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ON MODELING OF THE SOCIAL-DEPENDED NATURAL OBJECT

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The integral approach proposed to assess functional value of the links in marine ecosystem (ME) is based on the concept that the pertinent natural, social and economic complexes develop as a steady whole. Having assessed the value of every block individually one would have got the insight into the integrated value of marine ecosystem.

Introduction and objectives. In modelling the structural changes in marine ecosystem that would develop in response to external transformations from outside it is essential to take in consideration special features characteristic of the process. Marine ecosystem is the product of evolution that has spatial limits and is persistently self-sustainable, with functional relationships developed within the system; besides this there is a set of system-forming factors, which maintains the particular biotope of marine ecosystem at the corresponding biodiversity level.

Any community of marine species exists within a larger space of marine ecosystem. Ecosystem is not visible by the eye and not perceptible in borders. This is the only concept that implies a certain level of abstract concepts, beyond which is an area of science called ***general systems theory***. In the frame of system concepts this abstraction with respect to natural object has been created [1, 2].

Likewise, community, in the ecological sense (sometimes designated as "biotic community"), includes all the populations occupying a given area. Community and nonliving environment are functioned together as an ecological system or ecosystem. Biocoenosis and biogeocoenosis (literally, "life and Earth functioning together"), terms frequently used in European and Russian literature, are roughly equivalent to community and ecosystem, respectively [2].

Ecosystem as complex concept includes many systems, both living (populations), and environmental. Target setting determines essence of the phenomena: “to build the system model”. “Ecological model building takes many different forms, depending on purpose for which it is done. At one extreme are so-called “explanantotory models”. In contrast to models designed only to explain are models designed to predict future. The great importance of such models in all branches of applied ecology is obvious. They strive to answer the question: how will a given ecosystem continue to develop if left to itself, and how will it react if interfered with? Purely predictive models are of two kinds, regression-type models and time series models. The third approach is consists in processing large bodies of observational data in such a way that interesting regularities hitherto buried from sight become apparent” [3]. Delimitation of an area within which solutions would be realizable is a complicated problem. It seems reasonable to define ***temporal and spatial scale*** chosen in study. Spatial boundaries will inevitably leads to the concept of landscape defined as "heterogenous area composed of a cluster of interacting ecosystems that are repeated in a similar manner throughout» [4].

The nature of ecosystem is “four – dimensional (including time) to account for the variety of marine resources utilized. Fisheries are exploited throughout the water column and along the sea-floor, while mineral resources in the same location can be mined. In terms of a cadastre, a terrestrial equivalent would be a spatial administration system simultaneously encompassing roads, flight paths, cattle herds and flocks of birds. Theoretically the sea-floor can be treated in a similar way to land and its mineral resources” [5].

The allocation of system components and borders suppose existence of a real object and subject of study. Ideally, the observer should create ***problem statement*** for the object. That process determines the selection of the natural elements in systemmaking process and further studies of their essential properties.

According to the definition adopted for general systems theory (GST), the object of study is not the physical reality: “System is a formal relationship between the observed characteristics and properties” [1]. In definition of system elements stringency of test is a significant issue. The more system elements are functionally linked, the more fruitful would be the result of formalization changes in the properties of these elements.

Hypothesis generation on relationships between ME elements has several facets, involved sampling (i.e. so called fieldwork) and efficiently organized experiment. Last can provide an opportunity (but not always) of integrate formalization, which covers most of relationships under model or laboratory conditions. Sometimes the integrate formalization is provided by prior field observations of studied natural object units.

There are more then enough obstacles in complex natural objects study. The main obstacle is the limited human perception, including natural human capabilities. Modern scientific methods was accumulated in fighting with this limitation. At each stage of development in human society an arsenal of methods have been existed in one form or another.

It is easy to imagine a person who must lay out a park or a garden in the framework of the natural landscape. If the goal is not to harm nature it should be a very small kitchen garden or park. Generally the best solution is to leave things as they are in nature. But mankind is always confronted with a problem of survival. And the solution of that problem always required accumulation of new territories and resources. But going back to the process of functioning complex “environment-nature-society”, we can say more or less optimistically: there is a narrow methodological gap, which is called a "model". But in this gap one can lose objective complexity, because the model is always simplified observers idea. This process always presents ***limitations*** due to ***incomplete isomorphism of real*** object into ***the ideal model*.** Usually, the model can not capture the real complex object in its entirety, but only formalizes certain functional relationships amenable to formalization.

It is just a starting and decisive point in the choice of study methods. The contradiction brought to life ***variety of models.*** But if the ***model*** isn’t correlate to the general system, it always seemed helpless to some extent and useless to some extent.

Natural object (community, population, species, etc.) is completely indifferent to the society. For any natural object it will be much more natural and useful, or rather more favorable, if society is not exist at all. This would open all the benefits of full and the unrestricted life for the natural system. However, the process has developed to present-day state. Historically society is depleted nature in different ways. This is reflected on the resources extraction, species space limitation, depletion of animals and plants habitats. Society which is situated very closely to these species, successively deteriorates their living conditions. The current situation has led to a ***decrease of biological diversity on the planet***, and this process has been going steadily.

However, there is an optimistic trend in methods for these negative processes. The last century modeling techniques developed and successfully solved some global ***productivity problems.*** However, the problem ***of sustainable relations between nature and society*** is not advancement [6].

The complexity of studied objects is the main reason for this. It is known that the objects of wildlife and social stratum are classified as systems in which statistical methods can be used only to particular links of the system. In general sense for system inherent so called organized complexity, where a significant number of factors lead to the observed results [7].

Obviously, complex object study involves a complex set of methods. A variety of methods is just the set of models. And here we are confronted with the fact that marine ecosystem is the multifaceted_object of study. Description of the ecosystem in its completeness is not realizable in with single type of models. But there is no certainty that we will describe the object in the desired fullness, even using a variety of models. In a general sense model of any type involves only a ***partial isomorphic mapping of ME*** mentioned above.

The input ecosystem parameters (in real life the environmental and biotic factors) existing within the ecosystem as defined hierarchical links affecting the studied spatial level of ecosystem must form isomorphic formal constructed model. Thus one transformation (as closely as possible) of ecosystem inputs in model input parameters and ecosystem output parameters in the model output parameters are formed. And the state of the inputs / outputs of the model should be an inverse image of inputs and outputs of the ecosystem.

Community macro-scale model. Community model required a number of definitions in context of hierarchical environment. The biotic and abiotic factors are habitat forming conditions for the community at micro-scale. But at macro-scale community embedded in the society area. Community becomes the source of resources. And for society community be possessed of utilitarian value.

Functional value of natural system is predicated upon main immanent and essence process. The ***aim of any biological system*** is the reproduction of itself keeping constant own relations with the environment. This is a very particular process that is inherent only to living system.

Biological system value is a category which must be defined in connection with society process. For society ***biological system*** value is always revealed in utilization of biological system resources. So the society acts as a consumer. Though there are different society needs, and hence various properties of a natural object which can correspond to demands of society. There is an aesthetic value of natural object and any application of this value will not contradict the ecosystem stability process. Meeting the material society requirements (resources consumption) is more contradictory. This is due to the consumption resources. Extraction provided by nature resources means interference in ecosystem functioning.

Functional value of the marine ecosystem. A set of marine ecosystem properties should be considered for assessing intrinsic functional value. Uppermost functional ecosystem optimum is defined between the lower and upper bounds of abiotic and biotic factors. Functional optimum is determined in the model area. Under functional ecosystem value it is natural to mean assessment of its vital properties. Environment properties formed for species (involved in community) life optimum. Virtually this optimum can’t be observed by researchers. None the less it is always known, because it can be defined in ***terms of species density.***

Globally species functional optimum is realized through its actual or ***synecological natural habitat***. Synecological natural habitat exceeds the actual natural habitat on the potential areas where abiotic factors are adequate to needs of species and coexistence with other species is not limited by species competitors.

From the standpoint of society the consumer value (e.g. fishing value) is associated with live ecosystem. In consumer value are realized the utilitarian ecosystem properties. Society needs are involving live component in the extrinsic for ecosystem process. As already mentioned above the aesthetic and landscape demands of public are the least "injuring” for nature. Model of quantitative estimates is serve as a criterion for selection of ecosystem properties which society will bring into production.

Intrinsic model selection. The objective of this study is to reconcile the interests of society with nature processes. So desire of society to achieve ecosystem sustainability is initially supposed. Model adequacy to community processes depends on substantially on the goal setting. So called “embedding factor” should be considered turning to the intrinsic properties of the ecosystem. Ecosystem contains environmental factors and living organisms, conditionally divergent into different types of communities. Usually the division is conditional. Functional process in ecosystem is generally defined by habitat boundaries. In natural conditions it is vertical location of fauna in the layers of water column (neuston, plankton, benthos) or distinction the size groups of fauna (e.g. micro-, mezzo-, macro forms) These lead to system fragmentation into ***subsystems*** with different components and therefore with ***different functional properties***.

ME conceptual model is the basis of its formal model. Energy relationship between the populations of different trophic levels isolates the community. Pelagic or benthic community is distinguished as a separate unit of ecosystem functioning. That intrinsic functional value should be evaluated first.

Functional aspect is modified and should be expressed not in density terms but in cost terms in ecosystem interaction with society. It is rather complicated task to construct a more universal model that meets general laws of community functioning. Further difficult task is to find balance between community optimum and processes of society consumption. ***Population of species*** is element of any community. Relations between species populations formed the time-invariant ***community structure.***. The structure depends on nutrient, migration and energy fluxes between populations. ***Degree of fluxes isolation*** defined the degree of community isolation. ***Closed structure*** can be proceeded out only in the flux frames, because any community within its habitat is an open-system.

Integrity is one of the key system properties. The matter and energy flow between different trophic levels stipulates community integrity. Community structuring is very much essential in modeling. Different environmental factors created more or less preferred but non-uniform conditions and resulted in structure formed by unequal shares of different species. Some species or groups of species are becoming dominant in the community; they acquire the set of specific properties, which defined the community process [8].

This is closely related with theory of K and r-strategists [9]. Dominant species should be in a special position in relation to environmental factors determining ecological niche in the community [10, 11]. In a general sense edificatory species (K-strategists) are responsible for quantitative relationships in community structure [12, 13]. The renewal after hypoxia events in *Mytilus galloprovincialis* community subjected by modification of quantity K-strategists *M. galloprovincialis.* Core species portion were at constant level both in hypoxia and in normoxia area. The rare species decline correlated with observed quantities 2000 g*m-2 of *M. galloprovincialis* [12]. In the boundary community of the bivalve *Modiolula phaseolina* oxygen dependent structure changes observed. “At the Crimean slope at water depths of 70–90 m and oxygen concentrations of approximately 290 μmol L^{-1}, the only community-forming species found was the bivalve *M. phaseolina* (K-strategist) which made up 77% of the community, *while* smaller species, such as annelids (r-strategist), contributed only 14%. At the 100–150 m depth level, the oxygen concentration decreased to 140 μmol L^{-1} and the community structure changed: the proportion of annelids and other r-strategists increased to 42%, whereas *M. phaseolina* made up only 29% of the benthic community. R-strategists reproduce and grow fast and are therefore better adapted to unstable environments (e.g., rapidly changing oxygen concentrations) than K-strategists, who produce a lower number of offspring with lower growth rates [9, 14]. The predominance of *M. phaseolina* at shallower depths agreed with earlier reports of molluscs or K-strategists as typical community-structure forming species in the Black Sea under stable oxic conditions [13].

The ***concept of dominance*** is associated with the hypothesis of a ***hierarchical ordering*** of living open systems [15]. Levels defined in ME model should be considered not only as the external point of the structural hierarchy, but also as functional relations within uniting energy or matter fluxes. So accrued a new unit, which have acquired the ability to realize new functions [16].

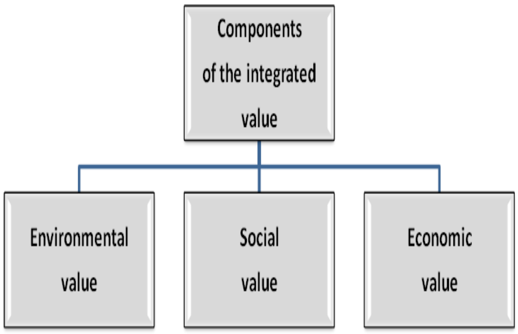
The hierarchy is formed in accordance with structural integrity. Each ecosystem hierarchy level is associated with the following one to maintain a stable state [17].

Species richness acceptance as the main variable is based on consideration, that the number of species is determined by the environmental factors [2, 4, 6, 8–11, 14]. Island communities, for example where there is a settlement and adaptation to incomplete food chains the number of species is determined by the environmental factors [18 – 20].

The order of magnitudes of species abundance or biomass can serve as a criterion for hierarchical order in the community [14, 21].

Ecological pyramid of abundance and biomass, only confirm the order of magnitudes for different species [15, 22]. In describing the ***carbon cycle in the ecosystem march*** each subsequent level is the result of the aggregation of the previous. In communities there is a so-called dimensional hierarchy, from the micro to the macro level. Each level has its own energy regularities, and hence, its own hierarchy. Trophic interactions of the lower level are included in the energy metabolism of the upper level.

Functional value of marine ecosystem links. The integrated approach proposed to assess functional value of the links of marine ecosystem (ME). It is based on the concept that the pertinent natural, social and economic complexes develop as a steady whole. A specific set of system-forming characteristics describes each of the blocks of the proposed model (fig. 1), which continuously interplays with each other. Having assessed the individual value of every block one would learn the integral value of a marine ecosystem. The analytical estimates suggest that public institutions are striving for the sustainable development of the three blocks [23, 24]. Ecological capacity of the environment is a standardizing parameter that links together all the three blocks.



F i g. 1. The conceptual model for assessing the marine ecosystem value

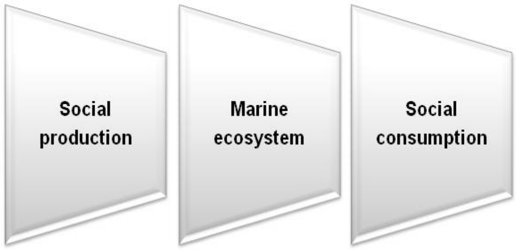
Being considered with regard to ME, ecological capacity means the substance and energy cycle coupled with the self-regulation machinery and the steady biodiversity inherent to the examined ecosystem.

The model that represents this approach specially focuses on the lower (initial) level of the object to be assessed, i.e. marine ecosystem (fig. 2).

F i g. 2. The services of marine ecosystem

Taking the system as a chain of several links – from social structures to the ecological structure of marine ecosystem, one finds out that fragile marine ecosystems communicate with humanity in many ways; the connection through the global biosphere is especially strict. System-forming relations underlay of ecosystem makes up the unbreakable unity of the chemical cycles of nutrients and biotic relations with elements outside the ecosystem [25].

Fundamental relationships between social system and biota as related to marine ecosystem exploitation. Spatially marine ecosystem is incorporated into some or other social structure and therefore cannot be regarded as an abstract idea having nothing to do with the social structure (fig. 3).



F i g. 3. The model of the socially depending natural object

In its turn, social system is an integrated formation in which people with their multiple and intricate relations, interactions and affairs exist. Social relations develop through collective human affords and activity. In studying marine ecosystem as a model of social depending natural object it is essential to remember that with regard to social framework the environment of marine ecosystem also incorporates public environment as the totality of human activity and habitat. The habitat consists of material objects and natural environment. Social production changes the environment through direct and indirect impacts upon all and every environmental elements [26].

This process is in close spatial and temporal interrelation with the society territorial structure, in particular 1) the arrangement of human population, the placement of the branches of industry, social and business institutions, 2) the territorial differentiation of labour, 3) nature exploitation, 4) regional economic division, and 5) territorial and administrative features special to the society.

Conclusions. Marine ecosystems are the product of evolution that has spatial limits and is persistently self-sustainable, with functional relationships developed within the system; besides, there is a set of system-forming factors, maintaining biodiversity at the level inherent to the ecosystem. The integral approach proposed to assess functional value of the links in marine ecosystem (ME) of is based on the concept that the pertinent natural, social and economic complexes develop as a steady whole. Having assessed the value of every block individually one would have got the insight into the integrated value of marine ecosystem. Ecological capacity of the environment is the standardizing parameter that links together all the three blocks.

Positioned within some or other social structure, ME spatially belongs to it. Exploitation ecosystem resources is associated with society territorial structure, in particular with arrangement of human population, the branches of industry, social and business institutions, etc.

Marine ecosystem state may conform to ecological norm been disturbed through unfavorable impacts. In modelling the structural changes we proceeded from the presumably operating model of sustainable development of ME incorporated into the larger global model of biosphere buffer, which opposes and neutralizes perilous anthropogenic impacts.

The proposed model of the sustainable exploitation of ME resources shows the preference for the normative removal of renewable resources.

The non-renewable resources which compose marine ecosystem are to be used mostly in the realms of science, education and recreation, and also in satisfying aesthetic interests of those loving nature.

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