THE BIODIVERSITY OF THE CASPIAN SEA

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I General Characteristics of the Caspian Sea

The Caspian Sea, located in an inland depression on the border of Europe and Asia, is the largest enclosed sea of the world, with the catchment area of 3.5 million km^2 and the total area of the sea covering 393,000 km^2 (Kosarev,Yablonskaya, 1994).

Origin: In the Late Mesozoic and Early Paleogene Ages, the ancient Tethys Sea occupied the area of the present Mediterranean, Black and Caspian seas. During Paleogene and Neogene times, the Black and Caspian Seas were joined and separated several times. In the Early Pliocene, the

Table 1. Caspian Sea natural dynamic forces

Bordering Countries	Azerbaijan, I.R.Iran, Kazakhstan, Russian Federation, Turkmenistan
Sea	located between 47^0 07' and 36^{0}33' North latitude and 46^0 43' and 54^0 03' East longitude (Kosarev, Yablonskaya 1994)
Total sea area Volume	393 000 km^2. (Kosarev, Yablonskaya 1994) 78 700 km^3
Mean depth Max depth	208 m 1 025 m
Coastal length Catchment area	7 000 km 3.5 million km^2
Number of major rivers	Volga, Ural, Terek, Sulak, Kura, Annual riverine input ca. 300 km^3 (Aubrey D.G. et al. 1994b)
Salinity regime	Salinity varies sharply in the North Caspian Sea, ranging from 0.1 parts per thousand (ppt) at the mouth of the Volga and Ural rivers up to 10-11 ppt near the border with the Middle Caspian. The middle and southern parts of the sea have only small fluctuations of salinity: surface salinity is about 12.6 to 13.5 ppt, increasing from north to south and from west to east. There is also a slight increase in salinity with depth (0.1 to 0.2 ppt). (Aubrey D.G. et al. 1994b)
Temperature regime	Water temperature varies considerably with latitude. This difference is greatest (about 10^o) in the winter when temperatures in the north are 0-0.5 ^{o} C near the ice and 10-11 ^{o}. C in the south. Freezing temperatures are found in the north and in shallow bays along the eastern coast. The water temperature of the west coast is generally 1-2 ^{o}. C higher than along the east coast. In the open sea, the water temperatures are higher than near the coast by 2-3 ^{o} C in the Middle Caspian and by 3-4 ^{o} C in the southern part of the Sea. (Aubrey D.G. et al. 1994b)
Tidal regime	Almost absent (Aubrey D.G. et al. 1994b)
Nutrient regime	In the North, inorganic phosphate 0.12-0.8 μ M, phosphorus in organic form 2-2.5 μ M, nitrogen – 10-250 μ M liter –1, nitrates 0.5 μ M in spring and summer, 7-10 μ M in winter, silica 60 μ M in winter, 20 μ M in summer (Kosarev, Yablonskaya 1994, Dumont H.J. 1998)
Sea bed types	On the shallow north shelf, sediments are predominately terrigenous shell and oolitic sands. Aleurolites and silt sediments with high calcium carbonate content cover the deeper areas. On some parts of the bottom, there are hard rock outcrops of Neogene age. The sediments of the Caspian Sea also contain rich oil and gas deposits. (Aubrey D.G. et al. 1994b)
Production	North Caspian - 22,7 mil. Tons of C org/year, Middle – 50,9, South – 41 (Kosarev, Yablonskaya 1994)

Caspian Sea was separated for the first time from the Black Sea. Accordingly, the primary marine fauna was partly eliminated and partly modified. During Mid Pliocene, the Caspian Sea was completely isolated from the Black Sea. The development of the Caspian and Black Sea basins, as well as their fauna, proceeded independently from that time. The typical brackish-water Caspian fauna formed then and it has persisted to the present day (Kosarev, Yablonskaya 1994).

II Ecosystem components

One of the most important features of the Caspian biodiversity is high endemism. The modern Caspian Sea organisms derived from three major origins: 1) the Mediterranean complex, 2) the Arctic complex, and 3) the freshwater (riverine) complex. **Phytoplankton**: Throughout the entire Caspian Sea, 450 species, varieties or forms of phytoplankton exist. Of these, the dominant forms numerically are *Cyanophyta*, *Bacillariophyta,* and *Chlorophyta*. Middle and South Caspian phytoplankton are mixed marine, brackish, fresh-brackish water, and freshwater forms. By contrast, North Caspian phytoplankton are represented by freshwater forms. **Zooplankton**: The diversity of zooplankton in the Caspian has representatives of Arctic, Mediterranean and endemic species, and is represented by 315 species. Of these Rotatoria – 135 species, Cladocera – 50; Copepoda – 43; Mysidacea – 20; Cumacea- 18; Amphipoda- 73, Total Crustacea – 236 (Studies…, 1997). **Phytobenthos**: 64 species of algae exist in the Caspian Sea, including 29 species of green algae, 22 species of red, and 13 species of brown. The opening of the Volga-Don canal in 1954 allowed introduction of new species of algae from the Black Sea. **Zoobenthos**: The bottom macrofauna of the Caspian Sea are represented by 379 species from 13 classes. Benthic fauna of the North Caspian are much poorer in diversity, in comparison with the Middle and South Caspian, in species composition. Moving from south to north, there is a steady disappearance of autochthonous clams and snails, mollusks, nematodes, turbellarians, deepwater amphipods, isopods, and crayfish.

The higher plants of the Caspian regions include about 950 species from 88 families (CEP, 1998a, Aubrey D.G. et al. 1994b, Studies…, 1997), among which the majority belong to dicotyledonous plants (766 species), followed by monocotyledonous plants (171), and with only 9 species of spore-bearing plants. True upland coastal flora are less rich with only 357 species from 35 families. The majority belongs to such wide-spread families as Asteraceae (65 species), Chenopediaceae (48 species), and Fabaceae (40 species). The dominant growth form is grass-like, with 86% of the total number of species. There are representatives of European, Siberian, Iran-Turan and Mediterranean flora. Autochthonous flora of the Caspian and Aral-Caspian species are not abundant, but do include 25 endemic Kazakhstan species (7%). Six of theses are included in the Red Data Book: *Tulipa schrenkii*, *Crambe tatarica*, *Medikago komarovil*, *Lepidium meyeri*, *Rubia cretacea*, and *Anthemis trozkiana*. Among the higher aquatic plants, there are rare and endemic

Table 2. Number of species in the Caspian Sea. (CEP, 1998a, Aubrey D.G. et al. 1994b, Dumont H.J. 1998, 9, Studies…, 1997, The Caspian Sea Fishery, 1997, Kasymov, 1994)

Natural marine resources:	No. Species and subspecies
Phytoplankton	450
Zooplankton	315
Phytobenthos	64
Zoobenthos	379
Fish	126
Mammals	1
Birds	466

species, like *Nelumbium caspica*, *Trapa natans*, *Aldrovanda vesiculosa*, *Zostera marina*, *Ruppia spiralis* and others (The Red Data Book, 1997). **Mammals**: The only mammal within the aquatic fauna is the Caspian seal (*Phoca* (*Pusa*) *caspica*). **Birds:** A total of 466 species of birds in 17 orders, 47 families and 141 genera can be found. Of these, 120 species are nesting birds, 68 species are wintering birds, and 278 species are migratory or summer residents.

Fisheries and other important living resources

The Caspian Sea is characterized by a small variety of fish species compared to open ocean regions, having approximately 76 to 126 species from 17 families. Up to 156 subspecies may exist. Most are carps (33% of forms), gobies (28%) and shads (14%) (Aubrey D.G. et al. 1994b). Most species are autochthonous, with few representatives of the Mediterranean complex. Sturgeon fish are abundant, having originated from freshwater forms and acclimatized to higher salinities as they now range the entire Caspian Sea. During the past fifty years significant alterations in fish populations have occurred due to human activities including foremost fisheries and habitat alteration. Four primary groups of fishes exist: Sea fishes (kilka, shad, and some gobies), anadromous fishes (lamprey, salmons, and all sturgeon fish (except sterlet)), semi-migratory fishes (Caspian roach, sazan, zander, and sterlet), and riverine fishes (perch, rudd, and tench). The traditional Caspian sturgeon fishery is well-known due to the economic value of Caspian-derived caviar. At its peak, the Caspian supplied more than 85% of the world's sturgeon stock. In recent years, however, sturgeon landings in the Caspian Sea have decreased dramatically: from 30,000 tons in 1985 to only 5,672 tons in 1995 (Studies…, 1997). A quota system, introduced together with a temporary ban on pelagic fishing, does not appear to have been effective in reviving the dwindling fish populations.

Sturgeon fish: The sturgeon fishes are the most valuable commercial fish in the Caspian. Important for their existence is the close proximity of brackish waters with rivers (the North Caspian being the most important example). Six species and 2 subspecies of sturgeon fish exist in the Caspian, belonging to the genera *Huso* and *Acipenser*.

The biggest sturgeon fish, the beluga (*Huso huso*), reaches more than 4 m and a weight of 500 kg. Reproduction occurs in the Volga, Ural, Kura, Terek, and Sefidrud rivers, with the Volga being most important. With the damming of all the major rivers, the range of migration has been reduced. The beluga feeds on gobies, shads, carps, and Mysidacae (in its first month). In the early 20th century, the beluga accounted for nearly 40% of the sturgeon catch. At present, it accounts for less than 10%.

Russian sturgeon (*Acipenser guldenstaedti*) accounts for between 40% and 50% of the catch (CEP, 1998a). It uses the Volga, Ural and Terek rivers, with the Volga dominating in importance.

Persian sturgeon (*Acipenser persicus*) lives mainly in the Middle and South Caspian, preferring the warmer waters there. It spawns in the river Kura, although some older individuals navigate the Volga and even fewer the Ural. The feeding habits are mixed (benthic invertebrates and other fishes).

Sevryuga sturgeon (or Starred sturgeon) is represented by two forms: North Caspian (*Acipenser stellatus stellatus* Pallas) and the South Caspian form (*Acipenser stellatus stellatus natio cyrenis* Berg). Both are spread widely throughout the Sea, but spawn in the Volga, Ural, Terek, Kura, and Sefidrud rivers. The Ural River has become the most frequent spawning area for the sevryuga. The proportion of sevryuga catch has increased recently to 45% of the total sturgeon fish catch (Ivanov et al., 1995).

Spiny Sturgeon (or bastard sturgeon, or ship) (*Acipenser nudiventris*) is a minor sturgeon of the Caspian. The ship spawns in the Kura, Ural and Sefidrud rivers, and is rarely seen in the Volga. After damming of the Kura River, the Ural became the most important spawning river for ship sturgeon. The ship sturgeon forages on fishes and bottom invertebrates (mixed diet). Spiny sturgeon fishing is now prohibited in the Ural River, because of depleted stocks; it is listed in National Red Data Books of some Caspian countries (The Red Data Book, 1997).

Sterlet Sturgeon (*Acipenser ruthenus*), like the spiny sturgeon, is a relatively rare type of sturgeon fish in Caspian Sea. Two populations exist in the Volga Basin: one limited to the upper and middle Volga, the second semi-migratory type that forages in the brackish Caspian. Middle Volga sterlet stocks decreased dramatically with the initial Volga regulation; however, lower Volga sterlet flourished. A similar semi-migratory population may exist in the Ural River.

III Threats to Biodiversity

The Caspian Preliminary Transboundary Diagnostic Analysis (CEP, 1998b) identifies major issues associated with the degradation of the Caspian Biodiversity:

- Loss of coastal habitats
- Loss or imminent loss of endangered species and their genomes
- Degradation of landscape

The major threats to biodiversity of the Caspian Sea and its coastal zone are the combination of natural and anthropogenic factors including:

Contamination

During the past forty years, the level of contamination of the Caspian Sea has increased due to anthropogenic activities not only in the immediate vicinity of the Caspian Sea. The entire drainage basin contributes to some extent to the Caspian problems, though to varying extent. Pollutants are transported to the Sea directly by river flow (estimated at 80% of the total contaminant load) (Glantz, Zonn, 1997), atmospheric input, groundwater flow, and direct input (such as oil contamination in the Baku region). The major sources of contamination in the Caspian include: onshore industry, agricultural practices, oil and gas production and processing, extraction and transportation, marine dumping.

Sea level fluctuation

The rise of the sea level causes the alteration of valuable habitats, due to the inundation of the vast coastal areas. The most affected are the areas in the North Caspian, near Ural delta, Volga delta, as well as lowlands in Azerbaijan (Aubrey D.G. et al. 1994a, CEP, 1998a).

Desertification

It is a basin-wide problem, though probably least severe in Azerbaijan. Iran, Kazakhstan, Russia, and Turkmenistan are the states threatened most by this phenomenon. The main factors causing desertification are: direct oil pollution of soils, underground and surface waters; disturbance of habitats; anthropogenic use of lands, and disturbance of functions of landscapes and their resource capacity (CEP, 1998a).

River regulation

Since the early 1930's, dam construction has altered the hydrology and ecosystem of the Caspian Sea. Dams were built on the Volga, Terek, Sulak, Samur, and Kura rivers. Some of the effects of dams on the rivers include: altered volume of river flow, altered timing of river flow, salinity variations, reduced inorganic nutrients, increased organic substances, reduced sediment delivery, reduced habitat for certain fishes, limited spawning area, eutrophication (Kuksa, 1994).

Table 3 Status of International Conventions in the Caspian Sea (CEP, 1998a)

	Azerbaijan	I.R.Iran	Kazakhstan	Russia	Turkmenistan
Biodiversity Convention	S (1992)	R (1996)	R (1994)	R (1995)	R (1996)
Man and Biosphere	+	+	+	+	+
Ramsar Convention	-	R (1975)	-	R (1977)	-
CITES	1999	1976	2000	1992	-
World Heritage Convention	R (1993)	Ac (1975)	Ac (1994)	R (1988)	Su (1994)
Desertification Convention	1998	1997	1997	-	1996

Ac - Acceptance, R-Ratified, S – Signed, Su – notification of succession, + participation
Otherwise date of entry in force

Poaching

This factor is the most serious threat to the sturgeon population at present. According to the local fisheries experts, illegal catch accounted in 1995 for about 90% of all sturgeon caught in the northern Caspian. It is comparable to former USSR commercial catches of 15 000 t per annum (Ivanov et al., 1995).

Introduced species

Occasionally, an ecosystem will experience biological invasion by a species that is able to occupy a particular niche in the ecosystem. Natural checks and balances normally operating within the ecosystem may fail for a variety of reasons, leading to a massive explosion of that organism in the ecosystem. Typically, growth is rapid but the decline may be equally precipitously fast. The danger of such invasions in the Caspian Sea is heightened by its near isolation. Species can enter through the Volga-Don canal, but they cannot leave easily, nor can predators be introduced as easily. This fact places the Caspian at some risk, particularly for species such as *Mnemiopsis*, which can exist in the salt levels of the Caspian. Since this ctenophore feeds on fish eggs and larvae, its presence might place fisheries at even more risk if it were to invade. In 1999, *Mnemiopsis* was first recorded in the Caspian Sea, presumably after being introduced few years earlier with ballast waters of oil tankers. Recently large blooms of *Mnemiopsis* were in the Northern and central parts of the Caspian Sea. The CEP is urgently addressing this issue by bringing together world-experts on *Mnemiopsis* to develop actions to control its population (First International meeting Report, 2001).

IV Conservation of Biodiversity: Policy and planning tools

Most of the threats to the Caspian Biodiversity are transboundary in their nature and require effective measures from all Caspian states. As a result, both international and national policies and planning actions are needed to insure an adequate and sustainable protection of the Caspian Biodiversity. Table 3 lists the main international conventions of relevance to biodiversity of the Caspian Sea and their status.

In 1994, Caspian States prepared a Convention (Agreement) on Conservation and Utilization of Bioresources of the Caspian Sea. Due to the political problems related to the legal status of the Caspian Sea, this Convention is still unsigned.

Since 1995, all Caspian countries, with assistance from UNEP, are actively involved in the preparation of the Caspian Framework Convention on the Protection and Sustainable Management of the Caspian Environment and its Resources, it is envisaged, that the next meeting of the expert group will be held in April 2000.

In 1998, the Caspian Environment Programme (CEP) was launched by the riparian states with support from EU/TACIS and Global Environment Facility (GEF). One of the most important components of CEP is assessment of transboundary biodiversity priorities. The regional center for Assessment of Transboundary Biodiversity Priorities was established in Atyrau (Kazakhstan) by early 1999.

All of the Caspian states have laws and regulations related to the protection of the biodiversity, several countries (Azerbaijan, Kazakhstan, and Russia) have Red Data Books describing endangered and rare species, in some countries a Biodiversity Action Plan is already prepared or under preparation. Unfortunately at present, national laws and regulations are weak and need enforcement. In all of the countries there are a number of protected areas with different status, management regime and functionality.

Conclusions – Uniqueness of the Biodiversity of the Caspian Sea

The modern Caspian Sea originated as part of an ancient, brackish Pontic lake-sea existing 5-7 million years ago. Thus, the oldest living organisms are among the group of autochthonous, brackish-water organisms. Among this group is a high percent of endemic species and even genera. The rest of the modern assemblage of organisms in the Caspian Sea is basically derived from three major origins: 1) the Mediterranean complex, 2) the Arctic complex, and 3) the freshwater (riverine) complex.

Because of its relative stability over time, its salinity regime (consistently brackish), and its central location, almost all autochthonous species are found in the Middle Caspian Sea, and consequently, the highest number of endemic species are found there. Conversely, the North Caspian has the greatest diversity of both habitat and biota. This diversity is due to the existence of big rivers, such as the Volga and the Ural, which for the mixing of marine and freshwater fauna. The Volga River system is also the place where, in ancient times, Arctic and Mediterranean species could penetrate into the Caspian Sea. In spite of absence of some deep-water species, the North Caspian has the maximum diversity of species due to invasion of large amounts of freshwater, Mediterranean and Arctic forms. The existence of vast shallows, some deep depressions, the vast Volga Delta and other rivers, and fluctuations of salinity from 0.12 to 10 ppt provide different ecological niches that, in turn, provide high diversity of organisms in this region.

The biological diversity of the Caspian Sea and its coastal zone, makes the region one of the most valuable ecosystem of the world. The rate of biological endemism in the Caspian Sea is extremely high and it has large representatives from almost all major phyla on earth. The Caspian with its diversified habitats ranges from vast river systems to extensive wetland systems, supporting the diverse flora and fauna with high natural productivity. The most important fauna of the Caspian Sea is the Sturgeon fish, which constitute 85 % of the standing stock of the world's sturgeon population. The Caspian Sea lies on the crossing of migration routes of millions of migrating birds and offers refuge for a number of rare and endangered birds of the world ornitofauna.

Since the collapse of the Soviet Union, the biodiversity of the Caspian Sea was not very well studied. There is a strong need to undertake an ecological survey of the coastal and marine species and habitats, their uses, values, and threats, for each of the five Caspian states. This survey will result in an Inventory of Caspian Ecological Resources. It is also important to develop strategies for the management of transboundary biodiversity, including threatened or endangered migratory species.

The Caspian Environment Programme (CEP), initiated by the Caspian Countries with the support from GEF and TACIS will address these important issues. The Regional Biodiversity center assisted the Caspian countries to prepare National Biodiversity reports, which will form a basis for the regional biodiversity assessment and biodiversity action plan. In the same time the Caspian countries have developed the National Action Plan for the protection of coastal habitats. The Biodiversity component of the CEP, will greatly contribute to the protection of regional biodiversity as well as the reinforcement of species and habitats of global significance. This component will result in comprehensive knowledge of the status of and threats to Caspian biodiversity, broadly accessible biodiversity databases, agreed-upon national and regional strategies for biodiversity protection and conservation, and identification of actions to mitigate threats from possible introduction of exotic species.

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РЕЗЮМЕ

***Мамаев В. О*. О биоразнообразии Каспийского Моря**

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Приводятся краткие сведения о разнообразии различных групп животных в Каспийском море и характеристика основных типов воздействий на экосистемы и биоразнобразие Каспия.