages and computers, they are of much help to parents in managing the farms and sometimes continue their education in universities in disciplines related to aquaculture. During summer holidays schoolchildren may also participate in fish farming activities. In most of CEE countries, children are not employed in aquaculture production, whereas in family-run farms children most probably help their parents with simple duties.

## **8. TRENDS, ISSUES AND DEVELOPMENT**

### **8.1 External and internal driving forces and reasons of main development trends in the sector**

The nineteen countries of CEE region have common background regarding the development of their economies in the last sixty years. Accordingly the background and foundation of the development of their aquaculture sector has also some uniform features. These are the strong centralized socialist economy in the past, which prioritized quantity against quality, the contradicting sometimes difficult processes of privatization of aquaculture facilities and the long, still ongoing transition period to introduce modern capitalist market economy.

Some CEE countries have already formulated their national fisheries or aquaculture development strategies and programs, but their implementation is delayed due to lack of funds.

The tough reforms of the old administration in the sector resulted in the establishment of practically new institutional, administrative and regulatory systems in many of CEE countries. However, aquaculture-specific legal provisions are not being developed or not yet implemented hence aquaculture is relatively unregulated in some countries.

Institutional frameworks are highly inefficient in some countries, like in Serbia and Montenegro, or Bosnia and Herzegovina, where there are many line agencies replicated in both districts and provinces. Institutional changes such as adjustment of the objectives of existing old institutions to the changed circumstances and establishment of new institutions where they were missing also constituted significant driving forces and reasons of main development trends in the aquaculture sector.

Social aspects are also very important determining factors of the sector's development. The changing economy resulted in the redundancy of many of the people, who earlier were employed at state owned companies. In addition to the transition to capitalist market economy, the mentality and values of many people in CEE countries are also undergoing a transition, particularly when not only learned and accepted values and moral attitudes, but also previously received skills and practices proved to be useless, forcing many people into skepticism.

The changing, often low-price oriented demand by many consumers and the opening of the national markets for imported aquaculture products are also very significant factors, which

determined both the development and competitiveness of the aquaculture sector in the different CEE countries. Generally, increasingly wealthy urban consumers can afford buying fish products, including high-value aquaculture products, whereas rural population in some areas faces reduced access to affordable fish (e.g. Hungary and Russian Federation).

The rising environmental awareness and the increasing strictness of rules and regulations focusing on environmental protection in general and on sustainable water use in particular are significant driving forces and reasons of main development trends in the sector. The environmental fees and penalties are targeting specifically aquaculture and high charges for water use. These charges are increasing significantly the production costs, which drives the development toward environment friendly and water efficient aquaculture systems.

Carp polyculture in ponds is dominant in the region. The facilities of this aquaculture production system are in poor condition, under-equipped and oversized in many CEE countries, therefore there is need for rehabilitation and modernization of existing farms. The lack of funds required for rehabilitation of old facilities, replacement of outdated equipment and adoption of new production systems with advanced technologies is delaying expected success.

The importance of fry and fingerling production for stocking natural or artificial water bodies in order to improve the conditions of recreational and commercial fisheries is increasing. There is strong demand for seed by anglers in Hungary, Slovakia, the Czech Republic and Poland and by commercial fishermen in the Russian Federation, Ukraine, and Belarus.

There are various levels of biodiversity protection measures, in particular as regards stocking of alien species in natural waters. Therefore the hatchery production of indigenous non-commercial species is a growing trend for conservation purposes (e.g. Belarus, Czech Republic).

There is an insufficient supply of locally produced stocking material of improved/high quality of the main commercial marine aquatic species (e.g. Albania, Bulgaria and Croatia).

Apart from carp polyculture technologies, advanced pond aquaculture production technologies are not well known by many farmers or there is a reluctance to apply them. A high quality environment friendly aqua-feed production industry is practically non-existent in the CEE region. The fish processing industry and marketing, including modern promotion, is less known and established but improving.

Staff qualified in farm management and operation is missing in some countries, and the skills and commitment of employees should also be improved.

## **8.2 Main development trends in the sector**

### ***8.2.1 Growth of aquaculture production***

There has been a steady growth in world aquaculture production over the past ten years. The growth pattern of aquaculture production in CEE region is different from the global trends.

Generally, in the CEE region, the production volume of capture fisheries increased until the 1990s, while aquaculture production was on a very low level until the second half of 1980s then it started to grow. In the 1990s, a dramatic decline started both in capture fisheries and



aquaculture. The drop of the production of capture fisheries was a result of the political and economical changes in the early nineties and the consequent difficulties to maintain and operate the fishing fleets. The increasingly strict regulations and the general public concern also affected the production of the fisheries industry. At the same time recreational fisheries are becoming more dominant in freshwater fisheries.

While the volume of capture fisheries is still on decline, there is a gradual increase in aquaculture production since 1996. Still, the production level in 2003 was below the results of 1993 and it was only about 50 percent of the peak production level of 1990 (Figure 5). However, comparing aquaculture production data of 1996 and 2005 shows that in that decade there has been an increase in total regional production from 177 000 to 267 000 tonnes.<sup>4</sup>

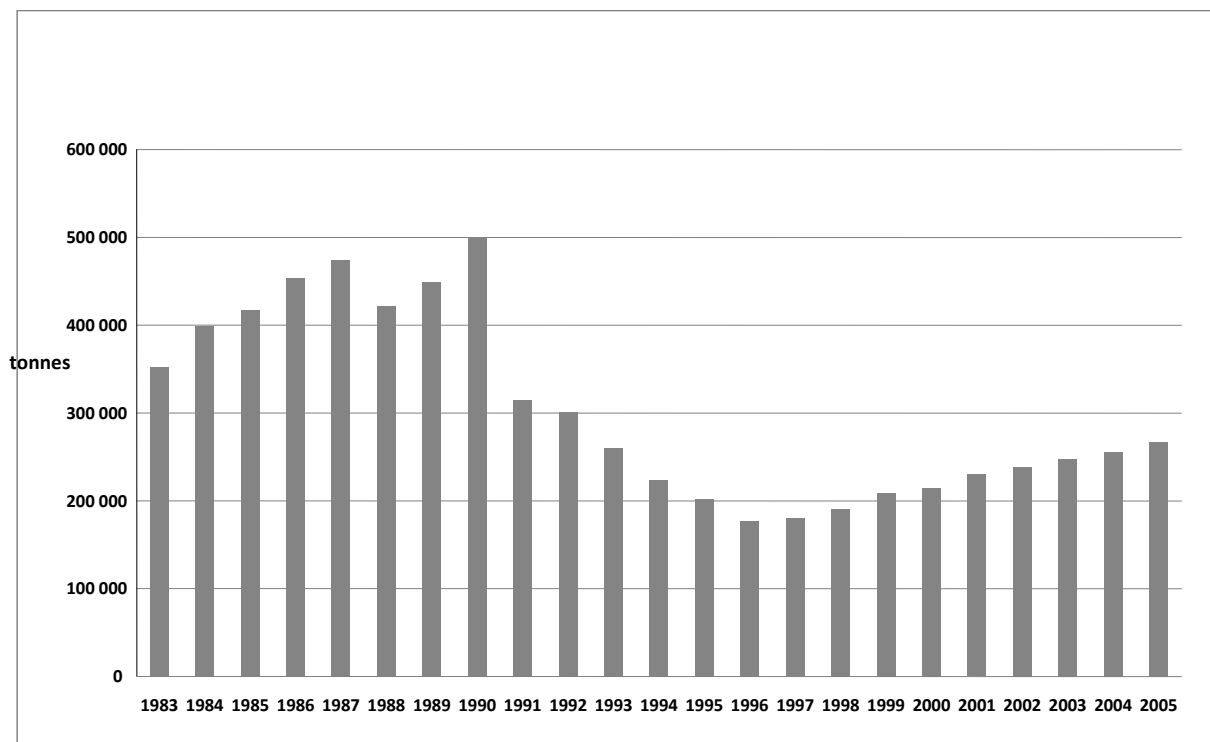


Figure 5. Aquaculture production in CEE countries, 1983-2005 (source: Fishstat Plus, 2006)

### 8.2.2 Utilization of water resources

In Table 20 some relative aquaculture production indicators are compared between Western and Central and Eastern Europe for the year 2003. It is an attempt to characterize the utilization of resources for aquaculture production in these regions.

The low exploitation of marine resources are indicated by the low marine aquaculture production per 1 km length coastline in Central and Eastern Europe, which is only 0.37 tonnes/km against the 17.9 tonnes/km in Western Europe.

<sup>4</sup> The changes in the CEE region also had an impact on statistics both in terms of changes of datasets due to the division of countries and also in terms of accuracy. In spite of these uncertainties Figure 5 illustrates well the regional production trend over a long period such as 1983-2005. It should be noted however that the aquaculture production data of the Caucasian and the Asian countries in the FishStat Plus dataset for "Former USSR area" cannot be separated from other European countries of the region. Thus the production of these non-European countries is included in the dataset until 1987. The production in these non-European countries of the former USSR was about 13 percent of the total aquaculture production of the former USSR region in 1988.

It can also be seen, however, that the utilization of the available annual renewable water resources (ARWR) for freshwater aquaculture production is about the same in both main European regions, even if these resources are not all actually used or not effectively used. The specific freshwater fish production per ARWR is practically the same in Western Europe and Central and Eastern Europe, which implies that there is an equal potential or possibility to use and further utilize the available ARWR in both regions.

**Table 20. Comparison of some relative aquaculture production indicators in Western and in Central and Eastern Europe in 2003** (source: adapted from AQUASTAT, 2005 and FAO FISHSTAT Plus 2005)

Indicator	Western Europe	Central and Eastern Europe
Per caput marine aquaculture production (kg/cap)	4.35	0.019
Per caput freshwater aquaculture production (kg/cap)	0.59	0.71
Marine aquaculture production relative to coastline length (t/km coastline)	17.9	0.37 <sup>1</sup>
Freshwater aquaculture production relative to available ARWR (t/km <sup>3</sup> ARWR)	112.3	112.4 <sup>1</sup>

<sup>1</sup> Without data from the Russian Federation

If it was assumed that freshwater and marine resources have been exploited better in the more developed countries of Western Europe, then it may be concluded hypothetically that the development of marine aquaculture in Central and Eastern Europe in the future has a better potential, even if the differences in geographic and climatic conditions were taken into account.

### **8.2.3 Production systems**

Even if the indicators on the use of freshwater resources were similar both in Western Europe and Central and Eastern Europe, there are significant differences in the production systems and cultured species. Trout production in flow-through systems is dominant in Western Europe, and this type of aquaculture provided 77 percent of the total freshwater production in this region in 2003. In Eastern Europe, however, in 2003 about 82 percent of the total freshwater production was based on various carp species, which were cultivated mainly in extensive and semi-intensive ponds. No trend can be discerned which would show that there will be changes of this described situation in the coming years.

### **8.2.4 Market**

Markets have become the driving force of aquaculture development in Central and Eastern Europe since the early nineties. However, market orientation of some farms is slow and aquaculture development is highly dependent on the overall economic situation and political decisions in a given country.

### **8.2.5 The role of aquaculture in the rural economy**

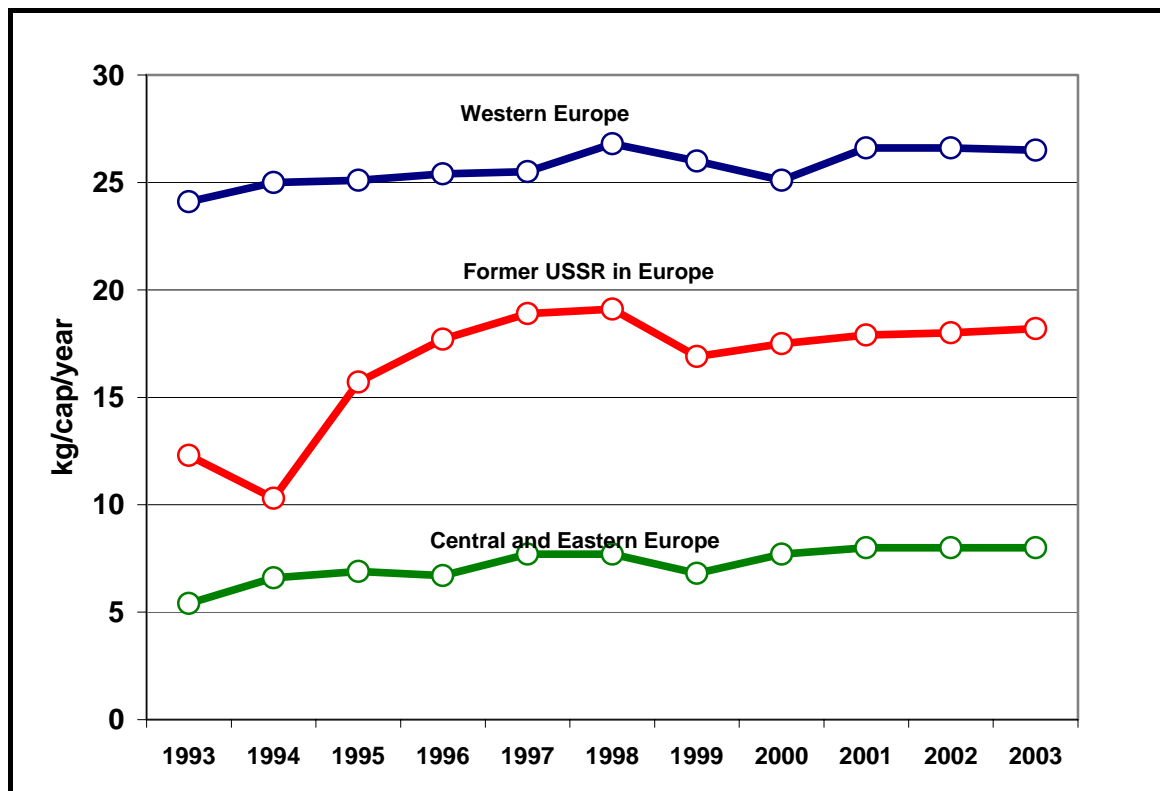
The available NASO and PAFAD country studies indicate that the contribution of aquaculture production to the national economy in countries of Central and Eastern Europe is not very considerable because – in purely economic terms – aquaculture is only a minor component of the national economy in all CEE countries.

However, when the role of aquaculture in the national economy is evaluated one has to take into account that a major part of aquaculture production in Central and Eastern Europe comes from earthen fish ponds, which play a special role in the agro-ecosystem of rural areas. This special role includes various services for the environment, water management and tourism. These services can provide additional income to the farmers in addition to income from fish farming.

Unfortunately, pond aquaculture is not always acknowledged as an element of “rurality” besides agriculture and forestry. There is a need for awareness campaigns and better communication with people and policy-makers in order to get pond aquaculture acknowledged as an important element of the rural economy in Central and Eastern Europe.

### **8.2.6 Contribution of aquaculture to the better fish supply of local population**

Although fish is a traditional food item in various parts of Central and Eastern Europe, fish consumption is relatively high only in certain regions close to water resources and is often linked to religious holidays like Christmas and Lent. The overall fish consumption in CEE countries is strikingly low compared to fish consumption in Western Europe (Figure 6).



**Figure 6: Fish consumption in Western and Eastern Europe during 1993–2003** (source: adapted from FAOSTAT database, 2005; accessed March 2006)

Measures to increase fish consumption could be important driving forces of aquaculture development in Central and Eastern Europe however local fish products should be competitive in quality and price with imported products, which are supplied to the local markets in an increasing rate through super- and hypermarkets.

To improve competitiveness is a major challenge for the aquaculture industry in Central and Eastern Europe, which requires not only research, development, training and investments, but there is also a need to change the attitude of many farmers towards being more innovative and cooperative.

### ***8.2.7 Development of aquaculture technologies***

#### *Pond aquaculture*

The modernization of the dominant traditional pond fish production has several elements, among them intensification. However, intensification can not be applied to most or all of the pond fish farms. Intensity of production can only be increased in some of the small sized ponds, where adequate conditions for controlling environmental parameters (e.g. water quality, oxygen level in the ponds, bio-manipulation and nutrient management, effluent treatment) are both present as well as economically viable and profitable.

The introduction and dissemination of non-conventional fish pond technologies is another important element in the development of pond fish production in Central and Eastern Europe. The research and development work should focus on the elaboration of such technologies (like Partitioned Aquaculture Systems; Combined Extensive-Intensive Systems; Minimal Discharge Systems) in the future. In these systems only a small part of the water surface area will be used for intensive production of conventional and non-conventional species, while the larger part of the water surface will be utilized for water treatment and for ecological services (habitat management and restoration, maintenance of biodiversity), water management and tourism.

Fish ponds also offer excellent conditions for organic fish production, which may offer opportunities for many fish farmers to export their organic products to solvent markets in general and to the European niche market in particular. There is a need, however, to develop organic fish standards (which presently are available only in Hungary) and harmonize them with other relevant standards.

The production of freshwater crayfish is another future opportunity in many countries in Central and Eastern Europe.

#### *Intensive freshwater aquaculture*

There is a small trout production sector in most of the Central and Eastern European countries, which provides a good basis for further development of the sector mainly for supplying fresh fish to local markets and restaurants. Although the development of recirculation technology and the application of water-efficient and environment friendly Recirculation Aquaculture Systems (RAS) is a priority area of sustainable aquaculture development in Western Europe, production in such systems is still negligible in Central and Eastern parts of Europe. The main obstacle of the development of RAS in the region is the lack of funds for investments and operation. There are, however, locations (e.g. with abundant geothermal water resources) where the establishment of such systems may be feasible for the production of high value species. Cage culture of some species with high market value can also be an alternative of aquaculture development in some freshwater areas (e.g. in large rivers like Volga or in reservoirs like in Bulgaria), where certain level of cage fish culture is already practised.

*Marine aquaculture*

The marine resources suitable for aquaculture production in Central and Eastern Europe are very far from optimal exploitation. The development of marine aquaculture seems to be a potential development area in those CEE countries, where such sites are available (HAKI, 1999 and 2000). The growth of tuna production in Croatia is a good example for the recent developments in marine aquaculture, where the yearly production of this species increased from 672 tonnes up to 3 971 tonnes between 1999 and 2002 and production still continues to grow. The export of farmed tuna from Croatia accounts for more than 74 percent of total fish exports in 2003 (Piria, 2005). Exploration of new opportunities in marine aquaculture has been started in some other countries of the region like in Bulgaria, where two farms started seaweed production in 2005.

## 9. REFERENCES

- Békefi, E., Lengyel, P. & Váradi, L. 2004.** Review of Fish Producers Associations in Eastern Europe. Rome, FAO. FAO Aquaculture Newsletter No. 31: 12-16.
- Békefi, E., Lengyel, P. & Váradi, L. 2006.** Review of Producers Associations and their Role in Aquaculture Development in Eastern Europe, pp. 51-55. In: European Inland Fisheries Advisory Commission, 2006. Report and Proceedings of the EIFAC Symposium on Aquaculture Development – Partnership between Science and Producers Associations. Wierzba, Poland, 26-29 May 2004, held in connection with the twenty-third EIFAC Session, 26 May – 2 June 2004. *EIFAC Occasional Paper*. No. 37, Rome, FAO. 2006. 136p.
- Commission of the European Communities. 2002.** *A strategy for the sustainable development of European aquaculture*. COM(2002) 511 final, 26 pp.. Available at: <[http://www.europa.eu.int/eur-lex/en/com/cnc/2002/com2002\\_0511en01.pdf](http://www.europa.eu.int/eur-lex/en/com/cnc/2002/com2002_0511en01.pdf)>
- European Inland Fisheries Advisory Commission (EIFAC). 2001.** Report of the Ad Hoc EIFAC/EC Working Party on Market Perspectives for European Freshwater Aquaculture. Brussels, Belgium, 14-16 May 2001. *EIFAC Occasional Paper*. No. 35. Rome, FAO. 2001. 142p. <ftp://ftp.fao.org/docrep/fao/004/y2792e/y2792e00.pdf>
- Failler, P. 2003.** Fish Consumption in the European Union in 2015 and 2030. In cooperation with G. Van de Walle, N. Lecrivain, A. Himbes and R. Lewins. Report prepared for the FAO Fisheries Department. Centre for the Economics and Management of Aquatic Resources, Department of Economy, University of Portsmouth, United Kingdom. FAO, Rome. Part I and Part II, 205p and 405p.
- Failler, P. & Lecrivain, N. 2003.** Future Fish Consumption in the European Union in 2030. XV EAFE Conference, Ifremer, Brest, 14-16 May, 2003. Session 11. Seafood chain, markets and consumption, pp. 1-10. <http://www.ifremer.fr/eafe/pdf/session%2011.pdf>
- HAKI. 1999.** Regional Review on Trends of Aquaculture Development in Europe. Fish Culture Research Institute (HAKI), Szarvas, Hungary. 237 p. <ftp://ftp.fao.org/fi/document/eifac/SubComII/europe/europe.pdf>
- HAKI. 2000.** Regional Review on Trends of Aquaculture Development in the Former USSR countries. Fish Culture Research Institute (HAKI), Szarvas, Hungary. 87 p. <ftp://ftp.fao.org/fi/document/eifac/SubComII/exussr/exussr.pdf>
- Huet, M. 1972.** Textbook of Fish Culture, Breeding and Cultivation of Fish, Fishing News (Books) Ltd., London
- Szücs, I. 2002.** A halászati ágazat gazdasági, szervezeti és piaci kérdései, Szaktudás Kiadó Ház, (Economic, structural and market issues of the fish production sector) Knowledge Publishing House, Budapest.
- Tacon, A. 2005.** Compilation of statistical data on aquaculture and fisheries in Central and Eastern Europe from FAO Fishstat Plus 2005 (manuscript prepared in support of preparation of FAO National and Regional Aquaculture Reviews)

**UN, 2006.** Demographic Yearbook 2003. Fifty-fifth issue. ST/ESA/STAT/SER.R/34. New York, United Nations Statistics Division. 829 p.  
<http://unstats.un.org/unsd/demographic/products/dyb/dyb2003.htm>  
<http://unstats.un.org/unsd/demographic/products/dyb/dybsets/2003%20DYB.pdf>

**UNDP, 2005.** Human Development Report 2005. United Nations Development Programme, New York. 338 p. <http://hdr.undp.org/reports/global/2005/>  
[http://hdr.undp.org/reports/global/2005/pdf/HDR05\\_complete.pdf](http://hdr.undp.org/reports/global/2005/pdf/HDR05_complete.pdf)  
<http://www.sd.undp.org/HDR/HDR05e.pdf>

**Váradi, L. 2000.** Responsible management of inland waters for fisheries and aquaculture. Keynote Lecture presented at the International Conference AQUA 2000, May 2-6, 2000, Nice, France

**Váradi, L. 2002.** Results and experiences of the operation of a combined intensive-extensive pond fish production system in Hungary. Pond Aquaculture in Central and Eastern Europe in the 21<sup>st</sup> Century, Manuscripts presented at the international workshop, Vodnany, Czech Republic, May 2-4, 2001. 79-83.

**Váradi, L., Blokhin, S., Pekar, F., Szucs, I. & Csavas, I. 2001a.** Aquaculture development trends in the countries of the former USSR area. In R.P. Subasinghe, P. Bueno, M.J. Phillips, C. Hough, S.E. McGladdery & J.R. Arthur, eds. Aquaculture in the Third Millennium. Technical Proceedings of the Conference on Aquaculture in the Third Millennium, Bangkok, Thailand, 20-25 February 2000. pp.417-429. NACA, Bangkok and FAO, Rome.  
<http://www.fao.org/docrep/003/AB412E/ab412e25.htm>

**Váradi, L., Blokhin, S., Pekar, F., Szucs, I., & Csavas, I. 2001b.** Aquaculture development trends in Europe. In R.P. Subasinghe, P. Bueno, M.J. Phillips, C. Hough, S.E. McGladdery & J.R. Arthur, eds. Aquaculture in the Third Millennium. Technical Proceedings of the Conference on Aquaculture in the Third Millennium, Bangkok, Thailand, 20-25 February 2000. pp. 397-416. NACA, Bangkok and FAO, Rome.  
<http://www.fao.org/docrep/003/AB412E/ab412e24.htm>

## **NASO-PAFAD COUNTRY STUDY REPORTS (2005 – 2006) REFERRED TO IN THIS REGIONAL REVIEW.**

**Adámek, Z. 2005.** NASO-PAFAD study reports of Czech Republic.

**Békefi, E. 2005.** Prospective Analysis Future Aquaculture Development (PAFAD) study reports of Hungary.

**Békefi, E. 2005.** National Aquaculture Sector Overview (NASO) study report of Hungary.

**Bekh, V. 2006.** National Aquaculture Sector Overview (NASO) study report of Ukraine.

**Bekh, V. 2006.** Prospective Analysis Future Aquaculture Development (PAFAD) study report of Ukraine.

**Bogeruk, A. 2005.** National Aquaculture Sector Overview (NASO) study report of Russian Federation.

**Cobani, M. 2005.** National Aquaculture Sector Overview (NASO) study report of Albania.

**Cobani, M. 2005.** Prospective Analysis Future Aquaculture Development (PAFAD) study report of Albania.

**Cristea, V. & Patriche, N. 2005.** National Aquaculture Sector Overview (NASO) study report of Romania.

- Hamzic, A. 2005.** Prospective Analysis Future Aquaculture Development (PAFAD) study report of Bosnia and Herzegovina.
- Hamzic, A. 2005.** – National Aquaculture Sector Overview (NASO) study report of Bosnia and Herzegovina.
- Hubenova, T. 2005.** National Aquaculture Sector Overview (NASO) and Prospective Analysis Future Aquaculture Development (PAFAD) study reports of Bulgaria.
- Koustousov, V. 2005.** National aquaculture Sector Overview (NASO) and Prospective Analysis Future Aquaculture Development (PAFAD) study reports of Belarus.
- Markovic, Z. & Poleksic, V. 2005.** National Aquaculture Sector Overview (NASO) study reports of Serbia and Montenegro.
- Markovic, Z. & Poleksic, V. 2005.** Prospective Analysis Future Aquaculture Development (PAFAD) study reports of Serbia and Montenegro.
- Paaver, T. 2006.** National Aquaculture Sector Overview (NASO) study report of Estonia.
- Paaver, T. 2006.** Prospective Analysis Future Aquaculture Development (PAFAD) study report of Estonia.
- Piria, M. 2005.** National Aquaculture Sector Overview (NASO) study report of Croatia.
- Piria, M. 2005.** Prospective Analysis Future Aquaculture Development (PAFAD) study reports of Croatia.
- Podgornik, S. 2005.** National Aquaculture Sector Overview (NASO) and Prospective Analysis Future Aquaculture Development (PAFAD) study reports of Slovenia.
- Poviliunas, J. 2006.** National Aquaculture Sector Overview (NASO) study report of Lithuania.
- Poviliunas, J. 2006.** Prospective Analysis Future Aquaculture Development (PAFAD) study reports of Lithuania.
- Regenda, J. 2005.** National Aquaculture Sector Overview (NASO) study report of Slovakia.
- Spirkovski, Z. 2005.** National Aquaculture Sector Overview (NASO) study report of The former Yugoslav Republic of Macedonia.
- Spirkovski, Z. 2005.** Prospective Analysis Future Aquaculture Development (PAFAD) study report of The former Yugoslav Republic of Macedonia.
- Zakeš, Z. 2005.** National Aquaculture Sector Overview (NASO) study report of Poland.
- Zubcov, E. 2005.** National aquaculture Sector Overview (NASO) and Prospective Analysis Future Aquaculture Development (PAFAD) study reports of Moldova.

**Note:** FAO NASO study reports for 83 countries are available at:  
<http://www.fao.org/fi/website/FISearch.do?dom=countrysector>

## WEB SITES

- CIA.** The World Factbook. US Central Intelligence Agency.  
<http://www.cia.gov/cia/publications/Factbook/index.html>;  
<https://www.cia.gov/library/publications/the-world-factbook/index.html>
- EU.** Environment. [http://europa.eu.int/comm/environment/ecolabel/index\\_en.htm](http://europa.eu.int/comm/environment/ecolabel/index_en.htm)
- EUROSTAT.**  
[http://epp.eurostat.cec.eu.int/portal/page?\\_pageid=1090,1&\\_dad=portal&\\_schema=PORTAL](http://epp.eurostat.cec.eu.int/portal/page?_pageid=1090,1&_dad=portal&_schema=PORTAL)
- FAO AQUASTAT.** <http://www.fao.org/ag/agl/aglw/aquastat/main/>
- FAO FISHSTAT.** Plus. <http://www.fao.org/fi/statist/FISOFT/FISHPLUS.asp>
- FAOSTAT.** <http://faostat.fao.org/faostat/collections?subset=nutrition>
- FIN.** Fishmeal Information Network. <http://www.gafta.com/fin/finfacts6b.html>
- Human Development Indicators.** <http://hdr.undp.org/statistics/data/>
- United Nations Commission on Sustainable Development,** Background papers.



<http://www.un.org/documents/ecosoc/cn17/1996/background/ecn171996-bp8.htm>  
**United Nations Statistics Division.** <http://unstats.un.org/unsd/default.htm>  
**World Development Indicators.** <http://devdata.worldbank.org/data-query/>  
**WRI Earthtrends World Resources Institute.** <http://www.earthtrends.wri.org>



## **PART II**

# **REPORT OF THE FAO EXPERT WORKSHOP ON REGIONAL AQUACULTURE REVIEW IN CENTRAL AND EASTERN EUROPE**

Astrakhan, Russian Federation, 5-7 September 2005

in collaboration with

the Network of Aquaculture Centres in Central  
and Eastern Europe (NACEE)

and

the Pedigree Fish Breeding Center – Moscow Branch of the  
Federal Center of Fish Genetics and Selection

hosted by

the BIOS Research and Production Center for Sturgeon Breeding



## **PART II**

### **REPORT OF THE FAO EXPERT WORKSHOP ON REGIONAL AQUACULTURE REVIEW IN CENTRAL AND EASTERN EUROPE**

Astrakhan, Russian Federation, 5–7 September 2005

in collaboration with  
the Network of Aquaculture Centres in  
Central and Eastern Europe (NACEE)  
and  
the Pedigree Fish Breeding Center – Moscow Branch of the  
Federal Center of Fish Genetics and Selection  
hosted by  
the BIOS Research and Production Center for Sturgeon Breeding

1. The “BIOS” Research and Production Center for Sturgeon Breeding in Astrakhan hosted the FAO Expert Workshop on Regional Aquaculture Review in Central and Eastern Europe, which was organized by FAO’s Inland Water Resources and Aquaculture Service (FIRI) in collaboration with the Research Institute for Fisheries, Aquaculture and Irrigation (HAKI), Szarvas, Hungary, as coordinating institution of the Network of Aquaculture Centers in Central and Eastern Europe (NACEE), and the Pedigree Fish Breeding Center – Moscow Branch of the Federal Center of Fish Genetics and Selection.

2. The prospectus and the detailed programme of the workshop are included in Annex 1. The Expert Workshop was attended by 44 participants from 13 countries. Experts of international organizations such as the European Aquaculture Society (EAS), EUROFISH and the Network of Aquaculture Centres in Asia-Pacific (NACA) also participated (Annex 2 contains the list of participants).

#### **OPENING CEREMONY**

3. The participants were welcomed by the Governor of the Astrakhan Region, Mr Aleksandr Zhilkin, who emphasized the importance of aquaculture in saving the declining natural fish resources and underlined the achievements of Astrakhan Region in replenishment of sturgeon stocks. In addition to these important tasks, aquaculture development also contributes to poverty reduction of the rural population. He recognized the importance of FAO holding this expert meeting in Astrakhan for the first time in Russian Federation.

4. Mr Jiansan Jia, Chief of the Inland Water Resources and Aquaculture Service of FAO Fisheries Department, also welcomed the participants and appreciated the organizational efforts by the Host organization “BIOS”, the Pedigree Fish Breeding Center (Moscow), NACEE members and especially HAKI. He emphasized the significance of this Expert Meeting in the context of FAO’s efforts of Regional and Global Aquaculture Reviews, which are based on the recommendations of the COFI Sub-Committee on Aquaculture.

5. Mr Andrey Bogeruk, Director of the Pedigree Fish Breeding Center, conveyed the words of greeting of Mr Aleksey Gordeev, Minister of Agriculture of the Russian Federation, to the participants. Recognizing the stagnating fish supply by capture fisheries, the Minister stressed the vast potential for aquaculture development in many areas of the Russian Federation.

6. Mr Vasiliy Glushchenko, Chairman of the Executive Committee of “Rosrybkhoz”, referred to the Aquaculture Development Program of the Russian Federation that envisages doubling of the aquaculture production by year 2010. He drew the attention of the participants to the fact that Russian Federation intends to host the World Aquaculture Exhibition in 2010 or 2012. He also requested support and participation by NACEE and FAO in this event.

7. Ms Zinaida Sergieva, Representative of the Federal Fishery Agency, expressed her hope that the meetings would be fruitful and beneficial for promotion of research and development towards the sustainable aquaculture development.

8. Mr László Váradi, Director General of HAKI, the coordinating institution of NACEE, made a brief overview of the development of NACEE during the last year, noting that it has been acknowledged as a major aquaculture network in Europe, and reiterated the NACEE's guiding principle of making “small steps in the right direction”.

9. On behalf of NACA, Mr Le Thanh Luu said that before the establishment of NACEE, NACA already had a good tradition of cooperating with eastern European institutions and welcomed the opportunity of enhancing the collaboration through NACA-NACEE partnerships.

10. Ms Lidiya Vasilyeva, Director of “BIOS” Research and Production Center for Sturgeon Breeding, warmly welcomed the participants wishing them useful discussions and a pleasant stay in Astrakhan.

#### **PRESENTATION AND DISCUSSION OF COUNTRY REVIEWS**

11. The session was chaired by Ms Lidiya Vasilyeva and Mr Zdenek Adámek. Mr László Váradi and Mr Jiansan Jia gave a short introduction on the origins and purpose of this Expert Meeting. The presentation and discussion of the country reviews (NASO/PAFAD studies) should contribute to a better understanding of status and trends of aquaculture development both in individual countries as well as in the Region as a whole. These country reviews were analyzed, summarized and synthesized into the draft Regional Review. Both the individual country reviews and the Regional Review are important components in the overall process of preparing Regional and Global Reviews, as being undertaken in various regions of the world. These outputs will be presented at the third session of the FAO COFI Sub-Committee on Aquaculture to be held in September 2006 in India.

12. Thirteen country reviews were presented and discussed (Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Hungary, Moldova, Poland, Russian Federation, Serbia and Montenegro, Slovakia and Ukraine).

13. The participants recognized that the following issues, problems, constraints, trends are typical and common to all the countries in the region:

- predominance of carp production in aquaculture;
- decline in aquaculture production after the social and economic changes in Eastern Europe (aquaculture in Poland and Czech Republic did not experience a significant negative effect);
- still very few intensive systems; however, a trend for intensification of biotechnological processes is visible, in particular in the production of high-value species;

- very low production levels from coastal and marine areas. Mariculture is in many cases in early stages of development;
- production facilities are in poor condition, under-equipped, ill-designed, oversized, etc. need for rehabilitation and modernization of existing farms;
- very low and inefficient current level of resource exploitation (e.g. land, water, labor). Huge potential for further development, expansion, diversification and specialization of farming systems and production practices;
- lack of staff qualified in farm management and operation in some countries;
- financial problems due to changes in ownership structure;
- poaching/theft causes significant losses both to natural fish resources and aquaculture;
- different levels of privatization, resulting sometimes in unclarity of ownership;
- low or declining production of aquafeeds within the countries and growing dependence on aquafeed supply from abroad;
- underdeveloped processing industry;
- breakdown of networks and chains of supply of information, raw materials, fish stocking material, technologies, exchange of specialists, training and education etc. This breakdown was due to the disintegration of formerly existing state, political, economic, institutional structures and bodies;
- contribution of aquaculture to national economy is low in terms of value;
- start-up difficulties for new aquaculture establishments;
- a major problem is not to produce but to sell fish due to low capacity for distribution and marketing of aquaculture products. Difficulties in establishing and maintaining export markets. Lack of information and low recognition of consumer preferences both in domestic and export markets;
- different levels of stringency and application of regulations and standards on food quality and safety, production management and environmental protection. This applies to issues of international markets and trade within Europe and beyond;
- lack of institutional and policy recognition of aquaculture among decision-makers and administrations;
- severe financial problems in research and academic institutions leading to stagnation of technology development and reduced ability to respond to the needs of the production sector;
- increasing awareness of environmental issues and increasing conflicts with environmental protection groups. Possible risks of intensification (e.g. eutrophication) and introduction of alien species. Opportunities for multiple use of environmental resources (combined agri-aquaculture systems), conservation of endangered species, development of eco-tourism;
- consumers prefer fish grown in unpolluted water and controlled aquaculture conditions, especially after pollution incidents in major freshwater bodies, which have increased contamination of tissues of natural fish populations to toxicants.

14. The following issues and trends were reported to be common for a number of countries:

- very significant production of fry and fingerlings for stocking seed into natural or artificial water bodies for purposes of recreational and culture-based fisheries; strong demand for seed resources by anglers in Slovakia, the Czech Republic, Poland, etc.; culture-based fisheries in the Russian Federation, Ukraine, Belarus;
- insufficient supply of locally produced stocking material of improved/high quality of the main commercial species (e.g. Albania, Bulgaria, Croatia);
- some countries have already formulated their national fisheries or aquaculture development programmes, but their implementation is sometimes delayed due to lack of funds;
- differing levels of biodiversity protection measures, in particular as regards stocking of alien species in natural waters;
- significant consideration of genetic diversity of autochthonous salmonids, e.g. Bosnia and Herzegovina;
- increasing concern over the environmental impact of cage aquaculture;
- combined efforts of aquatic habitat rehabilitation and stocking of aquaculture-raised seed for conservation purposes (e.g. Belarus, Czech Republic);
- aquaculture-specific legal provisions are not being developed or not yet implemented; unregulated aquaculture development (farms operating without licenses);
- generally, increasingly wealthy urban consumers can afford buying fish products, including high-value aquaculture products, whereas rural population in some areas faces reduced access to affordable fish (e.g. Russian Federation, Belarus);
- highly inefficient institutional framework, e.g. Serbia and Montenegro, Bosnia and Herzegovina, where there are many line agencies replicated in both districts or cantons;
- privatization as a very significant process leading to reorganization and success of the aquaculture industry;
- multifunctional use of ponds (water management, recreation, ecotourism, nature reserves) in many countries;
- ornamental fish production (the Czech Republic and Slovakia);
- very severe problems with nuisance species, in particular, bird predation and concomitantly, inexistent or inefficient compensation schemes for the losses suffered;
- high charges for water use increasing significantly the production costs;
- environmental fees and penalties targeting specifically aquaculture.

15. The session was concluded by Mr László Váradi who briefly summarized the main findings, highlighting in particular the need to focus more on consumer demand, the uncertainties of the market and on identifying the strengths in order to remain competitive on the world market.



## **PRESENTATION AND DISCUSSION OF THE DRAFT REGIONAL REVIEW AND SYNTHESIS DOCUMENT**

16. The session was chaired by Ms Tania Hubenova and Mr Nikolay Grinzhevsky. Mr László Váradi gave a presentation on the contents of the draft regional review and synthesis document. This document had been prepared by the HAKI team, based on the analysis of NASO-PAFAD country reports received from the participating authors and institutes in the various central and eastern European countries. With the exception of the report expected from Latvia, all 18 other country authors submitted their reports.

17. In discussing the presented statistics of fish and meat supply of central and eastern Europe, the participants recognized inconsistencies in the data presented as well as the importance of appropriate methodologies in the collection of statistical data. It was emphasized that data and statistics are very important for analysis and planning of aquaculture development. Data provided by governments to FAO may well be inaccurate and additional sources of data on production, supply and consumption of fish and fishery products should be consulted. Mr Jia (FAO) confirmed that FAO is both aware and concerned about the accuracy of aquaculture statistics and that every effort is made by FAO to improve official global aquaculture data collection and information about apparent fish consumption.

18. The presentation by Mr Váradi followed the structure of the draft review document which had been prepared based on the terms of reference given by FAO. In the following, the main highlights of the discussions and suggestions by the participants for inclusion into the draft review are summarized under each heading of this structure:

### ***Characteristics and the structure of the sector***

- In addition to production for food, aquaculture is also important for stocking of natural water bodies.
- While carp production dominates in the region, production of salmonids and other species can be significant in some countries and regions.
- The sector continues to be highly dependent on supply of good quality seeds and feeds; economic efficiency in the use of these resources must be considered for all systems, including intensive and “organic” farming.
- Producers should inform consumers about the production process.

### ***Production, species and values***

- All major species should be referred to, not only carp and trout but also tuna, sturgeon, several coldwater species, as well as mariculture species.

### ***Economics and trade***

- Aquaculture can be very significant in development of some rural areas, and we should emphasize the rural, traditional and cultural characteristics of aquaculture.
- Production must address market demand. Marketing strategies should mainly focus on regional and local opportunities. New markets should be created.
- Investment needs and opportunities (including loans, credits and grants) should be defined in support of aquaculture development.

### ***Contribution to food security; access to food, nutrition and food safety***

- Many people cannot afford buying fish because it is too expensive in some areas.

### ***Environment and resources***

- While diseases in intensive systems are dangerous, the occurrence of the Koi Herpes virus in carp pond aquaculture of many countries and the risk of its spreading to neighbouring countries is of major concern.
- Hatchery capacity needs to be enhanced in terms of equipment, efficiency and ability to reproduce traditional and new species both in freshwaters and mariculture.
- Emphasis is to be given also to locally produced fish feeds as well as to natural feed ingredients.
- Positive functions of pond ecosystems and stocking in support of biodiversity conservation (protection of species and habitats) should be recognized.
- There are opportunities for cooperation and integration of aquaculture with agricultural practices (e.g. multiple purpose use of ponds in agro-ecosystems).
- Ecosystem approaches should include the use of different water bodies for culture-based fisheries.

### ***Legal, institutional and management aspects of the aquaculture sector***

- In many countries, there is a continuous need for the development of an appropriate legal and regulatory framework for aquaculture.
- Specific characteristics of aquaculture should be recognized by different institutions and public authorities, including agencies with mandate over fisheries, agriculture, water management, environmental protection and assurance of food safety.
- Financial institutions and insurance companies are often not aware of the specific characteristics of different aquaculture farming systems.

### ***Social impacts, employment and poverty reduction***

- Crisis in capture fisheries and related unemployment lead to poaching, whereas fishermen could find new jobs in aquaculture.
- There are needs and opportunities for human resource development including training, education, etc., for farm operators and farm managers.

### ***Trends, issues and development***

- Aquaculture is a significant contributor to rural development.
- Aquaculture is important for recovery of species diversity in natural water bodies.

## **DISCUSSION OF SELECTED KEY THEMES OF PRIORITY FOR THE CENTRAL AND EASTERN EUROPEAN REGION**

19. Four major thematic areas were identified for discussion by the participants. The experts provided comments, suggestions and additions to the following thematic areas:

### ***Policy framework, legislation, institutional systems (banking, insurance, etc.)***

- Should address different types of aquaculture (including pond aquaculture, culture-based fisheries, mariculture, intensive systems).

- Responsibility and mandate for aquaculture sector management is often unclear.
- The status of aquaculture is uncertain, especially during and after the transition period. Aquaculture should be recognized as legitimate and equal right user of resources and be eligible for institutional and financial support.
- There might be a need for a specialized agency for aquaculture as well as for specific legislation on aquaculture issues.
- National aquaculture development strategies must be developed with a view to providing enabling policy frameworks, including institutional recognition and adequate financial measures in support of aquaculture.

***Farming systems, species and technologies (environmental interactions, profitability, etc.)***

- The region has capacity and expertise for carp production, gene banking of carp, salmonids and sturgeons, and pond aquaculture technologies.
- Adequate and sufficient supply of seed and feed is indispensable for sustainable aquaculture.
- There are opportunities of further, more efficient farming system developments by combining traditional methods with high-tech systems.
- At the same time, rehabilitation and modernization of existing facilities and farms should also be based on continued increase of efficiency of aquaculture production, farm management and resource utilization.
- Continued R&D efforts with particular emphasis on efficiency and profitability aspects should help reduce production costs.

***Processing and marketing (consumers' demand, labeling, certification, quality schemes, etc.)***

- Aquaculturists are increasingly recognizing the importance of the market and the demand by consumers.
- Cross-cutting efforts in terms of research and education on market demand, efficient farm management and resource utilization should be included in aquaculture manpower development.
- Many non-European Union countries have to comply with European Union regulations and requirements associated with trade of aquaculture products. Assistance is required for many aquaculture sectors and authorities to meet these requirements and standards. The perception of unjustified and discriminatory trade barriers should be avoided.
- Organic fish farming might develop niche markets in some countries.

***Social aspects (food supply, employment, income generation, etc.)***

- Aquaculture can generate jobs and additional income in rural areas, either directly by on-farm employment or indirectly by attracting other investments and practices, e.g. tourism, angling.
- The image of aquaculture might benefit from awareness-raising initiatives, such as the European Aquaculture Day and special harvesting days open to the public.

## **INVITED PRESENTATIONS BY EXPERTS FROM INTERNATIONAL ORGANIZATIONS**

### **EAS (European Aquaculture Society) presented by Mr Johan Verreth**

20. The European Aquaculture Society (EAS; <http://www.easonline.org>) is a non-profit, member based organization that aims to promote contacts among all those involved in European aquaculture, to disseminate information relating to European aquaculture and to function as platform for discussion and networking. EAS has currently more than 500 members from about 60 countries, encompassing all sectors in the industry: scientists, policy-makers, small scale farmers, representatives of the larger industry conglomerates, and so on.

21. Through its activities, EAS has the ambition to contribute to the innovation agenda of European aquaculture. It organizes conferences on all major issues relevant to aquaculture (technical, environmental, and consumer related aspects) and regional and/or species oriented workshops, and disseminates information through its magazine, Aquaculture Europe, its website containing searchable databases (>300 project summaries, >500 contact details), etc. EAS is a leading stakeholder in European aquaculture. It also runs or coordinates several technical European projects in the area of aquaculture, usually funded by the European Union. For example, one of these projects (CONSENSUS) aims at developing standards for a sustainable aquaculture industry and involves the cooperation of all stakeholders in Europe.

22. EAS is willing to support the Network for Aquaculture in Central and Eastern Europe (NACEE) and is ready to explore the feasibility of several joint activities, for example, the organization of an Aquaculture Europe conference in a NACEE member country, the organization of specific workshops, such as on sturgeon aquaculture and/or conservation (among others) in the NACEE area, offering space in its magazine to NACEE related areas, enhanced student involvement and so on.

### **EUROFISH presented by Mme Anca Sfetcovici**

23. EUROFISH (<http://www.eurofish.dk>) is an international organization created to assist the fisheries and aquaculture sector in Central and Eastern Europe (CEE). EUROFISH provides information, advice and training in CEE, focusing on trade and markets, fish processing and aquaculture.

24. Publications and dissemination of information. EUROFISH produces regular and ad hoc specialized publications such as: EUROFISH Magazine (largest distributed trade magazine, produced in English, printed in 5000 copies and distributed mainly in Europe; it has regular features on processing, aquaculture, trade and markets, country profiles, including Central and Eastern Europe), the Russian Fish Report and the Factory Guides (Guide to Traceability, Guide to Seafood Hygiene Management). EUROFISH also promotes and distributes FAO-GLOBEFISH publications (commodity updates, research publications, etc). EUROFISH's website is also an important tool for promotion and dissemination of information.

25. Trade and markets. EUROFISH provides advice on trade development, market studies, match-making of exporters and importers, participation in international trade events, (co)organization of workshops, conferences, etc.

26. Projects and training. This involves identification of sector needs, donors and sponsors in Central and Eastern Europe as well as project and investment opportunities. EUROFISH is a disseminating partner in a series of large European Union projects but EUROFISH also manages smaller projects such as organization of traceability and food safety (HACCP) workshops.

27. EUROFISH is part of a worldwide network, the FISH INFO network (<http://www.fishinfonet.com>), working together with FAO-GLOBEFISH to support the fisheries in the less-developed areas of the world. EUROFISH has a series of working agreements with other organizations and governments in Europe, such as: EAS (European Aquaculture Society), SIPPO (Swiss Import Promotion Programme), HAKI (Research Institute for Fisheries, Aquaculture and Irrigation) and many others.

28. EUROFISH has currently nine member countries: Albania, Bulgaria, Croatia, Denmark, Latvia, Lithuania, Norway, Romania and Turkey. Several other European countries have expressed their interest in becoming EUROFISH members in the near future.

**NACA (Network of Aquaculture Centres in Asia-Pacific) presented by Mr Le Thanh Luu**

29. NACA member countries have contributed to about the 94 percent of the Asian aquaculture production. Aquaculture in the NACA member countries is most diversified in terms of species and culture systems, although, the main portion of aquaculture production comes from small scale farms. The rapid development of aquaculture in NACA member countries was due to high demand for food and food security needs in the region as well as due to strong support by government agencies, involvement of large number of households and private sector, and strong linkages between research, education and extension.

30. NACA (<http://www.enaca.org>) is an intergovernmental organization that promotes rural development through sustainable aquaculture. NACA seeks to improve rural income, increase food production and foreign exchange earnings and to diversify farm production. The ultimate beneficiaries of NACA activities are farmers and rural communities.

31. The core activities of NACA are:

- capacity building through education and training;
- collaborative research and development through networking among centers and people;
- development of information and communication networks;
- policy guidelines and support to policies and institutional capacities, and
- aquatic animal health and disease management.

32. The main scientific and technological areas where NACA and NACEE can collaborate include: genetics and biodiversity; aquatic animal health management; inland aquaculture; marine finfish aquaculture; integrated aquaculture; shrimp farming; the environment and trading and marketing.

## MAIN FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

33. The session was chaired by Mr Andrey Bogeruk and Mr Ryszard Kolman. In summarizing the discussions on key themes of priority areas for central and eastern European aquaculture, Mr L. Váradi invited the participants to consider all the discussions they had over the regional and national aquaculture reviews with a view to formulating conclusions and recommendations to different target groups including governments, producers, researchers, trade, press, the general public, etc. as regards the needs and opportunities for aquaculture in the region.

34. The meeting strongly recommended that the report of the expert workshop as well as the regional aquaculture review be sent to the government authorities and organizations concerned with aquaculture. The significance of aquaculture development for the central and eastern European region should be emphasized and recognized.

35. Several participants reiterated the significant problems with accuracy of statistical data and information of aquaculture, fisheries and fish consumption. Available data from FAO should be compared with data from other sources.

36. The legal and regulatory framework of aquaculture in many countries is still being developed and adapted to new social and economic conditions, following the transition into market economy. The aquaculture sector in some countries is still facing significant problems with insufficient, inadequate or lacking legislation specific to aquaculture. In some cases, there are unlicensed and unregulated aquaculture developments. Governments should pay particular attention to this issue.

37. Special attention should be given to environmental legislation addressing aquaculture issues, for example, conservation of autochthonous species, escapees, effluent management and transboundary waters.

38. Governments, authorities, politicians, decision-makers and others should be informed about the specific characteristics, opportunities and needs of aquaculture. Appropriate and competent authorities should be designated for the management and promotion of sustainable aquaculture development. Unfortunately, there is still insufficient interest and recognition of aquaculture, resulting in limited or no support, financial or administrative, for aquaculturists.

39. Producers and producer organizations should be consulted in discussions and decisions concerning the management and future planning of the aquaculture sector. Other private sector stakeholders, including suppliers, retailers, processors, financial institutions, etc. should also participate in such meetings. The role and benefits of fish producer associations were highlighted, in particular their public position and strength in consultations with authorities, retailers, suppliers, advocacy groups, etc. It was strongly recommended that such associations be established and strengthened.

40. Existing and new aquaculture farming systems should be improved or developed, with due consideration of efficiency and profitability criteria. Research and technology development for aquaculture needs financial support from government and other sources.

41. Technical and financial assistance is required in several countries to ensure that aquaculture products meet food safety and food quality standards, both in international and

domestic markets. It is essential that safety and quality of products for domestic markets is not neglected.

42. Aquaculture of sturgeon is crucial for the conservation of various sturgeon species. Sturgeon trade issues deserve special attention, and governments should prepare for international consultations, for example, in CITES and FAO committees.

43. Aquaculturists must recognize consumer demands and market competition with other commodities, for example, chicken, at national and international levels.

44. There are opportunities for information exchange among central and eastern European countries, and NACEE can play an important role in facilitating such activities. Regional information needs exist, for example, on national aquaculture development strategies, organic farming standards, best management practices, legislation, etc.

45. FAO representatives confirmed that the workshop report, together with the regional aquaculture review and the NASO-PAFAD studies will be published in English and Russian, to be made available to governments, and to be presented to the envisaged Global Aquaculture Review Meeting as well as to the Third Session of the COFI Sub-Committee of Aquaculture in 2006. In addition, FAO is presently working on a database of National Aquaculture Legislation Overviews, to be made available on FAO's aquaculture gateway.

#### **CLOSING REMARKS**

46. Mr Barg (FAO) thanked all experts for all their technical contributions, including their NASO-PAFAD country reports, HAKI/NACEE for their support in the preparation of relevant technical regional aquaculture review documentation and for the organization of the meeting, Mr Bogeruk for arrangements in Russian Federation, and, especially, Mme Vassilieva and her team at BIOS for excellent hosting of the expert workshop. Mr Váradi (HAKI/NACEE) also expressed appreciation to participants, and emphasized the significance of FAO's regional and global aquaculture review process for NACEE and aquaculture developments efforts in Central and Eastern Europe.

#### **DISCUSSION AND ADOPTION OF THE EXPERT MEETING REPORT**

47. The report of this meeting was revised, discussed and adopted by the participants on 7 September 2005. The final version of the report together with its annexes will be published by FAO and circulated among all interested parties.

### Prospectus

The Inland Water Resources and Aquaculture Service (FIRI) of FAO's Fisheries Department, Rome and the Research Institute for Fisheries, Aquaculture and Irrigation (HAKI), Szarvas, Hungary, as coordinating institution of the Network of Aquaculture Centers in Central-Eastern Europe, will hold the FAO/NACEE Expert Meeting on the Regional Review of Aquaculture Development Trends in Central and Eastern Europe in Astrakhan, Russian Federation between 5–7 September 2005, in conjunction with the Second Meeting of NACEE Directors, 8–9 September 2005. Both meetings are hosted by the Scientific and Production Centre of Sturgeon Culture "BIOS", Astrakhan, Russian Federation, in collaboration with the Pedigree Fish Breeding Centre – Moscow Branch of Federal Center of Fish Genetics and Selection, Moscow, Russian Federation.

The main objectives of the meeting are to present, discuss and synthesize:

- (i) the National Aquaculture Sector Overviews (NASO) and Prospective Analyses of Future Aquaculture Development (PAFAD) from the CEE countries, and
- (ii) the Draft Regional Review and Synthesis of Aquaculture Development Trends in the CEE Region.

### Background and rationale

FAO is currently initiating the preparation of global and regional reviews of aquaculture development for presentation at the third session of the COFI Sub-Committee on Aquaculture foreseen for 2006. This initiative is expected to contribute to a better understanding of the trends, processes and development prospects of aquaculture in individual countries, regions and worldwide.

One of the target regions of this approach is Central and Eastern Europe (CEE), which constitutes a significant part of Europe, both in terms of area and population. The region includes 19 countries having much in common in many respects. Their historical past is similar, they have all gone or going through a difficult transition process from centrally planned to market economy. Their aquaculture traditions are also similar, with predominance of carp-dominated pond aquaculture. All these reasons justify treating them as a separate, well-defined region.

As the aquaculture of the CEE region differs from the Western European aquaculture, and as, in spite of the decline of aquaculture that took place during the transition period, it presents great development potential, it is essential to obtain a better view of the current status and development perspectives of the region's aquaculture sector.

On this basis, FAO-FIRI commissioned the Research Institute for Fisheries, Aquaculture and Irrigation (HAKI) to collect, review and synthesize the National Aquaculture Sector Overviews (NASO) and Prospective Analyses of Future Aquaculture Development (PAFAD) from the CEE countries. The purpose of NASO and PAFAD is to provide a concise and comprehensive product that gives a general overview of the aquaculture and culture based fisheries aspects and development outlooks at national level for each country. HAKI is also to compile, on their basis, a Draft Regional Review and Synthesis of Aquaculture Development Trends in the CEE Region. After presentation and discussion during the FAO/NACEE Expert Meeting on the Regional Review of Aquaculture Development Trends in Central and Eastern Europe, the reports will be finalized and published.

### Preparation of documents for the Expert Meeting

Participating experts are expected to produce country reviews on their aquaculture sector as contribution to the regional review and synthesis. The reviews are to be prepared on the basis of the template elaborated by FIRI, containing the standard outline of structure, contents and format of the



envisaged National Aquaculture Sector Overviews (NASOs) and Prospective Analyses of Future Aquaculture Development (PAFAD), for use by experts authoring these reviews in the CEE region.

On the basis of the submitted NASO and PAFAD country reviews, a Draft Regional Review and Synthesis of Aquaculture Development Trends in the CEE Region will be compiled in advance of the Meeting by the Research Institute for Fisheries, Aquaculture and Irrigation (HAKI), Szarvas, Hungary. This draft regional review and synthesis document will be discussed and approved by the participating experts.

The deadlines of preparation of the above documents are as follows:

- Nineteen Draft National Aquaculture Sector Overviews (NASOs) and Prospective Analyses of Future Aquaculture Development (PAFAD) (one for each CEE country), based on the guidelines provided – deadline of submission: 31 May 2005 (responsible: experts selected by HAKI).
- Draft Regional Review and Synthesis of Aquaculture Development Trends in the CEE Region – deadline: 15 August 2005 (responsible: HAKI).

### **Expected outputs**

- Meeting Prospectus and Programme;
- Guidelines for authors and experts preparing the draft regional review and synthesis;
- Nineteen National Aquaculture Sector Overviews (NASOs) and Prospective Analysis of Future Aquaculture Development (PAFAD);
- Regional Review and Synthesis of Aquaculture Development Trends in the CEE Region;
- Report of the FAO/NACEE Expert Meeting on Regional Review of Aquaculture Development Trends in Central and Eastern Europe;
- Final Regional Review Document containing both the Regional Review/Synthesis of Aquaculture Development in the CEE Region and the compiled Regional Review Proceedings (including all NASOs and PAFADs contributed).

### **Participation**

The Meeting is expected to be attended by directors of NACEE member institutions; leading experts of some of the institutions; experts of CEE countries that are not yet members of NACEE; experts of FAO Inland Water Resources and Aquaculture Service, FAO, Rome; FAO Sub-Regional Office Budapest, Hungary. Experts from the following institutions and organizations will also be invited: European Commission (Aquaculture Unit); European Aquaculture Society (EAS), EUROFISH, Network of Aquaculture Centres in Asia-Pacific (NACA), European Fisheries and Aquaculture Research Organization (EFARO), The World Conservation Union (IUCN) and Akvaforsk.

### Programme

4 September, Sunday	Arrival of participants and accommodation in Hotel Lotos	
5 September, Monday	7.30-8.30	Registration of participants and guests in «Gazprom» Center
	8.30-9.30	Opening of the Meeting (Assembly Hall)
		Opening addresses: - Chief of FAO Inland Water Resources and Aquaculture Service - Governor of Astrakhan Province - Deputy Minister of Agriculture of the Russian Federation - Director of the Coordinating Institution of the Network of Aquaculture Centres in Central-Eastern Europe (NACEE) - Representative of the Network of Aquaculture Centres in Asia-Pacific (NACA) - Director of «BIOS» Research and Production Center for Sturgeon Breeding
	9.30-11.10	Presentation and discussion of country reviews (Albania, Belarus, Bosnia & Herzegovina, Bulgaria)
	11.10-11.20	Coffee break
	11.20-13.00	Presentation and discussion of national reviews (Croatia, Czech Republic, Hungary)
	13.00-14.00	Lunch
	14.00-16.05	Presentation and discussion of national reviews (Moldova, Poland, Russian Federation)
	16.05-16.15	Coffee break
	16.15-18.45	Presentation and discussion of national reviews (Serbia and Montenegro, Slovakia, Ukraine)
	19.00-22.00	Dinner
6 September, Tuesday	9.00-10.30	Presentation and discussion of the Draft Regional Review and Synthesis Document
	10.30-10.40	Coffee break
	10.40-12.00	Continuation of presentation and discussion of the Draft Regional Review and Synthesis Document
	12.00-13.00	Lunch
	13.00-14.30	Discussion of selected key themes of priority for the Central-Eastern Europe
	14.30-14.40	Coffee break
	14.40-16.00	Continuation of discussion of selected key themes of priority for the Central-Eastern Europe
	16.00-18.00	Session on final review of key elements of the Regional Review of Aquaculture Development in Central-Eastern Europe
	18.00-20.00	Visit to «BIOS» Research and Production Center for Sturgeon Breeding
	20.00-22.00	Dinner
7 September, Wednesday	8.00-10.00	Invited presentations by experts from relevant international organizations
	10.00-10.10	Coffee break

	10.10-13.00	Session on main findings, conclusions and recommendations
	13.00-14.00	Lunch
	14.00-16.00	A tour of Astrakhan including a visit to the Kremlin
	16.00-18.30	Discussion and adoption of the Report of the Expert Meeting
	18.30-19.00	Closing remarks
	19.00-22.00	Closing dinner
8 September, Thursday		Departure

**List of participants****ALBANIA**

Mimoza Çobani (Ms)  
 Head of Fishery Inspectorate  
 Fishery Directorate  
 Ministry of Agriculture and Food  
 Skenderbej Square  
 Tirana  
 Tel: +355-692-332-200  
 E-mail: mimoza\_cobani@yahoo.com

**REPUBLIC OF BELARUS**

Aleksandr Slukvin  
 Deputy Head of Research and Innovation  
 Department  
 Institute of Genetics and Cytology of the  
 National Academy of Sciences of the  
 Republic of Belarus  
 27 Akademicheskaya St.  
 220072 Minsk  
 Tel: +375-017-873-494  
 Fax: +375-17-284-1917  
 E-mail: slukvin@mail.ru

Viktor Konchits  
 Director  
 Institute of Fisheries of the National Academy  
 of Sciences of the Republic of Belarus  
 22 Stebenev St.  
 220024 Minsk  
 Tel: +375-17-275-3641  
 Tel/Fax: +375-017-275-3660  
 E-mail: belniirh@infonet.by

Vladimir Kostousov  
 Deputy Director  
 Institute of Fisheries of the National Academy  
 of Sciences of the Republic of Belarus  
 22 Stebenev St.  
 220024 Minsk  
 Tel: +375-17-275-3641  
 Tel/Fax: +375-017-275-3660  
 E-mail: belniirh@infonet.by

**BOSNIA AND HERZEGOVINA**

Adem Hamzic  
 Senior Associate for Ichthyology and  
 Aquaculture  
 Faculty of Science University of Sarajevo  
 33 Zmaja od Bosne  
 71000 Sarajevo  
 Tel: +387 33 250 442  
 Fax: +387 33 279 964  
 E-mail: adem\_hamzic@yahoo.com

**BULGARIA**

Liliana Hadjinikolova  
 Director, Institute of Fisheries and  
 Aquaculture  
 Varna – Branch of Freshwater Fisheries,  
 Plovdiv  
 248 V. Levski Str.  
 4003 Plovdiv  
 Tel: +359-32-956-033  
 Fax: +359-32-953-924  
 E-mail: lhadjinikolova@yahoo.com

Tania Hubenova  
 Head of the Aquaculture Department  
 Institute of Fisheries and Aquaculture  
 Varna – Branch of Freshwater Fisheries,  
 Plovdiv  
 248 V. Levski Str.  
 4003 Plovdiv  
 Tel: +359-32-956-033  
 Fax: +359-32-953-924  
 E-mail: thubenova@yahoo.com

**CROATIA**

Maria Natalia Stagl-Skaro  
 Director of International Relations  
 University of Dubrovnik  
 Ćira Carića 4,  
 20000 Dubrovnik  
 Tel: +385-20-445-786  
 Fax: +385-20-445-786  
 E-mail: natalia@unidu.hr

Branko Glamuzina  
 Head of Department for Aquaculture  
 University of Dubrovnik  
 Ćira Carića 4  
 20000 Dubrovnik  
 Tel: +385-98-393-775  
 Fax: +385-20-435-590  
 E-mail: glamuzina@yahoo.com

#### **CZECH REPUBLIC**

Zdeněk Adámek  
 Senior Researcher  
 University of South Bohemia  
 Research Institute of Fish Culture and  
 Hydrobiology  
 Laboratory Pohorelice, Vídeňská 717  
 69123 Pohořelice  
 Tel: +420-519-424-372/3  
 Fax: +420-519-424-243  
 E-mail: adamek.zdenek@quick.cz

#### **HUNGARY**

László Váradi  
 Director General  
 Research Institute for Fisheries, Aquaculture  
 and Irrigation  
 P.O. Box 47, H-5541 Szarvas  
 Tel: +36-66-515-302  
 Fax: +36-66-312-142  
 E-mail: varadil@haki.hu

Péter Lengyel  
 NACEE Liaison Officer  
 Research Institute for Fisheries, Aquaculture  
 and Irrigation  
 P.O. Box 47, H-5541 Szarvas  
 Tel: +36-66-515-312  
 Fax: +36-66-312-142  
 E-mail: lengyelp@haki.hu

#### **MOLDOVA**

Elena Zubcov  
 Head of Laboratory of Hydrobiology and  
 Ecotoxicology  
 Institute of Zoology of the Academy of  
 Sciences of Moldova  
 1 Academiei Str.  
 MD-2028 Chisinau  
 Tel: +373-22-737-509  
 Fax: +373-22-737-509  
 E-mail: elzubcov@mail.md  
 elzubcov@mcc.md

Galina Curcubet  
 Director of the Fisheries Research Station  
 6, Cosmonautilor Str.  
 Chisinau MD-2005  
 Tel: +373-22-241-547  
 Fax: +373-22-241-547  
 E-mail: scsp@agriculture.md  
 scsp59@mail.ru

#### **POLAND**

Ilgiz Irnazarow  
 Institute of Ichthyobiology and Aquaculture  
 Polish Academy of Sciences  
 Gołysz, 43-520 Chybie  
 Tel: +48-33-856-1551  
 Fax: + 48-33-858-9292  
 E-mail: ilgiz@poczta.onet.pl

Ryszard Kolman  
 Head of Ichthyology Department  
 The Stanisław Sakowicz Inland Fisheries  
 Institute  
 10 Oczapowskiego  
 10-719 Olsztyn-Kortowo  
 Tel: +48-89-524-0171  
 Fax: +48-89-524-0505  
 E-mail: kolrys@infish.com.pl

#### **RUSSIAN FEDERATION**

Lidiya Vasilieva  
 Director  
 "BIOS" Research and Production Center for  
 Sturgeon Breeding  
 14a Volodarsky Str.  
 414000 Astrakhan  
 Tel: +7-8512-390-511/8512-391-126  
 Fax: +7-8512-391-129  
 E-mail: bios94@mail.ru

Natalia Soudakova  
 Head of Research Department  
 "BIOS" Research and Production Center for  
 Sturgeon Breeding  
 14a Volodarsky Str.  
 414000 Astrakhan  
 Tel: +7-8512-718-555/8512-390-511  
 Fax: +7-8512-391-129  
 E-mail: sudakorm@mail.ru

Serguei Petrov  
 Manager-Interpreter of International Issues  
 "BIOS" Research and Production Center for  
 Sturgeon Breeding  
 14a Volodarsky Str.  
 414000 Astrakhan  
 Tel: +7-8512-390-511/8512-391-126  
 Fax: +7-8512-391-129  
 E-mail: bios94@mail.ru

Denis Mordovtsev  
 Multimedia Manager  
 "BIOS" Research and Production Center for  
 Sturgeon Breeding  
 14a Volodarsky Str.  
 414000 Astrakhan  
 Tel: +7-8512-390-511/8512-391-126  
 Fax: +7-8512-391-129  
 E-mail: bios94@mail.ru

Evgeniy Gamygin  
 Deputy Director  
 All-Russian Research Institute of Freshwater  
 Fish Farming  
 141821 Rybnoe, Dmitrov Region  
 Moscow Province  
 Tel: +7-095-993-8198/587-2713  
 Fax: +7-095-993-8198/587-2703  
 E-mail: vniph@mail.ru

Dmitriy Ivanov  
 Director  
 State Research Institute on Lake and River  
 Fisheries  
 26 Makarov emb.  
 199055 St. Petersburg  
 Tel: +7-812-323-7724  
 Fax: +7-812-328-0742/812-323-6051  
 E-mail: ivanov@gosniorh.ru

Andrey Bogeruk  
 Director, Pedigree Fish Breeding Centre  
 18a Ermolaevskiy per.  
 103001 Moscow  
 Tel/Fax: +7-095-976-1475/976-2954  
 E-mail: fsgcr@ipc.ru

Irina Lukanova (Ms)  
 Head of the Section on co-ordination,  
 information and international contacts  
 Pedigree Fish Breeding Centre  
 18a Ermolaevskiy per.  
 103001 Moscow  
 Tel/Fax: +7-095-976-1475/976-2954  
 E-mail: fsgcr@ipc.ru

Valeriy Krupkin  
 Director  
 Federal Centre for Fish Genetics and Selection  
 188514 Ropsha  
 Lomonosov Region, Leningrad Province  
 Tel./Fax: +7-812-422-7995  
 E-mail: ropshatrout@mail.ru

Alexandr Litvinenko  
 General Director  
 State Scientific and Production Center for  
 Fisheries  
 33 Odesskaya Street  
 625023 Tyumen  
 Tel: +7 3452 415 803  
 Fax: +7 3452 415 804  
 E-mail: lotsman@sibtel.ru

Konstantin Tylik  
 Dean, Faculty of Biological Resources and  
 Nature Exploitation  
 Kaliningrad State Technical University  
 Sovetskiy prospekt, 1  
 236000, Kaliningrad  
 Tel: +7-0112 273 009  
 Fax: +7 0112 916 846  
 E-mail: tylik@klgtu.ru

Nina Abrosimova (Ms)  
 Head of Aquaculture Department  
 Azov Fishery Research Institute  
 Rostov-na-Donu

Serguei Ponomarev  
 Dean, Head of Department of Biological  
 Resources and Aquaculture  
 Astrakhan State Technical University  
 Tatishcheva st., 16  
 414056, Astrakhan  
 Tel: +7 (8512) 250 429/542 723  
 Fax: +7 (8512) 257 368  
 E-mail: doc\_ponomarev@astranet.ru

Alexandr Zhilkin  
 Governor of Astrakhan Region  
 15 Sovetskaya Str.  
 414008, Astrakhan  
 Tel: +7 (8512) 228 519  
 Fax: +7 (8512) 229-514  
 E-mail: gov@astrobl.ru

Ivan Nesterenko  
Deputy Chairman of the Government of  
Astrakhan Region  
Minister of Agriculture of Astrakhan Region  
Astrakhan

Pavel Anisimov  
Chairman of the State Duma of Astrakhan  
Region  
Astrakhan

Gennadiy Soudakov  
Head of the Fishery and Fish Breeding Agency  
of Astrakhan Region  
Astrakhan

Feliks Magomaev  
Professor of the Ichthyology Department,  
Dagestan State University  
43a M. Gadzhieva St.  
367025 Makhachkala  
Republic of Dagestan  
Tel: +8 (8722) 675 915/682 326  
Fax: +8 (8722) 675 915  
E-mail: felix\_magomaev@mail.ru

Vasilij Glushchenko  
Chairman of the Executive Committee of  
«Rosrybkhoz»  
Moscow

Ekaterina Mikodina (Ms)  
Head of the Department of Reproduction and  
Mariculture  
Russian Federal Research Institute of Fisheries  
and Oceanography  
17 V. Krasnoselskaya St.  
107140 Moscow  
Tel: +7 (095) 264 8883  
Fax: +7 (095) 264 9187  
E-mail: mikodina@vniro.ru

Michail Golovushkin  
Official of "Fish industry" magazine  
Moscow

Andrey Kulikov  
Official of "Fish industry" magazine  
Moscow

Zinaida Sergieva (Ms)  
Officer of the Federal Fishery Agency  
Moscow

Viktor Fedotov  
Head of Department of land-improvement  
systems and agricultural objects  
Moscow

### **SERBIA AND MONTENEGRO**

Vesna Poleksic (Ms)  
Professor  
Faculty of Agriculture University of Belgrade  
11080 Beograd-Zemun Nemanjina 6  
Tel: +381 638044146  
Fax: +381 11193659  
E-mail: poleksic@agrifaculty.bg.ac.yu

### **SLOVAKIA**

Jan Regenda  
Ministry of Agriculture of the Slovak Republic  
81266 Bratislava  
Dobrovicova 12  
Tel: +421-2-59-266-554  
Fax: +421-2-592-66-756  
E-mail: jan.regenda@land.gov.sk

### **UKRAINE**

Nikolay Grinzhevskiy  
Deputy Director  
Research and Design Technological Center  
"Tekhrybvod"  
135 Obukhovskaya Str.  
03164 Kiev  
Tel: +380-44-423-7467  
Fax: +380-44-423-7467  
E-mail: sokbtrw@visti.com

Vitaliy Bekh  
Deputy Director  
Institute for Fisheries of the Ukrainian  
Academy of Agricultural Sciences  
135 Obukhovskaya Str., 03164 Kiev  
Tel: +380-44-423-7461  
Fax: +380-44-423-7458  
E-mail: vitbekh@online.com.ua

Isaak Sherman  
Dean, Faculty of Hydrobiological Resources  
and Aquaculture  
Kherson State Agrarian University  
23 R. Luxemburg St.  
73006 Kherson  
Tel: +380-552-429-451  
Fax: +380-552-429-289  
E-mail: webneon@mail.ru

**INTERNATIONAL ORGANIZATIONS****EUROPEAN AQUACULTURE SOCIETY  
(EAS)**

Johan Verreth  
 President of EAS  
 Wageningen University  
 Marijkeweg 40  
 6709 Wageningen  
 E-mail: Johan.Verreth@wur.nl

**FOOD AND AGRICULTURE  
ORGANIZATION OF THE UNITED  
NATIONS (FAO)**

Uwe Barg  
 FAO Fisheries and Aquaculture Department  
 Viale delle Terme di Caracalla  
 00153 Rome, Italy  
 Tel: +39-06-570-53454  
 Fax: +39-06-570-53020  
 E-mail: Uwe.Barg@fao.org

Jiansan Jia  
 FAO Fisheries and Aquaculture Department  
 Viale delle Terme di Caracalla  
 00153 Rome, Italy  
 Tel: +39-06-570-55007  
 Fax: +39-06-570-53020  
 E-mail: Jiansan.Jia@fao.org

**EUROFISH**

Anca Violeta Sfetcovici (Ms)  
 Projects "Eurofish"  
 H.C. Andersens Boulevard 44-46  
 DK-1553 Copenhagen V, Denmark  
 Tel: +45-33377755  
 Fax: +45-33377756  
 E-mail: info@eurofish.dk

**NETWORK OF AQUACULTURE  
CENTRES IN ASIA-PACIFIC (NACA)**

Le Thanh Luu  
 Director  
 Research Institute for Aquaculture  
 No. 1, Dinh Bang – Tu Son – Bac Ninh  
 Viet Nam, Bac ninh  
 Tel: +84 4 8273072  
 Fax: +84 4 8273070  
 E-mail: ria1@hn.vnn.vn



ISBN 978-92-5-105826-8 ISSN 0429-9329



9 789251 058268

TR/M/A1356E/1/10.07/700