Transactions on Ecology and the Environment vol 32, © 1998 WIT Press, www.witpress.com, ISSN 1743-3541

The use of coastal ponds for shrimp production and the conservation of the vegetation in Northwest Mexico

A. Ortega-Rubio, H. Romero, C Arguelles, A. Naranjo, R. Aguilar, F. Salinas, A. Rodríguez, V. Serrano, A. Castellanos

Centro de Investigaciones Biológicas del Noroeste, Apdo, PO Box 128, La Paz, 23070 B.C.S., México

Email: aortega@cibnor.mx

Abstract

At the Northwest coast of Mexico the severely limited freshwater supply, and the geographic isolation determines the scarcity of productive activities. Specially at Baja California Sur. Aquaculture is a major productive alternative for the economic development of this State. Despite the aridity, the natural vegetation of Baja California Sur is diverse and structurally complex with a high percentage (20%) of endemic species, including 85 cacti species. Shrimp aquaculture is expected to grow quickly in the state in the next few years. One hectare of inland pond produces approximately 1 t of shrimp per year. One hectare of coastal pond produces, in the same year, 1.5 t shrimp. Construction and operation of the coastal ponds does not imply the destruction of the natural vegetation on the coast, as is required for the inland ponds. One hectare of sarcocaulescent scrub, the main vegetation type adjacent to the coastal vegetation type of Baja California Sur, contains 12 species of trees, 11 shrub species, and 8 cacti species. In Baja California Sur, there are 7,560 hectares of land with this kind of natural vegetation that could be used for the development of inland shrimp culture ponds. These 7,560 hectares contain millions of plant individuals, including, for instance, the cacti Pachycereus pringlei. P. pringlei individuals take about 300 years on average to attain a height of 2 meters. To reduce the negative impacts of aquaculture and to protect the vegetation of Baja California Sur we recommend the use of coastal ponds for the shrimp production.

Introduction

In spite of the severe aridity prevailing at the Mexican State of Baja California Sur (BCS), 110 mm of total raifall per year [11], vegetation is very diverse and structurally complex, including 7 types of associations ranging from the halophyte grassland to oak-pine forest and tropical deciduous forest [5, 6]. The main vegetation type in BCS is the sarcocaulescent scrub [7].

Because of severely limited freshwater and the state's geographic isolation, aquaculture is the main alternative for the economic development of BCS, and it is expected to be strongly developed in the next few years [2]. Traditional shrimp aquaculture systems in northwest México are those using inland ponds. The ponds are built on the land surrounding the coast line. Inland ponds imply the permanent destruction of the natural soil and vegetation surrounding the coast line. In BCS, however, a technology has been developed to build coastal ponds for shrimp aquaculture. Coastal ponds imply the construction, of the coast line, of dikes to build and operate the ponds.

To evaluate the impact of the use of coastal ponds, instead of inland ponds, for natural vegetation conservation in BCS, we studied the following aspects and characteristics: determination of the best areas for coastal pond construction in BCS; determination of the type and structure of the vegetation surrounding these areas; and determination of the productive efficiency of the coastal ponds as compared with the inland ponds.

Material and Methods

To determine the susceptibility of the different BCS coastal zones for coastal pond development, we analyzed the map of the state, and selected the potentially promising places, taking into account the tide range and wave force data. Coastal pond construction and operation depends, among other factors, mainly on the proper tide range (between 7 and 15 m) and the wave force (< 3.0 Joules). In April and May 1995, we verified, in the field, the feasibility of the selected zones for coastal ponds establishment.

Using aerial photography and verifying this information in the field, we determined the main vegetation types associated with the selected areas for coastal pond construction. Using ten quadrants of one hectare each, randomly selected, we analyzed the following data using common vegetation analysis

methods [9]: Diversity (species number) of the tree, shrubs, and cacti; individual number of each species; and height and cover of each individual. Field work was done during June to September 1995.

Coastal and inland pond productivity were analyzed comparing the shrimp production data for the year 1995, of two farms in Bahía de La Paz, one coastal (CIBNOR) and the other inland (La Mancha).

Results

Approximately 625 km of coastline of BCS are propitious to develop coastal shrimp-production farms. If this coastline were developed as inland farms, calculating conservatively of development of the land to 200 m away from the coastline, the total area permanently affected by the inland aquaculture is 12,500 hectares.

The most widely represented vegetation type on these 12,500 hectares is the sarcocaulescent scrub, covering approximately 60% (7,560 hectares). Analyzing the diversity and structure of one average hectare of the sarcocaulescent scrub, we found that one hectare contains, in average, 625 individual trees of 12 species, 1,550 individual shrubs of 11 species, and 1378 cactus individuals of 8 species. On this average hectare of sarcocaulescent scrub, there are 5 species of endemic plants. Analyzing the productivity of both aquaculture systems, we found that one hectare of inland pond produces approximately one t of shrimp per year, whereas one hectare of coastal pond produces, in the same year, 1.5 t of shrimp. In addition, inland ponds require continuous seawater pumping to the ponds. The energy used represents an important cost. However, the coastal ponds do not require such a cost, because the water change is made by the tidal changes.

Conclusions

From with the area covered by the sarcocaulescent scrub susceptible of being affected by the inland farms, we can conclude that use of coastal ponds could significantly reduce the negative (and permanent) impact on the vegetation of BCS.

The results obtained are not only important for the purpose of vegetation conservation. The animal terrestrial biodiversity is correlated with

the vegetation structure and cover [3, 10, 12, 13]. Even more, terrestrial vertebrate biodiversity is totally dependent on the diversity and conservation of the vegetation structure and cover [1, 4, 8].

If aquaculture is the main productive activity to be developed in BCS in the next few years, we strongly recommended the use of coastal ponds as an alternative for the development of the state, as well as to preserve the natural vegetation and biodiversity of this Peninsula.

Acknowledgments

This work was supported by the National Council of Sciences and Technology of Mexico (CONACYT) Project No, 1895P-N9507, and the Centro de Investigaciones Biológicas del Noroeste, S.C. We would like to thank M. Acevedo for his help during the field work. Thanks also to Dr. Ellis Glazier for editing the English-language manuscript. Dolores Vázquez provided expert secretarial assistance.

References

[1] Bock, C. E., Bock, J.H., Kenney, W.R. & Hawthorne, V.M. Responses of birds, rodents, and vegetation to livestock exclosure in a semidesert grassland site, *Journal of Range Management*. 37, pp. 239-242, 1984.

[2] Casas-Valdéz, M., Ponce, G., Hernández, A., González, M.A., Galum, F., Guzmán, E., Hernández S.& Sui-Qui, A., Introducción, Chapter 1, *Estudio de Potencial Pesquero y Acuícola de Baja California Sur*, eds. M Casas & G. Ponce, Centro Regional de Investigaciones Pesqueras. La Paz, BCS, Mexico, pp. 1-14 , 1996.

[3] Chew, R.M. Changes in herbaceous and sufrutescent perennials in grazed desertified grassland in southeastern Arizona, 1958-1978, *The American Midland Naturalist*, 108, pp. 159-169, 1982.

[4] Heske, E.J., & Campbell, M.C. Effects of an 11 year livestock exclosure on rodent and ant numbers in the Chihuahuan desert, Southeastern Arizona,

The Soutwestern Naturalist, 36, pp. 89-93, 1991.

[5] León, J.L., Domínguez, R., & Coria, R. Aspectos Florísticos, Chapter 4, *La Sierra de La Laguna de Baja California Sur,* eds. L. Arriaga & A. Ortega, Centro de Investigaciones Biológicas de Baja California Sur. Publicación No. 1. La Paz, BCS , pp. 83-97. 1988.

[6] León de La Luz, J.L., Cancino, J. & L. Arriaga, Asociaciones Fisonómico- floristicas y flora, Chapter 9, *La Reserva de la Biosfera El Vizcaíno en la Península de Baja California,* eds. Ortega A. & L. Arriaga . Centro de Investigaciones Biológicas de Baja California Sur. Publicación No. 4. La Paz, BCS, pp: 177- 212. 1991.

[7] León de La Luz, J.L., Coria-Benet, R., & Cruz-Estrada, M.. Fenología Floral de una Comunidad Arido-Tropical de Baja California Sur, México, *Acta Botánica Méxicana*, 35, pp. 45-64. 1996.

[8] Milchunas, D.G., Sala, O.E., & Laureroth, W.K. A generalized model of the effects of grazing by large herbivores on grassland community structure. *The American Naturalist*, 132, pp. 87-106. 1988.

[9] Moore, P.D., & Chapman, S.B. *Methods in Plant Ecology*, Blackwell Scientific Publications. Oxford. pp. 170-275. 1986.

[10] Ortega, R. A., & Hernández, L. Abundancia relativa de insectos en un medio estacional: su influencia en la historia de vida de dos iguanidos simpatricos, *Folia Entomológica Mexicana,* 55, pp. 129-144. 1983.

[11] Ortega-Rubio, A., Avarez-Cárdenas, S. and Galina-Tessaro, P. Possible effects of microhabitat avaibility on lizard diversity and density at Baja California Sur. *Miscel.lanea Zoologica,* 13, pp. 133-139. 1989.

[12] Romero-Schmidt, H., Ortega-Rubio, A., Arguelles-Méndez, C., Coria-Benet R., & Solís-Marín, S. Effect of Livestock Grazing Exclosure upon abundance of lizard community in Baja California Sur, México, *Bulletin of Chicago Herpetological Society*, 29, pp. 245-248. 1994.

[13] West, N. E., Provenza, F.D., Johnson, P.S. & Owens,M.K. Vegetation changes after 13 years of livestock grazing exclusion on sagebrush semidesert in west central Utah. *Journal of Range Management*, 37, pp. 262-264. 1984.