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NATIVE MOLLUSC BEDS: STRATEGIC MANAGEMENT, PROTECTION, RESTORATION AND EXPLOITATION

Autohtoni nasadi mekušaca: strategijsko upravljanje, zaštita, obnavljanje i eksploatacija

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Pregledni članak
Review

Sažetak

Općenito je poznato da su nasadi kamenica posvuda u svijetu izloženi većim oscilacijama ili su u opadanju. U SAD-u, Chesapeake Bay, u razdoblju od 1985. do 1990. zabilježeno je znatno opadanje u proizvodnji sa 700 - 800.000 kg godišnje na 4.000 - 5.000 kg godišnje. U Australiji proizvodnja je u padu od Drugog svjetskog rata, i iznosi 45%. Slično je i na Mediteranu: prema godišnjaku FAO (1997.) europski stokovi kamenica pokazivali su rast u razdoblju 1950.-1990., nakon toga opadanje je linearnog oblika pa od 1995. do 2000. iznosi 45-50%. Što se tiče proizvodnje ostalih pripadnika skupine školjkaša, smatra se da su stokovi u opadanju te prate "konkavno silazeću" putanju (FAO, 1997.). Glavni proizvođači europske plosnate kamenice na istočnom Mediteranu su: Italija (46,1%), Grčka (4,4%), Turska (2,2%) i Hrvatska (1,5%). Glavne zemlje proizvođači skupine mekušaca su: Italija (69,0%), Grčka (16,0%), Turska (2,2%) i Hrvatska (3,7%). Površina Jadranskog mora, sa značajnim dotokom slatke vode i visokim stupnjem eutrofikacije, bitno je područje za proizvodnju mekušaca. Ključno je pitanje pritom koliko je ova industrija osjetljiva i stabilna.

Abstract

It is no secret that commercially important oyster beds are declining or fluctuating sharply all over the world. In Chesapeake Bay (USA) from 1985-1990 there was a sharp decline in production from 700,000 - 800,000 kg to 4,000 - 5,000 kg. In Australia production has declined since World War II to 45% of earlier levels. The same has occurred in the Mediterranean: according to F.A.O. (1997) European oyster stocks increased from 1950-1990, but by 1995-2000 they had declined almost linearly to about one-half earlier amounts. In addition, other Molluscs are considered to represent "concave downward" declining stocks (F.A.O., 1997). The main producing countries in the East Mediterranean for the European flat oyster are Italy (46.1%), Greece (4.4%), Turkey (2.2%), and Croatia (1.5%). For other species, the main producing countries are Italy (69.0%), Greece (16.0%), Turkey (2.2%), and Croatia (3.7%). The Adriatic, with considerable river input and a high degree of eutrophication, is important for mollusc production. The main question, however, is how stable and sensitive this industry is.

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Starting from the main issue that the natural stocks decline the need for the elaboration of a strategic management plan for the native mollusc beds is imperative. Strategic planning is an important tool for any sector when we need to do more than react to events as they unfold. Strategic planning involves a realistic assessment of the external environment and the factors bearing on it, now and in the future. Arising from this analysis, various "strategies" can be determined which will enable overall objectives to be met. The framework of a strategic management plan includes discussion and measures on issues such as property rights, policy issues affecting water quality and quality assurance, other aspects of government administration, generic promotion and R&D. Issues affecting business structure, the specific production technology employed, brand development and related aspects of marketing, are more likely to reflect the goals of individual businesses, although there may be a role for voluntary collective action (but not mandatory, or industry-wide action) in some circumstances.

Strategic planning for the development of mollusc industry is not strictly a scientific or a administration problem to solve. It is a multi-parametric and multi-sectoral problem and as in any similar case, our inability to handle multi-parametric problems results to plans with limited results or more frequently, to disasters.

Management Plan Vision

Vizija plana upravljanja

A typical oyster management plan should address both habitat restoration and fishery management in one cohesive document. The basis of strategic decision-making should be on the known biology of the species. It should also establish adaptive management approach and provide better coordination among key agencies, organizations and institutions involved in the oyster restoration effort.

Plan Structure

Struktura plana

There are 6 main components within a strategic management plan for oysters aiming to the rebuilding and managing the native populations in a given site:

1. Establish sanctuaries that protect oyster populations from harvest and implement restoration projects based on salinity zones;
2. Rebuild oyster habitat;
3. Implement harvest strategies;
4. Increase hatchery production;
5. Improve coordination among the oyster partners and,
6. Develop a database to track oyster restoration projects.

All strategies consider the impacts and limiting factors associated with disease, environmental quality degradation (water quality and habitats) and the management of fisheries. A plan provides guidance on restoration areas and a standardized approach to implementing restoration projects. A typical structure and elements are illustrated in Figure 1.

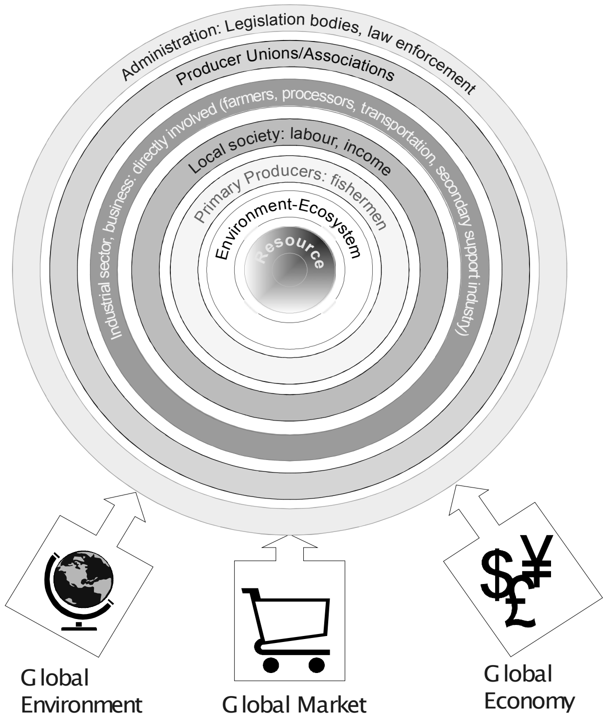

Figure 1. Oyster management plan elements and interactions

Slika 1. Elementi interakcije plana upravljanja kamenicama

Management Plan Objectives

Cilj plana upravljanja

The first step for the establishment of a management plan is to identify a clear, well documented and understandable set of objectives which will be common to all stakeholders involved in the process.

<u>Objective 1:</u>

To increase oyster populations to levels that restore important ecological functions, including: water filtration and nutrient cycling; habitat creation for organisms such as oysters, finfish, crabs, and a diversity of other species; and adequate broodstock to sustain regional populations. Accordingly, this objective emphasizes the need to focus on ecological functions in judging the long-term success of restoration efforts.

In order to achieve the primary ecological objective, the plan commits to the following:

1st. Achieve a significant increase in oyster biomass (for example, five-fold) within a certain period (for example, until 2010).

2nd. Rebuild habitat by constructing new reefs on appropriate bottom type; considering environmental conditions and, increasing production from remaining reefs.

3rd. Conserve a percentage or all of the remaining historically productive oyster grounds as permanent sanctuaries.

Objective 2:

Achieve a sustainable oyster fishery. This objective reflects the economic and social value associated with commercial oyster production.

Objective 3:

Reduce the impacts of disease on oyster populations.

Objective 4:

Reduce environmental degradation and restore environmental quality suitable for oyster reproduction, growth, survival and resilience.

Objective 5:

Increase hatchery production for restocking and develop disease resistant strains. One approach to rebuilding oyster populations is increased hatchery production of oyster spat. Although hatcheries will never match the potential of wild oyster populations, hatchery production could play an important role in re-establishing oyster populations in depleted areas. Hatchery operations also have the potential to selectively breed oysters that are disease-resistant.

Strategy Overview
Pregled strategije

Typical management plans have one major axis of progress. Usually most management plans recognize that disease is the dominant factor and that disease is correlated with salinity. In addition to this, except from disease, salinity is an important parameter affecting oyster life history. Comprehensive management strategies defined according to salinity have two major benefits: prevention of disease (even if disease is not a problem); and rebuilding of oyster populations.

As estuarine organisms, oysters exist under a wide range of environmental conditions. In any given area, a particular oyster bar, river system, or region is subject to change, especially due to rainfall patterns. During periods of abnormal rainfall, salinity is altered dramatically. For example, Mali Ston Bay is strongly affected by salinity due to the Neretva River delta, low depth (in general), and geomorphology (narrow and long).

Based on other the management plans, 3 salinity zones have been recognized as applicable to oyster management plans (Calvo et al., 2001):

Zone 1

Zone 1 is the lower salinity water areas between 5‰ and <12‰. Zones of type-1 are characterized by lower disease and better survival, but low reproduction capability. Restoration efforts will depend on seed plantings to increase populations. If disease exists in this zone, low salinity reduces its impact. There is less mortality and oysters live longer. However, because of the decreased salinity spat settlement is very low, often non-existent. To increase the oyster population, this area is dependent on either natural or hatchery seed. Expectations are that oysters in this zone will contribute significantly to the long-term biomass accumulation.

Zone 2

Zone 2 is generally classified as 12-14‰ and has fluctuating boundaries based on climatic variation of wet and dry years/seasons. This zone experiences a range of spat settlement from low to moderate to high due to fluctuating environment parameters. Disease mortality, if existent, also fluctuates by increasing during dry periods and by decreasing during wet periods. When disease mortality is absent this zone can experience rapid recovery of populations and biomass due to increased survival in combination with successful recruitment. Fishing production will have varying results in such areas. Any oyster projects in such zones should be carefully considered on an annual basis.

Zone 3

Zone 3 is the highest salinity regions with greater than 14 ‰. If disease is existent in this area there will be a great pressure on the population. In diseased areas, there is generally heavy disease-related mortality and few oysters survive to market size. Those oysters that do survive beyond 3-4 years in this region may presumptively be disease resistant. This area favors spat settlement and there is a greater probability of yearly spat settlement events, which provides a fairly constant influx of new oysters to the zone. More aggressive restoration techniques involving stock enhancement with selectively bred oysters will be required. Restoration sites will require adaptive management and extensive maintenance.

Management
Upravljanje

Adaptive management is an excellent tool for applying oyster plans and receiving good results. However, adaptive management is costly at least because of its rapid response nature and constant monitoring actions. Before any plan is implemented in a certain region, the results of previous efforts should be considered to formulate the best approach for each project. Stakeholdesr should utilize the best available data to obtain the greatest level of success from each individual project and from all the projects within the plan. The essential elements of adaptive management are:

- Project Design: Projects will be designed to provide as much information as possible about the performance of the system.

- Measurable Objectives: All projects will have clearly defined, measurable objectives that relate directly to the objectives.
- Strategic Decision Making: Considerations of oyster biology, potential for project success, and contribution to overarching objectives will form the basis for decisions about where and how to invest limited resources.
- Project Review Process: Partners and stakeholders will participate in the review of proposed project plans and site designations through an ongoing review process.
- Monitoring: Project budgets need to include sufficient resources for monitoring in order to adequately measure and report the results of the project.
- Evaluation: Results of projects will be shared among the restoration partners through the ongoing project review process, as well as by the development of information management systems and annual review symposia.

Impacts of Disease

Utjecaj bolesti

When disease is existent or appears in an area, the plan should have already anticipated counter-measures to reduce its impact on the oysters and the success of ongoing projects. The impacts of disease on oyster populations are related to salinity. In low salinity areas (<12 ‰), a proportion of the individuals that survive to adulthood (i.e., reproductive maturity = about 3.5 to 4 cm) reach or exceed market size. However, these low-salinity areas also have low population recruitment rates because salinity affects the production of gametes, larval growth and settlement. Oysters in low-salinity areas are also subject to mortality during freshets. In mid-salinity areas (12-14‰), oyster survival and growth are variable depending on climatic fluctuations – in wet years survival is generally higher but spat settlement and growth are poor, and in dry years the opposite is true. Higher salinity areas (>14 ‰) tend to have large numbers of small oysters because population recruitment rates are higher but fewer individuals survive to large size.

Oyster Sanctuaries

Rezervat kamenica

One of the strategies for rebuilding the oyster resource and increasing oyster biomass is to designate sanctuaries. The creation of sanctuaries will also protect the complex biological interactions of oyster bar communities and transitory finfish populations. Shellfish harvest will be prohibited in sanctuaries and habitat will be improved to facilitate oyster growth and survival. By protecting oysters from harvest and rehabilitating habitat (e.g, bar cleaning; addition of cultch) there is the potential to increase oyster biomass, i.e., broodstock (spawning adults) and larval production. Environmental parameters such as salinity and temperature, and disease mortality will significantly affect the success of oyster sanctuaries A network of clearly marked oyster sanctuaries will be established.

Salinity patterns, disease prevalence and intensity, bottom type, historical productivity, stock abundance, currents, and water depth are all factors that affect oyster production and will be clearly measured and defined

Table 1 summarizes different project objectives and site characteristics that should be considered when determining placement of a sanctuary in low salinity zones.

Habitat Loss and Degradation

Gubitak staništa i degradacija

Oyster reefs as they occurred historically no longer exist in many areas due to the degradation of the habitats. Habitat degradation may be owed to human activities or natural processes. Massive fishing of oyster beds, disease outbreaks and alterations of the coastal morphology are the most common reasons for degradation of natural oyster beds (Hargis and Haven, 1995; Brush, 2001; MacKenzie 1983; Smith et al., 2001).

Table 1. Project objectives and site characters for oyster management

Tablica 1. Ciljevi projekta i karakteristike pozicije zbog upravljanja kamenicama

OBJECTIVE	CHARACTER
Long-term survival	Salinity <10‰ Limit oyster placement to bottoms contaiing potentially disease-resistant individuals
High oyster density	Seed at high densities (>250/m²) Use disease-free seed from aquaculture
Sustained population recruitment	Salinity > 12‰ or repeated stocking from aquaculture-produced seed
Oyster reef growth	Low sedimentation rates (soluble solids etc.)
Disease dependent natural selection	Salinity >15‰ High disease mortality
Reproduction and spat settlement	Salinity >10‰ and known history of sp[at settlement
High disease-tolerant biomass	Plant seed in high densities Use disease tolerant species
Local larval retention	Suitable hydrography and water currents

Fishery Management

Upravljanje ribarstvom

By definition, fishery management is the act of managing harvest. The main strategy for regulating harvest and enhancing harvest potential is to establish sanctuaries and special management areas. By establishing areas that are protected from harvest, fishing mortality rates (F) in managed areas and the overall F for the population will decrease (Powell et al., 1994). If these measures don't provide the needed increases in biomass, it may be necessary to further regulate the fishery.

Fishery management guidelines may be to:

- Develop guidelines for managing fishing effort and monitoring oysters in open and closed areas.
- Monitor the population size, age structure, and disease prevalence and intensity.
- Determine level of acceptable exploitation.
- Regulate harvest and gear types.
- Develop additional monitoring efforts depending on criteria for opening/closing an area
- Close area when harvest criteria are met.

Control of oyster harvest can be achieved by one or more of the following methods to reach an appropriate fishing mortality rate (F):

- limited entry into the fishery
- time limits
- altering size limits
- bushel limits
- seasonal restrictions on public grounds
- area restrictions (eg. sanctuaries and reserves)
- partial or a full moratorium with or without a license "buy-out."
- establish a total allowable catch (TAC) based on current environmental conditions

Hatchery and Aquaculture Considerations

Mrijestilište, uloga u Akvakulturi

Oysters have been cultured or artificially propagated since historic times (Castagna et al., 1996). Traditional methods of oyster restocking involved the placement of oyster shell in areas of high larval settlement and subsequent transplanting of newly settled spat for grow-out in areas favoring oyster growth to market size. Most recently, hatcheries have been used to artificially produce seed oysters for a variety of purposes, ranging from recreational and commercial oyster aquaculture to broodstock enhancement and support of commercial fisheries (Meritt, 1977). Oyster hatcheries can produce seed oysters with potentially improved quality. Hatchery seed can be free of endemic oyster parasites that may provide some advantage when placed in the natural environment. In areas of low natural spat settlement, the use of hatchery seed provides an initial, dense population of oysters that otherwise would not be available. Hatchery production can also be used to artificially select for genetic traits which may lead to increased survival. Using hatchery-produced oysters to enhance broodstock could be a critical component in augmenting larval production and recruitment when natural spat settlement is low and could play a key role in rejuvenating oyster populations. However, the overall number of oysters that hatcheries can generate on an annual basis cannot compare with the numbers of larvae produced naturally. The problem of maintaining a substantial genetic diversity with the hatchery produced seed should be addressed (Allen and Hilbish, 2000)

Monitoring & Information Management

Nadgledanje, informacijsko upravljanje

An important part of the planning process is coordinating how the stakeholders will monitor their projects, process the data, and make the data available to each other and other interested groups. This process is necessary for assessing the status of the oyster resource, tracking the restoration effort, and evaluating management strategies and actions. There are several steps in coordinating data management. The first step is to define the critical data elements and to collect the data. The second step is to maintain a centralized database or databases, and identify the people/ organizations responsible for maintaining the data. The next step is to analyze the data and integrate the various project results into a comprehensive view. The last step is to make the data and results accessible to the stakeholders, the scientific community and the general public. Over time, monitoring programs should be periodically reviewed and adapted to the changing needs of restoration and assessment.

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Literatura

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