MEASUREMENT OF ECOSYSTEM INTEGRITY

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ABSTRACT. – Measurement of ecosystem integrity. Partial and totally exclusive decision alternative, intense and increasing public pressure for rapid and significant changes, important costs for certain groups, technical, ecological, and social uncertainties and repercussions on different sectors feature the current issues to be addressed in nature conservation. Within this framework, clear definition of objectives becomes a key requirement for ecosystem management. This requirement is conditioned by the measurement possibilities of ecosystem integrity, since the maintenance of i tis the general goal of nature conservation. On the other hand, the ecosystem notion is burdened by bias do to the low precision in spatial and temporal delimitation of ecosystems, fact that creates difficulties in the establishment of indicators and projection of feasible monitoring systems. The paper aims to analyze the progresses made in this direction and to assess the possibility to use different indicators in ecosystem management. In this respect it identifies and discusses a number of discourses in the definition of ecological integrity that are different by how they recognize the role of science and how they conceptualize the people-ecosystem relations and which could be relevant for creating a system of indicators.

Keywords: nature conservation, ecosystem management, ecosystem integrity, indicators.

1. INTRODUCTION

Nature conservation is a major public concern that focused the attention of public and authorities. This position is motivated on the one hand by the state of ecosystems, and on the other hand by the increasing pressure of humans that rely on these ecosystem. Therefore, intense research was carried out worldwide to improve the conceptual and practical framework of nature conservation.

Ecosystem management emerged as the most widely accepted approach, but its implementation necessitates several aspects to be discussed and agreed on. Among these the monitoring issue is quite prominent since it is important for both, planning and assessment, which, on their turn, are the main tools to address the uncertainties that feature the complex ecologic systems.

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Ecosystem integrity is the final aim of nature conservation its quantitative expression being therefore of crucial importance for an effective management. The paper aims to contribute in this area by discussing the discourses of ecosystem integrity definition (normative-conservative, normative-systemic, ecosystem-pluralistic, and transpersonal-collaborative) which are different by how they recognize the role of science and how they conceptualize the people-ecosystem relations.

2. DISCOURSES AND DEFINITIONS

The bias that surrounds the ecosystem concept was transmitted to its derivates such as ecosystem integrity. Navarette et al. (2004) approached this topic from a wide perspective and identified a number of discourses that underpin the various definitions for this concept. Thus, they differentiate four types of discourses and describe them using ten criteria, as it is presented in table 1.

Table 1. ***Ecological integrity discourses***

Criteria	**Wilderness-normative**	**Systemic-normative**	**Ecosystemic-pluralistic**	**Transpersonal-collaborative**
Mindset	Homeostatic	Homeorhetic	Self-organizing	Co-evolutionary
Definition of integrity	Pristine ecosystems	Certain states of ecosystems	Ability to continue self-organization	Metaphor of ecological, social, and individual co-evolution
Main objective	Preserve pristine ecosystem	Preserve certain capacities	Integrate human values and ecological realities	Integrate personal growth, social organization, and human-environment interactions
Role of science	Objective science inform about normative issues	Objective science with descriptive and normative functions	Different perspectives with descriptive and explanatory power	Individual's integrity through making sense of biophysical constraints
Role of scientists	Measurer and prescription	Assessor and prescription	Narrator and facilitator	Knower
Quality assessment	External truth	External truth but being explicit about uncertainities	Expert opinion, self-consistency and transparency	„well constructed" testimony
Role of humans	Humans are apart from and threaten ecosystems	Humans are apart, but ecosystems are always under anthropogenic stress	Humans are part of ecosystems. Thus, they both influence and are influenced	Ecosystems are part of humans and cannot be meaningfully separated

Criteria	**Wilderness-normative**	**Systemic-normative**	**Ecosystemic-pluralistic**	**Transpersonal-collaborative**
Main ethical discourse	Prescriptive Principle of Integrity Absolute autonomy of nature Integrity as a foundational value	Prescriptive Principle of Integrity Autonomy of nature in terms of self-organization processes -Integrity as a foundational value	Post-Normal Science Plurality of values in conflict leading to a participatory discussion	Collaborative learning about ecological integrity as an evolutionary path in our being-towards-death
How to deal with nature	*Command-and-control* focused on human activities in buffer areas	*Adaptative management* focused on human activities as they relate to ecosystems	*Collaborative management* focused on human-ecosystem trade-offs	*Collaborative learning* focused on respectful co-creation with our biophysical constituencies

The proponents of this approach do not make any normative remarks regarding the hierarchy of these discourses. Nevertheless they refer to an appropriation of situations and discourses. Thus normative discourses are considered adequate for emergency situations than urgent rules are needed and governments has to rely on „solid ground" and then population identify its interest with public actions. In case that public intervention are reluctantly accepted by population that will be burden with most of the costs of conservation it is suggested that collaborative and pluralistic discourses are far more effective than the normative ones.

3. INDICATORS OF ECOLOGICAL INTEGRITY

The analogy between the concepts of individual health and ecosystem integrity could be applied also for addressing problem solving. At individual health level problems are diseases that could be treated after a diagnosis based on symptoms and results of analysis. For ecosystem integrity this could be also true, but the symptoms are different, since there are no organs or nobody to speak about them. The question is which observable characteristics of the ecosystem could be used as indicators of its state and by their changes could represent symptoms for diagnosis. Considering the opinion of Bran and Ioan (2004) about the functioning of ecosystems, indicators of ecosystem integrity could be one or more of the following:

- biodiversity;
- resilience and resistance;
- complexity in structure and function;
- presence of large species;

- presence of higher order predators;
- controlled nutrient cycling;
- efficient energy use and transfer;
- ability to maintain native species;
- native/introduced species ratio.

Ecosystems with high integrity are more *resilient* to changes of environmental stresses. Resilience is defined as the capacity of ecosystems to tolerate increases in stress without exhibiting significant responses. Other definitions refer to the ability of ecosystem to recover from disturbance.

Biodiversity is made up by the number of components and their representation on at least three levels: genetic, species, and ecosystem. The relation between diversity and stability was explored in various settings and led to very different answers (fig.1).

Nevertheless, there is a widespread perception of a positive correlation between the diversity of ecosystem and its integrity, since diversity is an intrinsic feature of life at all levels. Although there are various indicators proposed for biodiversity measurement, the most frequently applied one is the number of species.

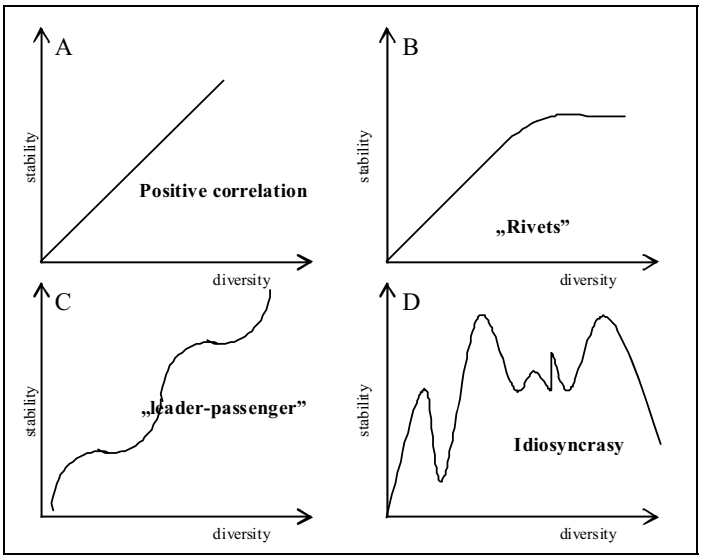

Fig. 1. ***Stability-diversity relation according to the hypotheses supported by A, MacArthur;B, Ehrlich&Ehrlich; C, Walker; D, Naem***

The *ecosystems' complexity of structure and function* is reactive to the stresses coming from climate, soil, chemistry. Therefore, an indicator of this complexity could indicate changes in the ecosystem integrity.

Presence of large species. Large species necessitate a large amount of food or nutrients provided in a continuous flow, usually for a long period, since most of them are long-lived (large trees could reach hundreds of years). In case of animals, there is also a need for large areas to be freely explored for food seeking. Thus, the

presence of large species is therefore an evidence of an intense nutrient cycling and of a large available area, that is the case a healthy or integer ecosystem.

Presence of higher order predators. According to the eltonian pyramids, high order predators have small populations, but the survival of such population indicate that populations in all inferior food levels are large enough and also that there is plenty of space available.

Controlled nutrient cycling. Although there is a regional and global scale in nutrient cycling, most of the ecosystems will „try" to reduce leakages by diversifying the food web and improving the recycling capacity. Young or disturbed ecosystems cannot make a good soil cover rainfall will wash away many of the organic and inorganic nutrients from soil.

Efficient energy use and transfer. Energy is at the heart of any transformation, including the ones that occur in ecosystems. Ecosystems are not very good in up taking and storing of energy, since energy transfer from one component to another is made by loosing most of it as heat. For example, photosynthesis transform only one percent of the incident light in organic matter. Further, herbivores can preserve only 10% from the energy of their food, the rest of it being lost as heat (transpiration) or used for procuring the food (movement, hunting). This is the case of a healthy ecosystem. Than the ratios are below such values it could be argued that the integrity is affected. Since assessments of energy transfer rates involve a lot of time and effort, biological productivity is used as a proxy to find out the intensity of energy flow. Ecosystems with high productivity could be considered healthy ecosystems.

Ability to maintain native species. In a healthy ecosystem, a native species is assumed to find all that it need to survive and have a stable population. In case that a species necessitate repeated interventions and management measures to secure a minimum population, this could be interpreted as a sign for a lower ecological integrity. Some unexplored elements or processes that are needed by the envisaged native species are missing leading to a high failure rate of management actions.

Native/introduced species ratio. The presence or high occurrence of introduced species could indicate that the web of interactions among native population is loose and there are free ecological niches.

4. FINAL REMARKS

The challenges of nature conservation are manifold while the emergency of increased effectiveness is more and more obvious. Ecosystem management is the latest development of nature conservation approaches because of experience, scientific knowledge and cooperation at national and international level. According to Ioan et al. (2010) a key driver of success in this approach is monitoring that allow both: planning and assessment.

The paper considered a central concept in nature conservation – ecosystem integrity, and a key success driver – monitoring. The aim was to establish a list of indicators that are feasible enough to be measured by the currently existing means. Although a process with a sound rational there is a conceptual gap stemming in

the bias that surround the ecosystem concept. Thus we started by engaging a discussion about different perceptions that compete in the definition of ecosystem integrity. It resulted that the concept could be better understood by an analogy with individual health. Further, the indicators of ecosystem integrity were established bearing in mind the proposed analogy, but also basic ecological knowledge.

REFERENCES

1. Bran, F., Ioan, I. (2004), *Ecologie generala*, Editura ASE, Bucuresti.
2. Ioan, I., Bran, F., Radulescu, C.V. (2010), *Dimensiunea manageriala a conservarii naturii*, Editura Universitara, Bucuresti.
3. Manuel-Navarrete, D., Kay, J.J., Dolderman, D. (2004), Ecological integrity discourses: linking ecology with cultural transformation, *Human Ecology Review*, vol.11, nr.3.