GENERAL FISHERIES COMMISSION
FOR THE MEDITERRANEAN

COMMISSION GÉNÉRALE DES PÊCHES
POUR LA MÉDITERRANÉE

Committee on Aquaculture (CAQ)

Working Group on the Black Sea (WGBS

Report of the ad hoc meeting on Black Sea aquaculture species diversification

Trabzon, Turkey, 21– February 2013

SUMMARY

1. The ad hoc meeting on Black Sea aquaculture species diversification was held at the Central Fisheries Research Institute (CFRI), Trabzon, Turkey, from 21–22 February 2013. The meeting was attended by experts from the Black Sea riparian countries Bulgaria, Romania, the Russian Federation, Turkey and Ukraine, as well as by lecture-experts from Spain, Greece, Italy and Turkey. The list of participants is provided in Appendix B to this report. The meeting was a follow-up to the work plan agreed at the first meeting of the Working Group on the Black Sea (WGBS) held in Constanta, Romania, from 16–18 January 2012, and was designed to support the development of sustainable marine and brackish aquaculture in the GFCM area.

2. The meeting attempted to discuss the current status of aquaculture in the Black Sea region and to explore potential species and farming systems for the diversification of the sector. A list of candidate species and related farming technologies were discussed and the key role of aquaculture for marine restocking and stock enhancement purposes was also highlighted. The meeting was organised back-to-back with the *Training Workshop on site selection, allocated zones for aquaculture and site management for coastal marine aquaculture* (WGSC-SHoCMed) at CFRI from 18-21 February 2013.

OPENING, ARRANGEMENT OF THE MEETING AND ADOPTION OF AGENDA

3. Mr Fabio Massa, GFCM Aquaculture Officer, opened the meeting. He presented the technical aspects related to the organization and functioning of the meeting. Ms Güzel Yücel-Gier acted as Chair of the meeting. The agenda was introduced and adopted (see Appendix A to this report).

BLACK SEA AQUACULTURE: PRESENT SITUATION, POTENTIAL SPECIES DIVERSIFICATION AND NECESSARY CHANGES IN FARMING TECHNIQUES

4. Mr Ilhan Aydın, Director of the CFRI, introduced the main traits of Black Sea aquaculture, including current status, potential for species diversification and necessary changes in farming systems.

5. Abstract: The important species for Black Sea aquaculture include the Black Sea trout, turbot, flounder, sturgeon, European seabass and mussel were reviewed.

Black Sea trout: The Black Sea trout (*Salmo trutta labrax*, Pallas, 1814), also called Black Sea salmon, is one of the best studied species. Some important projects have been implemented for this species:

- Appraisal of the sturgeon and sea trout fisheries and proposals for a rehabilitation programme (1989) (FAO/TCP Project);
- Determination of bio-ecological characteristics and culture possibilities of the Black Sea trout (*Salmo trutta*, Pallas,1814) (1998-2002);
- Culture of Black Sea trout and its use of releasing (2002-2007);
- Detecting genetical structure of brown trout (*Salmo trutta*) population in Turkey (2003-2007);
- Introduction of the Black Sea trout (*Salmo trutta labrax* Pallas, 1814) in the private sector (2007-2009);
- Determination of nutritional requirements for the Black Sea trout (*Salmo trutta labrax*) (2010-2013).

In this region, the Black Sea trout is farmed in open-flow-system ponds. At CFRI the recirculation system for raising trout is used also for the European seabass (*Dicentrarchus labrax*).

Turbot: The capture fisheries of turbot (*Psetta maxima*) in the Black Sea is declining. The first study on turbot "Fish Culture Development in the Black Sea" dates back to 1997 and was carried out by CFRI in collaboration with the Japanese International Cooperation Agency (JICA). This is still the most important research and development project on aquaculture in Turkey. The project led to important developments in the aquaculture of this species by the private sector. Turbot seeds were transferred to a number of farms located in the Aegean Sea in collaboration of JICA and the Mediterranean Research Institute. Training on turbot farming was delivered to the private sector and academic institutions. Turbot is normally reared in open-flow system tanks, whilst cage systems, commonly used in the Black Sea, are not suitable for this species.

Flounder: CFRI has been undertaking studies on flounder such as "Investigation on bio-ecological properties and aquaculture possibilities of flounder (*Platichthys flesus luscus*, Pallas, 1811)". The study includes the following activities: identification of bio-ecological and genetic characteristics of flounder; adaptation to the hatchery environment; the identification and development of juveniles; and recruitment and cultivation techniques. At CFRI flounder is farmed in open-flow systems of tanks.

Sturgeon: The number of sturgeons species had decreased to four (*Huso huso*, *Acipenser gueldenstaedtii, Acipenser stellatus,* and *Acipenser sturio*) by the end of the 1980s (Edwards and Doroshov, 1989)[1]. There were only three sturgeon species (*H. huso, A. gueldenstaedtii, A. stellatus*) left at the beginning of the 2000s (Çelikkale et al., 2003[2]; Akbulut et al., 2010[3]). Since 2000 CFRI has been working with the Universities of Istanbul and Sinop to reconstitute sturgeon broodstocks. Concurrently studies on the Black Sea sturgeon populations, habitats, genetic structure, and protection have been carried out. Awareness campaigns on the protection of sturgeon were also launched. As a result, at present four species of sturgeon including *H. huso, A. gueldenstaedtii, A. stellatus and A. baerii* can be found in Turkey. Fishing quotas for each species in terms of fish size have been in place since 1996, and five countries riparian to the Black Sea have banned open-sea fishing of sturgeon.

Activities of stock enhancement of sturgeon have been performed in Turkey: the FAO project "Recovery of sturgeon population in Turkey: habitat assessment and restocking" (TCP/TUR/3202 - D) was implemented in 2008–2010. Within this project, one kg of *A. gueldndseadtii* and one kg of *A. Stellatus* fertilized eggs were imported from Krasnodar (Russian Federation) and hatched in the hatchery in Amasya city in Turkey. Sturgeons were farmed using the open-flow systems in ponds.

Mussel: Within a cooperation framework between CFRI and the Institute for Marine Resources and Ecosystem Studies (IMARES), a preliminary study on "Black Sea Mussel Farming" is planned to be carried out.

Stock enhancement: Turbot stock enhancement was the main objective of two projects: (i) "An investigation on recruitment of hatchery-reared Black Sea turbot juveniles to natural stocks and its bio-ecological characteristics", and (ii) "Development of aquaculture techniques for turbot". A total of 38 109 juveniles of turbot were released at sea in different spots located along the coastal area between Rize-Pazar and Sinop-Akliman. As of sturgeon, a total of 10 000 individuals were released into the Kızılırmak, Yeşilırmak and Sakarya rivers within the above mentioned FAO project for the recovery of sturgeon populations in Turkey. At present, the project "Improvement of sturgeon aquaculture and stock protection strategy" aims at assessing and monitoring the dynamic of sturgeon populations also as result from the stock enhancement activities.

6. After the presentation, participants acknowledged the good work carried out by CFRI and stressed the relevance of sharing experiences with other research institutions working on aquaculture in the Black Sea. In this regard, participants also highlighted the benefits of training activities on the different methodologies applied for aquaculture purposes.

[1] Edwards, D.; Doroshov, S. 1989. Appraisal of the sturgeon and seatrout fisheries and proposals for a rehabilitation programme. FAO Technical Cooperation Programme, Project reports, p.38, Rome.

[2] Çelikkale, M.S., Memiş, D., Ercan, E. 2003. Sturgeon culture in Turkey. International Symposium of Fisheries and Zoology, 23-26 0ctober, Istanbul, Turkey.

[3] Akbulut, B., Zengin, M., Çiftçi, Y., Ustaoğlu Tırıl, S., Memiş, D., Alkan, A., Çakmak, E., Üstündağ, E. 2010. Determination of sturgeons' current population and research on aquaculture possibilities. Final project report, project number: TAGEM/HAYSÜD/2006/09/02/01.

7. It was stressed that for some species and due to the environmental conditions in the Black Sea, the use of recirculating aquaculture systems (RAS) would be suitable in terms of environmental compatibility and water management control. However, the high costs associated to start-up and use of RAS technology was also pointed out.

8. Participants informed that there were positive experiences regarding oyster culture in the Black Sea and that a programme of dissemination of these results to the private sector could facilitate the development of aquaculture in the area.

9. The different aspects related to the restocking programme for turbot carried out by CFRI with farmed fish were considered by participants as a good example of stock enhancement. Suggestions were made in relation to the need of having scientific cooperation and monitoring programme on restocking activities.

MARINE FINFISH DIVERSIFICATION IN THE MEDITERRANEAN AND AEGEAN SEA (PRESENTATION AND DISCUSSION)

10. Mr Kutsal Gamsiz, researcher at the Aegean University, delivered a presentation on marine finfish diversification in the Mediterranean and Aegean Seas.

11. Abstract: Turkey has an important potential for aquaculture, and marine finfish farming, which started in the 1980s. The first hatchery producing gilthead seabream (*Sparus auratus*) and European seabass (*Dicentrarchus labrax*) was established in 1985. According to recent statistics, in 2011 marine aquaculture production in Turkey reached 88 000 tonnes whilst the production of juveniles of marine species accounted for nearly 400 million in 2012. Aquaculture in the Mediterranean and Aegean Seas is based on the production of gilthead seabream and European seabass. In the last two decades, the prices of cultured fish dropped drastically due to an unbalanced situation of market supply and demand.

12. In this context, one possible market strategy for aquaculture is the diversification of fish species. Diversification studies began in Turkey in the 2000s and new cultured species could be clustered into three main groups:

- fast-growing and low-value species e.g. meagre (*Argyrosomus regius*), shi drum (*Umbrina cirrosa*), and brown meagre (*Sciaena umbra*);
- slow-growing and high-value species (e.g. common dentex (*Dentex dentex*), sharpsnout seabream (*Diplodus puntazzo*), red porgy (*Pagrus pagrus*), white seabream (*Diplodus sargus*), red banded seabream (*Pagrus auriga*), common pandora (*Pagellus erythrinus*), bluespotted seabream (*Pagrus caeruleostictus*); and
- fast-growing and high-value species such as bluefin tuna (*Thunnus thynnus*). Other potential candidates within this group include white grouper (*Epinephelus aeneus*) and greater amberjack (*Seriola dumerili*).

13. When considering a new species for aquaculture, the first step consists in adapting wild specimen to live in artificial conditions such as tanks and ponds to become fertile broodstock. The second step is to induce fish to spawn under controlled conditions. Species belonging to

Sparidae family can spawn in captivity without use of hormones but most species need hormonal manipulation. Developing an effective feeding regime for newly hatched larvae is another important step. At the early life stage, larval survival rates range between 0.1–75% depending on the species, eggs size, larva size at hatching and other factors. Another important requirement is a suitable culture system for each different phase of fish growth. Recently, RAS technologies have been the most widely used for the culture of larval and juvenile of new species. Finally, the introduction of a new species should also address issues such as production cost, growth rate and survival rate.

14. Participants considered that the particular environmental conditions in the Mediterranean and Aegean Sea would allow cultivating a wide number of species.

15. Furthermore, participants highlighted that at present the artificial reproduction of many new species (in particular for sparids) was possible thanks to the improved technologies for fish breeding and fry rearing which enabled the production of large number of juveniles for growth out. Some concerns related to the market aspects of new species in aquaculture were raised.

SHELLFISH AQUACULTURE AND ITS POTENTIALITY FOR BLACK SEA CONDITION

16. Mr Jose Carlos Macias, aquaculture consultant, delivered a presentation on the diversification of species in aquaculture.

17. Abstract: An analysis of the production of molluscs in the Mediterranean countries and the potential for the Black Sea was presented. According to FAO, mollusc aquaculture has been practiced since the early 20th century and involves the use of various techniques including fixed and floating structures. The bulk of mollusc production is represented by mussels, which include the Mediterranean mussel (*Mytilus galloprovincialis*) and the blue mussel (*Mytilus edulis*), and oysters, comprising the Pacific cupped oyster (*Crassostrea gigas*) and the European flat oyster (*Ostrea edulis*). Although other species such as scallops, clams and abalone have also been farmed in order to diversify the production, none of them reached the same commercial scale as mussels and oysters. In particular, the promising aquaculture of the imported Japanese carpet shell (*Ruditapes philippinarum*) also commonly called as Manila clam, was strongly constrained by its rapid adaptation to the natural environment (the Po river delta in Italy and the Morbihan Gulf in France), which gave rise to a competitive fisheries production. Mollusc aquaculture is highly developed in some European Mediterranean countries such as Spain, France, Italy and Greece, with a total of several hundred thousands of tonnes produced per year. The relevant production can also rely on a traditional domestic consumption of these species group.

18. The sector has reached a high level of technology and mechanization, and farms are operated both by private and corporate producers. In 2010, shellfish production in Mediterranean countries exceeded the 500 000 tonnes. When analysing the productions of all Mediterranean countries, it appears that most of the production (about 94.8 percent) comes from three countries Spain, France and Italy. Regarding the main species produced in 2010, 73 percent accounted for the production of mussels (including production in North West Spain), approximately 18 percent

of oysters (*Crassostrea gigas, Ostrea edulis*), slightly more than 8 percent of clams (*Ruditapes sp.*), and the remaining of other species.

19. Regarding the main shellfish species produced at Mediterranean level, a general review of the environmental conditions for cultivation, production areas, main techniques of aquaculture and production cycles was presented. The key factors when setting-up a mollusc's facility are mainly three: the depth, temperature and water quality with respect to the phytoplankton content (Chlorophyll a). A review of the main methods and shellfish aquaculture systems both on land and inter-tidal areas, and in areas at sea was introduced. The shellfish farming systems employed in Spain, Italy and France were described. In the case of Spain, a brief case study of mussel farming development in the south of the country (Andalucía) was presented, outlining major steps, needs, challenges and actions undertaken.

20. A number of key elements for mollusc culture could be drawn as follows:

- Source of seed: wilds populations and hatchery;
- High specialization in farming species: mussel in Spain, oysters in France and clams in Italy;
- Commitment to quality and local or national brand;
- Consolidated aquaculture systems;
- Dangerous occurrences of disease caused by biotoxins (sanitarian risk);
- High potential growth due to market demand;
- Competitive advantages of mollusc production compared to fish farming due to lower production costs.

21. Furthermore, key issues for the future development of shellfish farming were outlined such as sanitary control, monitoring of environmental conditions, quality and brands, new technologies and new species. Clam restocking examples in areas located in North West Spain and North East Italy were recalled. It was concluded that mollusc aquaculture offered new and interesting possibilities for the development of aquaculture in the Mediterranean and Black Sea.

22. Participants concurred that while farming systems for some mollusc species were well known, it was now necessary to assess the environmental conditions that make possible such activity and estimate the European market potential demand. Health control measures and a correct marketing should supplement the development of shellfish aquaculture.

DISCUSSION AND CONCLUSIONS ON THE POTENTIALITIES OF THE BLACK SEA AQUACULTURE DIVERSIFICATION LIST ACCORDING TO: SPECIES, ENVIRONMENT AND TECHNOLOGY

23. The working group agreed that brackish and marine aquaculture had a great development potential in the Black Sea area and acknowledged also the potential role of this sector in contributing to the fisheries production in the region. This potential from one side is supported by environmental conditions, the available expertise and competences, and proven technology. On the contrary constraints such as, among others, the competition over use of coastal areas and gaps on aquaculture regulatory and legislation issues, could hamper the development of aquaculture itself.

24. Looking at the future role of aquaculture in the region, participants discussed the technical aspects of aquaculture species diversification in the Black Sea and the potential role of aquaculture for restocking and stock enhancement.

25. The main conclusions from the ad hoc meeting on species diversification can be summarised as follows:

About species diversification

- Aquaculture development in Black Sea is characterized by a limited number of species, and diversification would be the way in support to aquaculture development for the Black Sea countries.

- If compared with the different condition in the Mediterranean Sea, the limited diversity in a number of species, water temperature and salinity characteristics could be considered as limiting factors for aquaculture development in the Black Sea. However, according to the existing expertise, knowledge and local environmental conditions, in the Black Sea there is quite a wide variety of potential species to develop aquaculture in the region.

- The development and/or further development of marine aquaculture in the Black Sea could be considered at different levels: according to the purpose (i.e. human consumption and/or restocking); according to the different methodologies and technologies (i.e. cages, ponds; recirculation systems; hatcheries); and according to the reference species by purpose and technology (i.e. turbot; European seabass; flounder; sturgeon; meager; shi-drum; brown meagre; sharpsnout sea bream; white sea bream; mussels; trout; oysters).

- A list of potential species for aquaculture activities in the Black Sea is presented in Table 1 as hereunder reported.

26. Participants also concurred that when considering aquaculture diversification, the main aspects related to the balance situation about market supply and demand should be taken into account.

TABLE 1: LIST OF POTENTIAL SPECIES FOR AQUACULTURE ACTIVITIES IN THE BLACK SEA AREA

ENVIRONMENT	GROUP	SPECIES	Native in the Black Sea	Type of aquaculture system tested or developed	Aquaculture purposes		Aquaculture in Black Sea			Range of tolerance conditions			Suggested techniques for on-growing
					Human consumption	Restocking activities	Innovative	Commercial farms	Pilot commercial farms	Salinity(%)	Temperature (ºC)	Oxigen(mg/l)	
Marine	Fish	***Turbot*** *(Psetta maxima)*	Y	▪ *Pond and tank culture*	Y	Y	Y	Y	Y	5-38	5-25	>4	**Closed/recirculation**
		European seabass *(Dicentrarchus labrax)*	Y	▪ *Sea cages / Pond and tank culture*	Y	N	-	Y	-	5-50	2-32	>5	**Hatchery / Cages**
		Flounder *(Platichtys flesus)*	Y	▪ *Pond and tank culture*	Y	N	Y		Y	0-38	5-25	>4	**Closed/recirculation**
		Horse Mackerel *(Trachurus mediterraneus)*	Y	▪ *Research phase*		N	Y	N	-	-	-	-	**Still in research phase**
		Meagre *(Argyrosomus regius)*	Y	▪ *Sea cages*	Y	N	Y	Y	Y	5-38	5-28	>5	**Floating sea cages**
		Shi Drum *(Umbrina cirrosa)*	Y	▪ *Pond and tank culture*	Y	N	Y	-	Y	5-38	5-28	>5	**Pond and tank culture**
		Brown meagre *(Sciaena umbra)*	Y	▪ *Pond and tank culture*	Y	N	Y	-	Y	5-38	5-28	>5	**Pond and tank culture**
		Sharpsnout seabream *(Diplodus puntazzo)*	Y	▪ *Sea cages / Pond and tank culture*	Y	N	Y	-	Y	5-40	5-28	>5	**Floating sea cages**
		White seabream *(Diplodus sargus)*	Y	▪ *Sea cages / Pond and tank culture*	Y	N	Y	-	Y	5-40	5-28	>5	**Floating sea cages**
	Mollusc	***Mussel*** *(Mytilus galloprovincialis)*	Y	▪ *Long-lines and rafts in the sea*	Y	N	-	Y	-	4-38	5-28	>5	**Long-lines or rafts**
		Oysters *(Crassostrea gigas, Ostrea edulis)*		▪ *Long-lines and rafts in the sea*	Y	N	-	Y	-	18-30	15-22	>5	**Long-lines or rafts**
Freshwater VS Marine	Fish	***Trout*** *(Salmo trutta labrax)*		*Moving strategy*	Y	Y	Y	Y	Y	0-30	4-20	>6	Pond and tank culture Floating sea cages
				▪ *Sea cages / Freshwater pond*									
		Sturgeon		▪ *Marine water ponds* *Freshwater pond*									Pond and tank culture
		Huso huso	Y		Y	Y	Y	N	N	0-30	2-22	>5	
		Acipenser gueldenstaedtii	Y		Y	Y	N	N	Y	0-30	2-22	>5	
		Acipenser stellatus	Y		Y	Y	Y	N	Y	0-30	2-22	>5	
		Acipenser Baerii	N		N	N	N	Y	Y	0-10	0-25	>5	

About restocking from aquaculture

27. Participants commented the achievements of the restocking programme for turbot carried out by CFRI and agreed on how these activities could be an opportunity for stock enhancement initiatives which would contribute to maintain stocks at an acceptable level.

28. Discussions focused on how aquaculture and restocking activities could potentially support fisheries stocks recovery and biodiversity conservation. Restocking could be considered as an example on how aquaculture could also contribute to sustainability.

29. There was a wide consensus that restocking should be accompanied by a monitoring programme, as it is the case for the turbot restocking programme implemented by CFRI. This activity would be essential in order to assess the real impact on wild stocks.

30. Additional suggestions were made by participants about restocking, and additional considerations were made on "responsible and precautionary approach" by taking into account a series of principles linked to conservation and marine biodiversity.

31. Within a restocking programme with farmed species the following aspects, among others, should be considered:

- Restocking programme and activities should be species-specific;
- Restocking programmes with non-native species should be avoided;
- The origin of the broodstock for breeding purposes should be based on specimens coming from local populations;
- The activities of restocking should be based on the best aquaculture knowledge, assessment of the stock considered;
- A good knowledge of biology and ecology of the species considered should be supported by research activities on the species including a management and monitoring programme;
- The aquaculture conditions must be very well known and proven in terms of technologies applied;
- The size of fingerlings to be released in the environment should be appropriate to ensure a higher survival rate;
- The quality of the fingerlings to be stocked should be wild-like and the specimens should be guaranteed as pathogen free;
- The stocking activities should be very accurate and the environmental carrying capacity known;
- A tagging programme is considered appropriate for restocking, in close cooperation with fishermen for recapture and monitoring, together with the involvement of fishermen in catch result analysis;
- Restocking programmes, in particular if referred to shared stocks, should consider scientific cooperation among the different institutions;
- The preparation of species-specific guidelines for "restocking activities for marine stock enhancement from farmed fish" would be useful in addressing responsible aquaculture and fisheries activities.

APPENDIX A

AGENDA

- Opening and meeting arrangements
- Black Sea aquaculture: present situation and potential species diversification and necessary changes farming techniques (presentation and discussion)
- Marine finfish diversification in Mediterranean and Aegean Sea (presentation and discussion)
- Shellfish aquaculture and its potentiality for Black Sea condition (presentation and discussion)
- Aquaculture experience and potentiality in restocking for stock enhancement purposes (discussion group)
- Potentiality of Black Sea aquaculture diversification - list according to: species; environment; and technology (discussion group)
- Conclusions and recommendations

APPENDIX B

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