MINISTRY OF ECOLOGY AND NATURAL RESOURCES OF UKRAINE

STATE ECOLOGY INSPECTION OF THE BLACK SEA

UKRAINIAN SCIENTIFIC CENTER OF MARINE ECOLOGY

ODESSA BRANCH INSTITUTE OF BIOLOGY OF SOUTHERN SEAS OF NATIONAL ACADEMY OF SCIENCE OF UKRAINE

SHIPPING SAFETY INSPECTION OF MINISTRY OF TRANSPORT OF UKRAINE

EUROPEAN UNION FOR COASTAL CONSERVATION

ECOLOGICAL SAFETY DEPARTMENT OF THE CITY EXECUTIVE COMITTEE OF ODESSA

STATE CENTRE FOR SCIENTIFIC AND ECONOMIC INFORMATION OF ODESSA

International symposium

THE BLACK SEA ECOLOGICAL PROBLEMS

Black Sea Strategic Action Plan Implementations (1996 - 2000)

Odessa
SCSEIO
2000

ББК 26.221 (922.8)
Э40
УДК 551.46.9:628.5(262.5)

Друкується за рішенням **Редакційно-видавничої Ради** при Одеському ЦНТЕІ. Протокол № 6 від 24. 10. 2000 р.

Екологічні проблеми Чорного моря: 36. наук. ст. / ОЦНТЕІ; - Одеса: ОЦНТЕІ, 2000. - 405с.

Цей збірник наукових доповідей присвячень основним підсумкам виконання Стратегічного плану дій по реабілітації і охороні Чорного моря (1996-2000 рр.), підсумкового документа першого етапу виконання Міжнародної Чорноморської Екологічної Програми ООН. У цьому зв'язку надруковані матеріали відображають основні розділи Програми, а саме: швидке реагування при надзвичайних ситуаціях, моніторинг забруднення і стандарти якості навколишнього середовища, захист біологічної різноманітності, розробка загальної методології управління прибережною зоною моря, рибальство, освіта і громадська поінформованість в природоохоронній області. В статтях представлені результати раніше не надруковані результати наукових досліджень. Подані дані, їх інтерпретація і закінчення належать авторам повідомлень і ні в коєму разі не можуть бути приписані членам організаційного комітету, які склали даний збірник.
Збірник призначень для широкого кола спеціалістів у галузі біології і екології моря, океанографії, техногенної безпеки і охорони природи.

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The Black Sea ecological problems: Collected papers / SCSEIO, Odessa: SCSEIO, 2000.- 405 p.

Present issue is devoted to the main results of Strategic Action Plan for the Rehabilitation and Protection (SAPRP) of the Black Sea (1996-2000) implementation. The SAPRP is a resulting document of the Black Sea Environmental Program (GEF/UN/UNDP) first step. The published materials have been reflected by the main Program sections: emergency response, pollution monitoring and environmental quality standards, protection of biodiversity, integrated coastal zone management, fisheries, environmental education and public awareness. These papers are the results of scientific research haven't been unpublished earlier. The findings, interpretations and conclusions expressed in papers, are in own property of the authors and should not battributed in any manner to the members of organization committee, which prepared this issue.
The issue was design for specialists in the field of marine biology and ecology, oceanology, technogenic safety and environmental protection.

] БК 26.221(922.8)
' ДК 551.46.9:628.5(262.5)

ISBN 966-7635-08-2

CHANGES IN PRODUCTIVITY OF THE BLACK SEA AND SOME PRACTICAL RECOMMENDATIONS FOR IT'S PROTECTION

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According to the Strategic Action Plan for the Rehabilitation and Protection of the Black Sea [9] eutrophication is the first reason of degradation of the Black Sea ecosystem. Eutrophication means sharp increasing influx of nutrients, which have a strong impact on rates of primary production [6].

A marked increase in the productivity of shelf ecosystems due to eutrophication had a different effect on other components of their biological structure. The increasing amounts of nutrients influenced the pelagic organisms. Their average biomass in the Black Sea rose in 3-30 times. However, salutation of the seabed, the subsequent decreasing in water transparency and oxygen regime caused a 5-10 fold drop in the numbers and biomass of benthic organisms. The catches of plankton feeding small fishes (anchovy and sprat) increased more than two fold [7]. When defining the general changes in the biological structure of the Black Sea ecosystem, an increase in small sized, short cycle species was observed [13]. In other words, eutrophication was favorable for organisms with higher productivity. Owing to this situation, it has been confirmed that with the changing conditions of the ecosystem that has taken place during a rise in trophic status, there has been a disturbance in the stability and the ecological niches formed by the invading highly productive species, which are more adapted to new conditions. For example, changes in biodiversity of the northwestern shelf, as most productive zone of the Black Sea, lead to preferred development of species with a specific production more than 2.4 in the composition of phytoplankton, 1.2 - zooplankton and 0.012 - macrophytobenthos. Changes in the functional activity of plankton and benthos due to restructuring of their biological structure during eutrophication were similar and doubled in comparison to the 1960-1970s [3].

The increase of a food supply of plankton feeding fish has entailed increase of their number on the average in 1,5-2 times. About 90 % of them make the most small-sized and cheap. At the same time the catches of the bottom feeding fish declined as a result of eutrophication. Taking into consideration that the majority of these fish is valuable, it is possible to draw a conclusion, that the overall costs of fish reserves of northwest shelf has decreased, as it is demonstrated on the example of the Danube river mouth zone (Tab. 1).

Table 1. Changing in species composition and quantity characteristics of the ichthyofauna in the Danube river mouth zone of the Black Sea and some economic evaluations

Species	Market зrice, Grn*/kg	Before eutrophication** (1956- 1959)			After eutrophication *** (1995 - 1997)		
		Average annual catch, tons	Share of catch, %	Total price, millions Gm	Average annual catch, tons	Share of catch, %	Total price, millions Gm
Plsnkton feeding fish							
Sprat	2,00	1398,4	42,31	2,797	3933,0	83,15	7.S66
Anchovy	3,00	826,1	25,00	2,478	249,0	5,26	0,747
Danube shad	4,00	13,1	0,40	0,052	163,3	3,45	0,653
Black Sea scad	4,00	498,5	15,08	1,994	30,7	0,65	0,123
Bonito	10,00	189,8	5,74	1,898	0,0	0,00	0,000
Mackerel	8,00	94,3	2,85	0,754	0,0	0,00	0,000
Total		**3020,2**	**91,38**	**9,973**	**4376,0**	**92,51**	**9,389**
Bottom feeding fish							
Great sturgeon	30,00	38,3	1,16	1,148	0,0	0,00	0,000
Russian sturgeon	25,00	5,8	0,18	0,145	0,7	0,01	0,018
Starred sturgeon	17,00	3,1	0,09	0,053	0,0	0,00	0,000
Grey mullet	5,00	2,5	0,07	0,012	0,3	0,01	0,002
Turbot	9,00	152,0	4,60	1,368	0,0	0,00	0,000
Flounder	9,00	2,2	0,07	0,019	23,7	0,50	0,213
Total		**203,7**	**6,16**	**2,745**	**24,7**	**ч 0,52**	**0,232**
Others	0,10	81,0	2,45	0,008	329,5	6,96	0,033
Total		**3305,0**	**100,00**	**12,726**	**4730,1**	**100,00**	**9,654**

*Rate of exchange is 1 USD= 5.00 Grivnyas (Grn)**According N.E. Salnikov [8]; ***According the data of Danube Biosphere Reserve (A. Voloshkevich - personal communication).

Dollar adjustment for property damage on living resources is the most prevailing and effective method among economic instruments of rehabilitation

and protection of the Black Sea ecosystem. It is well known that for calculation of the total sum of the damage on fish resources in countries former USSR use average value of phytoplankton, zooplankton, zoobenthos biomass and their annual specific production (P/B). At the same time in contrast to biomass the values of specific production assume as constants in equation of damage calculation [11]. By the way it is necessary to note that these values of specific production have been identify for period before intensive eutrophication and base on the data measurement collected in 60-70s.

The aim of present investigation was to determine the modern values of specific production of the Black Sea phytoplankton, zooplankton, zoobenthos and compare the difference between results of calculation of fee for the damage according to the modern and accepted (standard) values.

Investigated area was the Danube river mouth zone of the Black Sea as one of the richest in fish resources and mostly eutrophicated part of the sea. For the P/B calculations data of quantity investigations of aquatic organisms in different seasons of 1995-1999 were used. There were analyzed 81 samples of phytoplankton, 86 samples of zooplankton and 59 samples of zoobenthos. Biomass and production of all investigated organisms were identified with the help of equations from the papers: for phytoplankton [5, 10] and for pelagic and benthic invertebrates [1,2].

The increase of the updated annual specific production (P/B-coefficients) comparing to the base standards for a plankton (in 1,5-3 times) and benthos (in 1,2 times) influenced the value of demagnification during calculations. Another source of inaccuracy of P/B's determination is to fail to take into account the real water temperature during investigated period. The significant role in living conditions of aquatic organisms has not only absolute value of temperature, but it gradient (rate of change). Using this parameter it is possible conditionally to divide year into the main temperature periods. For the Danube influence zone in the Black Sea three time intervals were determined on the base of long-term changes of temperature [4]. The greatest degree of deviation of updated P/B values from normative (standard) is registered in the warm-water period. In particular the values of P/B were 3-5 times higher for pelagic organisms and 1,7 times - for zoobenthos (see table 2).

Thus it is possible to conclude, that for present ecological situation in the Black Sea, the application of existent method in calculation of damage to fish reserves from loss of fodder organisms causes the significant deviation from reality. In average the calculated total fish biomass understates in 1,5 time for plankton feeding fish and in 1,2 times for bottom feeding fish, if the standard not corrected method of calculation is used [11]. Moreover the

existent method of calculation has some deficiency in methodical order. Accepted values of P/B coefficients are adopted for the annual period. In this situation there is no possibility to take into account the seasonal changes of external natural factors, such as temperature, considerably oscillating during the year. So, in could-water period (January-March) the damage counted on the basis of standard values of P/B leads to the overshoot of results in 1,5-3 times, but during the rest part of the year (9 months) it is undervalued in 1,3-3 times (Tab. 2).

Table 2. Seasonal differences between the standard (St) and updated (Up) values of specific production of feeding organisms in Danube influence zone

Time intervals*		Feeding objects	Specific production		Deviation, %
			St	Up	
1 January - 20 March (Water temperature, T < 5,0°C)	C	Phytoplankton	0,685	0,452	66
		Zooplankton	0,090	0,121	134
		Zoobenthos	0,007	0,001	14
21 March-20 May 13 October - 31 December (T=5,0- 15,5°C)	I	Phytoplankton	0,685	0,962 ± 0,605	140
		Zooplankton	0,090	0,216 ±0,099	240
		Zoobenthos	0,007	0,008 ± 0,003	100
21 May - 12 October (T> 15,5°C)	w	Phytoplankton	0,685	1,939 ±0,166	283
		Zooplankton	0,090	0,536 ±0,194	595
		Zoobenthos	0,007	0,010 ±0,001	143
Average annual		Phytoplankton	**250,0**	**561,0**	**224**
		Zooplankton	**32,8**	**123,9**	**378**
		Zoobenthos	**2,6**	**3,1**	**119**

*Time intervals: C - cold-water, I - intermediate, W - warm-water.

Above-stated facts enable to recommend application of seasonal P/B-coefficients together with calculation of the temperature correction using existing method [12]. The similar approach will enable to promote realization of economic activities in winter season, when the damage is minimum and to minimize effect on water ecosystem in high temperature period of the year, when the probability of negative consequences considerably increases.

Possible recommendations:

- elaborate and approve the system of biological indicators and gradation of their values to identification of the different trophic levels of sea area;
- carry out the division of the Black Sea area into zones (districts) with different trophic level on basis of biological indicators of eutrophication;

- improve existent method of determination the damage to marine ecosystem in define more exactly the average specific production of it basic components (phytoplankton, zooplankton, zoobenthos) for different zones of the Black Sea.

ACKNOWLEDGMENTS

The author would like to thank Dr. D.A. Nesterova, Dr. L.N. Polyschuk and I.A. Sinegub (Odessa Branch, Institute of Biology of the Southern Seas) for phytoplankton, zooplankton and zoobenthos data.

References

1. *Alexandrov B.G. Prediction of production and respiration rate of aquatic invertebrates in ontogeny // Materials of the Second congress of hydroecologist of Ukraine.- T. I.-Kiev, 1997.-P. 98-100 (in Russian).*
2. *Aleksandrov B.G. The correlation between environmental quality and structure of aquatic communities. The ameliorative effect of reedbed ecosystem / In: Biodiversity of the Dunaisky Biosphere Reserve, protection and management. - Kiyv: Nauk. Dumka, 1999.- P. 449-473 (in Ukraine).*
3. *Alexandrov B.G., Zaitsev Yu.P. Black Sea biodiversity in eutrophication conditions / In: Conservation of the Biological Diversity as a Prerequisite for Sustainable Development in the Black Sea Region.- Dordrecht: Kluver Academic Publ., 1998.-P. 221-234.*
4. *Blatov A.S., Bulgakov N.P., Ivanov V.A., Kosarev A.N., Tuzhilkin V.S. Changeability of the Black Sea geophysics fields.- Leningrad: Gidrometeoizdat Publ, 1984.- 240pp. (in Russian).*
5. *Finenko Z.Z. General peculiarities of algae growth and photosynthesis / In: Pervichnaya i vtorichnaya produktsiya morskikh organizmov.- Kiev: Naukova dumka Publ., 1982.-P. 35-45 (in Russian).*
6. *Odum, E.P. Fundamentals of ecology.- Philadelphia. W.B. Sounders Comp.-1971.- 3-ed edition.- 574 pp.*
7. *Prodanov, K, Mikhailov, K, Daskalov, G., Maxim, K., Chashchin, A., Arkhipov, A., Shlyakhov, V., Ozdamar, E. Environmental management of fish resources in the Black Sea and their rational exploitation.- Studies and Reviews. General Fisheries Council for the Mediterranean.- №. 68.- Rome, FAO.- 1997.- 178 pp.*
8. *Salnikov N.E. Fishery characteristics of the lower Danube and embouchure coastal waters / In: Danube and adjoining water bodies within the borders of USSR.- Proceedings of Institute of hydrobiology.- T. 36.- Kiev: Ukr. Acad, of Sciences Publ, 1961.-274-311 (in Russian).*

9. *Strategic Action Plan for the Rehabilitation and Protection of the Black Sea - Turkey: Istanbul, 31 October 1996.- 29pp.*
10. *Strathmann, R.R. Estimating the organic carbon content of phytoplankton from cell volume or plasma volume // Limnol. Oceanogr.- 1967.- T. 12, v. 3.-P. 411-418.*
11. *Temporary method of appraisal of damage for fish stock as a consequence of building, reconstruction and widening enterprises, constructions and other objects; carrying out different kind of activities on the fisheries reservoirs.-Moscow, 1990.- 62pp. (in Russian).*
12. *The methods for the estimation of production of aquatic animals fliandbook and papers)/Ed. byG.G. Winberg.- Minsk: Higher school Publ, 1968.- 245pp. (in Russian).*
13. *Zaitsev, Yu.P. Impact of eutrophication on the Black Sea fauna.- Studies and Reviews. General Fisheries Council for the Mediterranean.- No. 64.- Rome, FAO -1993.-P. 63-86.*