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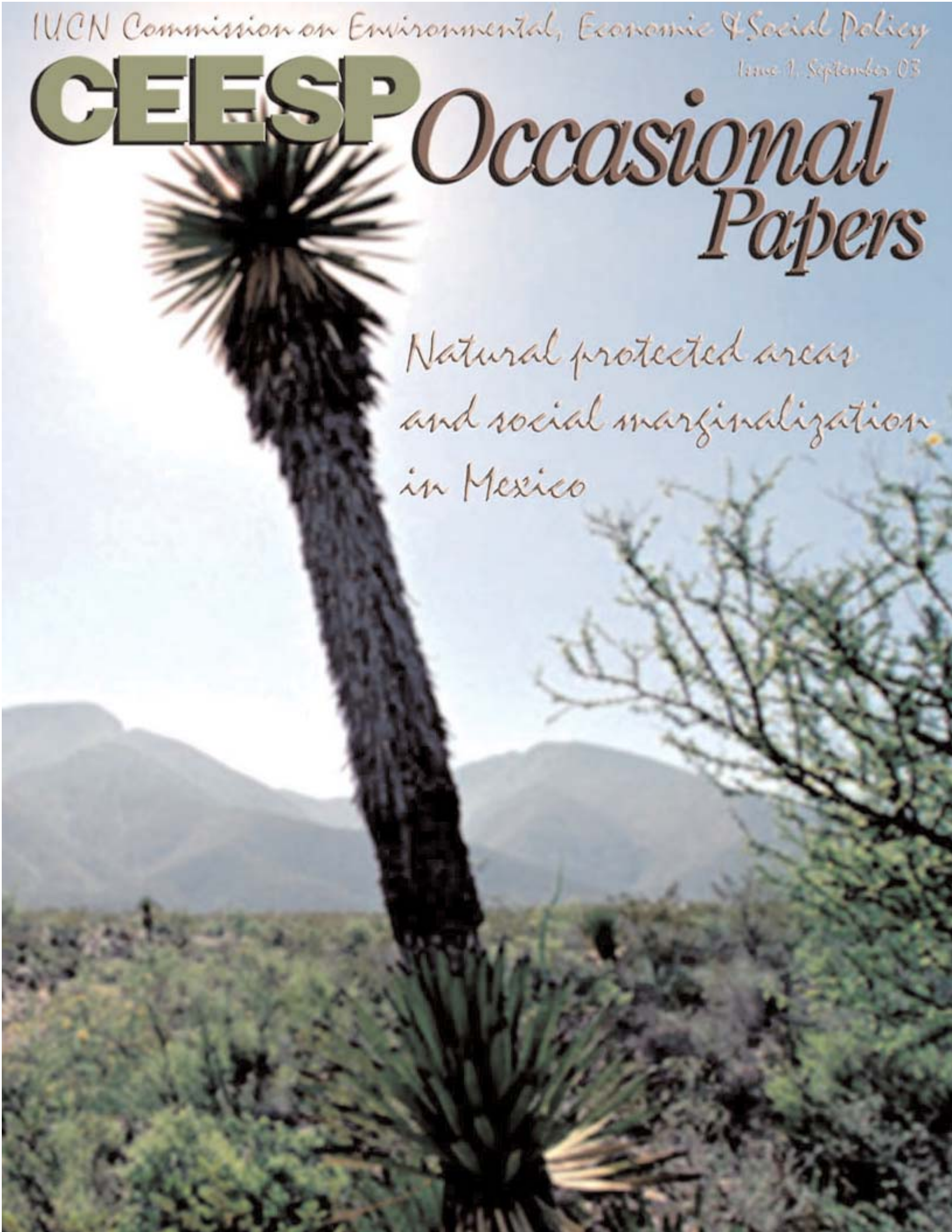
Natural protected areas and social marginalization in Mexico



Announcing a New Series of Occasional Papers for IUCN-CEESP

We are delighted to bring to our members the first issue of the **CEESP Occasional Papers Series**. The series aims to provide in-depth analysis of issues of importance to our readers.

As a Commission standing at the intersection of economic, social and environmental policy, CEESP is in a unique position to make the links between the diverse but ultimately inter-related causes of poverty and biodiversity loss, in other words unsustainable development. This first Occasional Paper, an article by Dr. Alejandro Nadal—a member of both the CEESP and GETI Steering Committees—is just such a contribution making the links between protected areas and poverty in Mexico, between biodiversity and economics.

Dr. Nadal's paper comes at an important time. As our leaders meet for the WTO Ministerial in Cancun, and as protected area policy makers as well as local communities meet in Durban for the World Parks Congress, we are reminded that biodiversity cannot be preserved in a hostile economic climate, one that spreads poverty to the very custodians of biodiversity, the local and indigenous communities who are our most important partners in conservation.

Following an analysis of protected areas and social marginalisation in Mexico, Dr. Nadal reminds us that "Unless viable alternatives are generated for the rural poor, biodiversity conservation will represent a desirable policy objective, but not necessarily a tangible success." This story is not just about Mexico.

This issue is indebted to GETI for financing this publication, to Tommy Huynh (www.lumika.org) for his kind permission to use his wonderful pictures of nature and protected areas in Mexico. Special thanks also go to Maryam Rahmanian, Executive Officer of CEESP, and to Jeyran Farvar, Co-Convenor of the Graphics and Architecture Group of CENESTA, for their diligent work in bringing out this issue.

Taghi Farvar,
Chair
CEESP

Glossary of Abbreviations

IUCN The World Conservation Union, headquartered in Gland, Switzerland
CEESP The IUCN Commission on Environmental, Economic & Social Policy
GETI The CEESP Theme/Working Group on Environment, Trade & Investment
CENESTA Centre for Sustainable Development, Tehran, host institution to CEESP

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Natural protected areas and social marginalization in Mexico

Alejandro Nadal Egea

Introduction

Mexico's biodiversity is of world importance. It is the fourteenth largest country in the world in terms of total surface, but ranks third in biological diversity (Mittermeier 1988). Because of its topography and climate regions which include a Nearctic realm in the north and a Neotropical realm in the south, Mexico hosts a wide variety of species in both flora and fauna (Rzedowski 1981).[1] Thus, with only 1.4% of the world's surface, Mexico is host to almost 12% of the total number of known species (Toledo and Ordóñez 1993). Endemism is very intense: for plants, the percentage of endemic species ranges between 44%-63%, and for vertebrate animals, this percentage is 30% (INE, 2000b). It ranks second in total number of reptiles, and first in number of endemic species of reptiles. It holds fifth place in total species of mammals. Harboring 30,000 species of plants, of which 21,600 are flowering plants (Rzedowski, 1993), Mexico occupies fifth place in the world with respect to total number of vascular plant species. It also ranks fourth in total number of amphibians. Finally, together with China and India, Mexico is a country where megadiversity coexists with a center of agricultural origin within the gene belt, the band that circles the world within the Tropics of Cancer and Capricorn (Ramamoorthy *et al* 1993).

Figure 1. Coastline of Campeche Sound, Campeche State, Mexico. *(© Tommy Huynh 2001)*

Mexico's Federal Program for Natural Protected Areas (FPNPA) is the most ambitious environmental policy instrument for the preservation of Mexico's biodiversity. In the past six years, the number of protected areas increased dramatically, and the total surface under the program's sponsorship expanded accordingly, making the FPNPA the centerpiece of biodiversity conservation.

If people in and around a protected area lack adequate economic alternatives, their survival strategies are likely to threaten resources inside protected areas. Biodiversity is a vulnerable resource and will suffer from this pressure.

The central question addressed by this paper concerns the long term viability of the NPA program. Good health of protected areas depends on resources allocated to address needs in terms of human resources, infrastructure, and sustainable income generating projects. But most important, it also depends on the capacity of populations in and around the protected areas to meet the challenge of their survival without exerting unbearable pressure on the resources of the protected areas. If people in and around a protected area lack adequate economic alternatives, their survival strategies are likely to threaten resources inside protected

areas. Biodiversity is a vulnerable resource and will suffer from this pressure.

It is difficult to establish a comprehensive catalogue of threats to resources within protected areas due to variations in ecosystems, population densities and socio-economic conditions. It is nevertheless possible to identify the most important sources of pressure on NPA's stemming from impoverished populations. In all cases, habitat destruction and damage to biodiversity ensue. In the case of populations in the fringes of NPA's, pressure is exerted through hunting, illegal trade of endangered or threatened plant and animal species, tree felling to sell timber, and excessive woodfuel collection.[2] Perceived profit opportunities may induce poor people to collect plant and animal specimens and this may lead to depletion of population stocks. Rivers, streams and lakes may also suffer from overfishing.

Agriculture and livestock production are another powerful source of pressure. In its extreme form, it can take the form of deforestation through land clearing, thus destroying wildlife habitats. It can also adopt the form of more intensive agricultural practices, including shorter fallowing periods in shifting agriculture. In some cases, use of fire in agriculture, a commonplace practice worldwide to facilitate clearing of vegetation and injection of minerals as nutrients into soil (Castilleja and Stedman-Edwards 1999), may pose serious threats to conserved areas, especially when poor farmers are unable to cover the cost of fire control practices (Nadal 2000).

How well are Mexico's ecosystems and environmental regions represented within the surface of these natural protected areas? This is a difficult question because of the extremely heterogeneous nature of Mexico's ecological regions.

Intensive use of existing land resources around NPA's can also affect biodiversity: pesticides decimate populations of useful insects and even micro-organisms, chemical inputs contaminate aquifers and contribute to contamination of soil, and the use of transgenic crops may affect population dynamics of weeds and wild relatives of certain crops, leading to loss of biodiversity.[3]

The paper is organized as follows. The **first section** presents a general overview of Mexico's natural protected areas' program. This section examines the objectives and recent evolution of the program. It also examines the main characteristics of the twenty five most important NPA's representing more than 90% of the overall surface covered by the FPNPA. The analysis also covers a qualitative assessment of the types of threats that each of these natural protected areas is encountering.

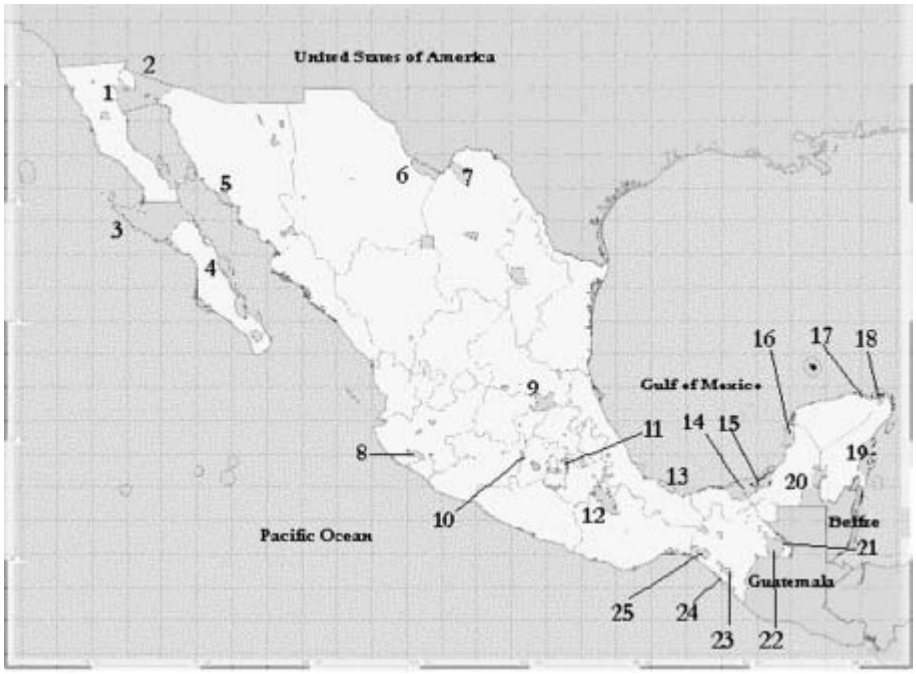
The **second section** focuses on patterns of regional disparities and sets the stage for a more detailed analysis of NPA's. The **third section** examines the levels of social marginalization in and around these twenty-five NPA's using actual coefficients of social marginalization from different data bases at the municipal level. This section links the qualitative analysis of threats to individual NPA's with data on marginalization at the municipal level. A **fourth section** examines agricultural policy implications for NPA's. Our concluding remarks center on the long term viability of the Federal natural protected areas program.

Natural protected areas are conceived by the Federal program as strategic productive units which generate a flow of social and environmental benefits. At the policy implementation level, NPA's are considered to reconcile the integrity of complex ecosystems that do not necessarily respect political or administrative boundaries, with resource management schemes involving novel institutional arrangements.

The federal program for natural protected areas

Natural protected areas are defined as parts of Mexico's territory which are representative of different ecosystems and their biodiversity, and in which the "original environment" has not been essentially altered by human activities (INE, 2000).[4] These areas are conceived by the Federal program as strategic productive units which generate a flow of social and environmental benefits. At the policy implementation level, NPA's are considered to reconcile the integrity of complex ecosystems that do not necessarily respect political or administrative boundaries, with resource management schemes involving novel institutional arrangements.

The FPNPA is run by the National Institute of Ecology (INE), which depends on the Ministry for the Environment and Natural Resources (SEMARNAT). Natural Protected Areas are classified in six different categories: biosphere reserves, national parks, marine national parks, areas for the protection of flora and fauna, special biosphere reserves, and natural monuments.[5] The system of NPA's is considered to be the key to meet the emerging challenges of biodiversity conservation in Mexico (INE 2000c). The policy thrust of INE is to change the status of all NPA's into biosphere reserves in order to improve resource management.



Map 1 Mexico's Natural Protected Areas.
Note. The numbers correspond to the twenty five NPA's considered in this study (see Table I).
Source: Instituto Nacional de Ecología (INE 2000c).

Biosphere reserves are designed to integrate protection of natural areas with economic activities compatible with conservation objectives (Young 1999). In core areas only nonmanipulative scientific research and monitoring activities are permitted. In the buffer areas economic activity is strictly regulated through a rigorous resource management plan. Finally, a transitional zone is usually defined in order to guarantee sustainability of the entire biosphere area. The notion is also better adapted to efficient resource management schemes in which different institutional actors play an active role.

The lack of a well defined (and accepted) resource management plan may transform the territories of natural protected areas into open access resources, especially in the case of the core zones where human activity is supposed to be reduced to minimum impact actions. This is aggravated in cases where there are ill-defined property rights, as seems to be the case in many of Mexico's NPA's.

In 2000 there were 119 natural protected areas, with a total surface of more than 15.8 million hectares, representing 6% of Mexico's total territory.[6] More than 7 million hectares of the total protected surface corresponds to biosphere reserves. NPA's cover important regions where animal, plant and microorganism variety far exceeds the national and international averages. Approximately 30% of this surface corresponds to marine ecosystems (coral reefs, islands). The rest is distributed among arid and semi-arid, humid tropic, subhumid tropic and subhumid temperate ecological regions. In addition, the set of natural protected areas is purported to form a system in which an international biological corridor is a key organizing element.

Map 1 shows the location of all the NPA's in the Federal program, as well as the twenty five protected areas covered in this study. How well are Mexico's ecosystems and environmental regions represented within the surface of these natural protected areas? This is a difficult question because of the extremely heterogeneous nature of Mexico's ecological regions. Coniferous and deciduous temperate forests, mainly found in mountainous parts in the center and northwest, cover 15% of Mexico's territory. Dry and rain tropical forests concentrate in the south and cover approximately 13% of total surface. Finally, arid and semi-arid ecosystems are mainly located in the north and central plateau and represent 30% of Mexico's territory (OECD 1998). The variety of topography and size of natural protected areas makes it impossible to make generalizations about numbers of species involved in each area.[7]

Table 1 classifies the largest twenty five terrestrial protected areas in terms of their respective ecological regions. The total surface covered by these twenty five NPA's is 9.6 million hectares. Approximately 52% of this area is located in arid and semi-arid ecosystems, while 26% covers humid tropic ecosystems and 10% correspond to subhumid tropic systems. The remaining 12% corresponds to subhumid temperate ecosystems.

NPA's covering humid tropic ecosystems (more than 3.6 million hectares) are in southern and southeastern states. These areas possess the highest level of biological diversity and their complex ecosystems make them particularly fragile. This vulnerability is accentuated by the fact that they are located in areas with backward economies.

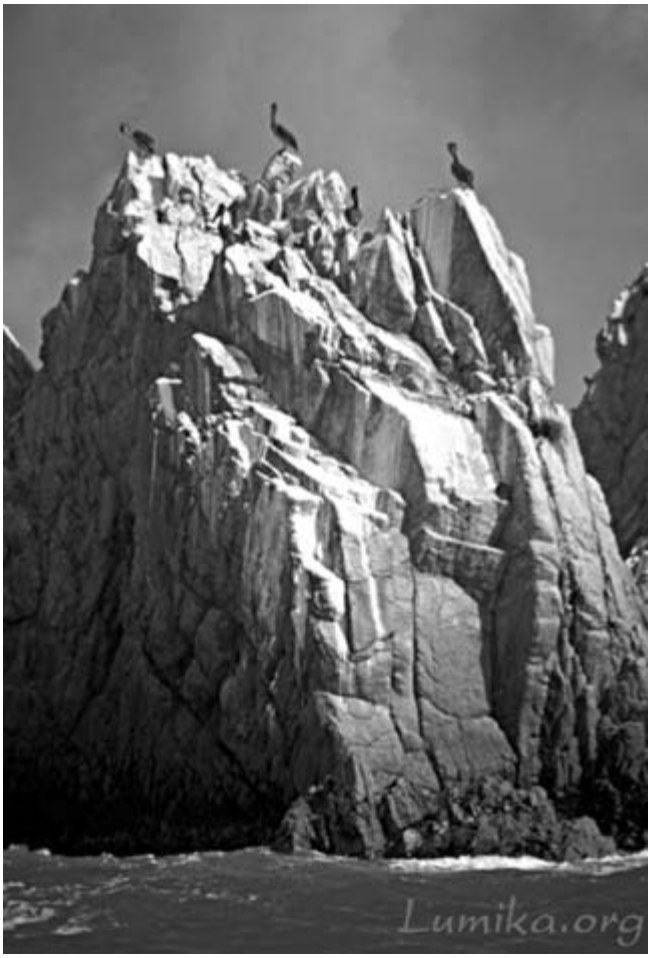


Figure 2. Pelican colony, Maruata Mexico. *(© Tommy Huynh 2001)*

Table 1 Main Natural Protected Areas by Ecological Region

Notes. (a) Part of the Tehuacán-Cuicatlán NPA covers semi-arid ecosystems.
Sources: Prepared by the author with information from INE (2000a and 200b); Rzedowski (1978 and 1973); Ramamoorthy *et al* (1993).

		Arid-semiarid	Humid tropic	Subhumid tropic	Subhumid temperate
1	Colorado Delta and Upper Gulf	934756			
2	Pinacate y Desierto Altar	714556			
3	El Vizcaíno	2546790			
4	Bahía de Loreto	206581			
5	Cajón del Diablo	147000			
6	Cañon de Santa Elena	277209			
7	Maderas del Carmen	208381			
8	Sierra de Manantlán				139577
9	Sierra Gorda				383567
10	Mariposa monarca				16110
11	Corredor Chichinautzin				37302
12	Tehuacán – Cuicatlán (a)				490186
13	Los Tuxtlas		155122		
14	Pantanos de Centla			302707	
15	Laguna de Términos			705016	
16	Ría Celestún		59130		
17	Ría Lagartos		60347		
18	Yum Balam		154052		
19	Sian Ka'an		528000		
20	Calakmul		723185		
21	Lacan-Tun		61874		
22	Montes Azules		331200		
23	El Triunfo		119177		
24	La Encrucijada		144868		
25	La Sepultura		167310		
	TOTAL	5035273	2504265	1007723	1066742

The possibility of assessing the relative importance of each area's coverage is further complicated because of the contrasts between areas in southern Mexico, where biodiversity is at its highest levels, and areas in the more arid and semi-arid north, where endemism is more intense. It is important to note that human population density in the central and southern states is greater than in the north.

The ten largest biosphere reserves cover 75% of the total terrestrial natural protected areas. At the other side of the spectrum lie many small NPA's. Many of these may harbor threatened species, but their size and dispersal makes it difficult to ensure their long term viability.

Activities in the buffer and transitional zones of biosphere reserves are restricted by a resource management plan which is

defined for each NPA through a complex participatory process involving owners of land in the protected area. To ensure implementation, the plan must be designed with the active participation of the local communities. Resource management plans include projects in conservation and infrastructure, as well as productive and scientific research ventures. Social development projects related to housing and municipal services are also included. Only 23 NPA's actually have an approved resource management plan, while the plans for 15 areas are still under preparation (INE 2000c). Total NPA surface endowed with resource management programs covers more than 8 million hectares. However, there are severe implementation problems with the majority of these programs and few have specific technical norms for economic activities.

The lack of a well defined (and accepted) resource management plan may transform the territories of natural protected areas into open access resources, especially in the case of the core zones where human activity is supposed to be reduced to minimum impact actions.[8] This is aggravated in cases where there are ill-defined property rights, as seems to be the case in many of Mexico's NPA's. In fact, it is important to note that well defined property rights are vulnerable and can be overwhelmed by population growth or increased economic pressure (Hanna et al 1995). This opens the way for a process similar to a "tragedy of the commons" syndrome à la Hardin (1968).

Marginalization is a concept that encompasses poverty as well as exclusion from economic and social opportunities, and even adequate political representation (Gore *et al* 1995).

Table 2 lists the most common sources of pressure for the twenty-five NPA's covered in this study.[9] Not surprisingly, activities related to agricultural and livestock production are the most common sources of threats.

Table 2 Sources of Threats to Twenty-Five Natural Protected Areas
Source: INE (2000).

Year	Constant 1993 Pesos
1995	7.4
1996	8.7
1997	13.1
1998	15.4
1999	17.5
2000	43.0

Adequate funding for a sustainable program of protected areas must cover wages and salaries of personnel, infrastructure to reduce loss of biodiversity and to recover lost species. Above all, it should support sustainable productive projects. Table 3 shows that funds for NPA's have increased (in real terms) over the past five years. However, it is estimated that on average a minimum of 3.2 million pesos is required for each natural protected area (INE 2000c). During fiscal year 2000 average resources accruing to each NPA were 1.2 million pesos. Total resources per hectare of NPA's are 9.8 pesos for 2000 (approximately one US dollar at the current exchange rate). Of course, requirements of individual NPA's vary enormously due to size, terrain and type of ecosystem included in its premises. But these numbers indicate the NPA program is severely under funded.

Table 3 Federal Budget Appropriations for NPA's (Millions of 1993 pesos)
Source: INE (2000c)

Sources of pressure on NPA's	NPA's
Agriculture (including deforestation, fires, etc.)	Calakmul, Sierra Gorda, Montes Azules, Pantanos de Centla, Cañon de Santa Elena, La Sepultura, Los Tuxtlas, Yum Balam, La Encrucijada, Sierra de Manantlán, El Triunfo, Mariposa Monarca, Corredor Chichinautzin
Livestock (overgrazing, deforestation, etc.)	Vizcaíno, Pinacate Desierto Altar, Cañon de Santa Elena, Maderas del Carmen, La Sepultura, Los Tuxtlas, Yum Balam, Cajón del Diablo, La Encrucijada, Sierra de Manantlán, Mariposa Monarca, Tehuacán-Cuicatlán, Corredor Chichinautzin
Overexploitation of forests	La Sepultura, Yum Balam, Mariposa Monarca, Corredor Chichinautzin
Soil erosion	Laguna de Terminos, Los Tuxtlas
Pollution (includes agrochemical inputs)	Vizcaíno, Laguna de Terminos, La Sepultura, Los Tuxtlas, La Encrucijada, Ria Lagartos, Corredor Chichinautzin
Overexploitation of acquifers	Vizcaíno, Alto Golfo and Delta Río Colorado, Pinacate Desierto Altar, Sierra Gorda
Overfishing	Vizcaíno, Bahía de Loreto, Yum Balam, Cajón del Diablo, Ría Lagartos, Ría Celestún
Illegal hunting	Calakmul, Sierra Gorda, Maderas del Carmen, La Sepultura, Yum Balam
Illegal felling of trees	Sierra Gorda, Maderas del Carmen, Los Tuxtlas, La Encrucijada, El Triunfo, Ría Lagartos, Corredor Chichinautzin
Illegal trade of plant/animal species	Pinacate Desierto Altar, Sian Ka'an, Tehuacán-Cuicatlán, Cañón de Santa Elena, Bahía de Loreto, Ría Lagartos, Tehuacán-Cuicatlán
Mining	Vizcaíno, Maderas del Carmen
Industrial pollution	Vizcaíno, Laguna de Términos, Pantanos de Centla
Infrastructure projects	Laguna de Términos, Pantanos de Centla, La Sepultura, Yum Balam
Tourism (tourist development projects and uncontrolled tourism)	Sian Ka'an, Yum Balam, Cajón del Diablo, Corredor Chichinautzin
Ill defined property rights	Calakmul, Sian Ka'an, Tehuacán-Cuicatlán, Montes Azules, Sierra de Manantlán, Tehuacán-Cuicatlán
Migration	Calakmul, Laguna de Terminos, Montes Azules, La Encrucijada, El Triunfo
Introduction of exotic species	Sian Ka'an, Maderas del Carmen, Bahía de Loreto
Natural hazards (hurricanes, forest fires, etc.)	Sian Ka'an
Other forms of habitat destruction (eutrophication, salinizaton, etc.)	Ría Lagartos, Ría Celestún

During the 1990's Mexico was granted 25 million dollars by the Global Environmental Facility for support of ten NPA's selected for their biodiversity and number of endemic species. An additional selection criterion pertains to the opportunities for collaborative work with local communities and NGO's. However, until 1997 only 8.7 million had been actually allocated to Mexico's NPA's. The remaining 16.3 million dollars went to the special trust Fund for Natural Protected Areas. Interest on these assets provides resources for the Federal NPA program.

Regional Disparities, Poverty And NPA's

Distortions in Mexico's regional development will condition the future of the FPNPA. Regional economic disparities have persisted in the past decade as shown by data on regional contribution to GDP between 1993 and 1999. Table 4 shows that five southern and southeastern states have diminished their contribution to national GDP, while two remained unchanged. Their share of total GDP was at an all time low in 1993 and this decline occurs in the context of an unsatisfactory performance of Mexico's economy.[10]

Figure 3. Storm clouds rolling over Pueblo fantasma, a silver mining ghost town. Real de Catorce Puebla Fantasma, Mexico. *(© Tommy Huynh 2001)*

Table 4 Regional Contribution to GDP, 1993-1998 (% of GDP)
Source: INEGI data base (www.inegi.gob.mx)

States	1993	1999
Campeche	1.2	1.2
Chiapas	1.8	1.7
Guerrero	1.9	1.7
Oaxaca	1.7	1.5
QR	1.3	1.4
Tabasco	1.3	1.2
Veracruz	4.6	4.1
Yucatán	1.3	1.4
Rest of states	85.1	85.8

NPA's covering humid tropic ecosystems (more than 3.6 million hectares) are in these southern and southeastern states. These areas possess the highest level of biological diversity and their complex ecosystems make them particularly fragile. This vulnerability is accentuated by the fact that they are located in areas with backward economies.

Mexico's GDP per capita was 36,400 pesos in 2000 (approximately 3,700 dollars at the going exchange rate), but the southern and southeast states show levels which are significantly below this national mean. Table 5 shows that in six southern states, per capita GDP is significantly below the national average, especially in the case of Oaxaca and Chiapas where it is less than half of the national level. These two states harbor sixteen natural protected areas representing 13% of the total surface of terrestrial NPA's.

Table 5 Regional Disparities in Mexico (1999)
Source: See Table IV.

States or Regions	Per Capita GDP (pesos)
Oaxaca	15,000
Chiapas	15,200
Guerrero	19,200
Veracruz	21,200
Tabasco	22,200
Yucatán	28,100
Campeche	54,100
Quintana Roo	60,600
Average	29,400
Rest of Mexico	40,800
National Total	36,400

The eight southern and southeastern states included in Table 5host some of the most important natural protected areas, covering 33% of the entire NPA program, and 45% of terrestrial NPA's.

These aggregate figures mask important subregional and local disparities of income levels. The states of Campeche and Quintana Roo, and to a lesser degree Tabasco, are a case in point. In Quintana Roo, tourism in the Cancun area is responsible for the high per capita figure. In Campeche and Tabasco oil introduces a bias in the income per capita measure. If we isolate oil-related activities GDP per capita levels drop to 18,800 in Tabasco, and to 27,800 pesos in the case of Campeche. The municipalities in Campeche, Quintana Roo and Tabasco that lie at a greater distance from the oil and tourism-related centers of activity show higher levels of poverty and marginalization, and they are closer to the natural protected areas in those states. [11]

During the nineties, income distribution worsened. Between 1992 and 1998, average real monetary income declined at an annual rate of 3.2%. Thus, although the Gini coefficient for Mexico's income distribution in 1998 (0.50) showed a marginal improvement with respect to 1992 (0.51), this change is the result of a general process of impoverishment, not of improvement in living standards. Income distribution in Mexico still shows greater inequality than in countries such as Perú (0.44), Paraguay (0.40), and Venezuela (0.44) (Hernández Laos 2000).

Real monetary income dropped between 1992 and 1998 for all deciles in localities of all sizes (Table VI).[12] In percentage terms, the drop was more intense for households in localities with more than 2,500 inhabitants (64%) than in localities with less than 2,500 inhabitants (59%). However, the level of monetary income for households in rural areas was lower than in urban areas so these reductions in income have a greater impact on their livelihood.[13] In this sense, poverty intensified in rural areas. The number of rural households with incomes below the rural average increased from 62% to 72% during the time period considered, while the equivalent for urban areas remained constant at 75%.[14] Households in the first and second deciles represented 48% of total rural households in 1998, while the equivalent share in urban areas was 11%.

Poverty can be overcome when economic conditions improve, while reducing marginalization requires a richer and more complex normative approach providing access to basic services and goods, and eliminating the barriers to economic opportunity.

Table 6 Monetary Household Income by Town Size

Source: Salas (2000) with data from INEGI, Encuesta nacional de ingresos de los hogares, 1992 and 1998.

(Quarterly data in constant 1994 pesos)				
	1992		**1998**	
Current Monetary Income Total Deciles	Townships with more than 2,500 inhabitants	Townships with less than 2,500 inhabitants	Townships with more than 2,500 inhabitants	Townships with less than 2,500 inhabitants
Total (Average)	7,077.00	2,551.00	5,802.00	2,180.00
I	596.00	600.00	457.00	452.00
II	1,377.00	1,335.00	1,107.00	1,069.00
III	2,013.00	1,987.00	1,598.00	1,584.00
IV	2,619.00	2,614.00	2,131.00	2,110.00
V	3,267.00	3,199.00	2,690.00	2,658.00
VI	4,049.00	3,991.00	3,374.00	3,330.00
VII	5,161.00	5,031.00	4,311.00	4,228.00
VIII	6,715.00	6,561.00	5,685.00	5,701.00
IX	9,617.00	9,447.00	8,061.00	8,027.00
X	24,444.00	22,348.00	19,827.00	17,660.00

In 1998 47% of Mexico's total population (99 million) lived below the poverty line, while 20% lived in conditions of extreme poverty (CEPAL 2000). These figures are based on a concept of poverty relying on a person's capacity to purchase a basket of basic foodstuffs. It does not take into consideration other basic needs in terms of clothing, health services, education and dwellings. According to other estimates, the percentage of Mexico's population living under the poverty line increases dramatically to 71% (Boltvinik 2001). Even with ECLA's more conservative results, the survival strategies of poor people could put additional pressure on Mexico's NPA's.

Social Marginalization And Mexico's NPA's

Poverty is closely associated with levels of social marginalization, but there are important differences between both concepts. Poverty can be defined in terms of low monetary income and reduced asset property. Marginalization covers a wider spectrum of socio-economic conditions: open and disguised unemployment, job precariousness and low remuneration rates, lack of credit to work land productively, lack of access to basic goods and services, structural conditions of dwellings, and schooling levels (Rodgers 1995). In a wider sense, marginalization frequently comprises vulnerability of social groups or individuals to natural disasters.

Thus, the concept of marginalization goes beyond simpler economic indicators such as monetary income or per capita GDP, and involves variables describing with greater accuracy the socio-economic condition of individuals or groups. Marginalization is a concept that encompasses poverty as well as exclusion from economic and social opportunities, and even adequate political representation (Gore et al 1995). Poverty can be overcome when economic conditions improve, while reducing marginalization requires a richer and more complex norma-

Figure 4. Texolo Waterfall, location for the filming of several movies including Romancing the Stone, Xico, Mexico.
(© Tommy Huynh 2001)

tive approach providing access to basic services and goods, and eliminating the barriers to economic opportunity.

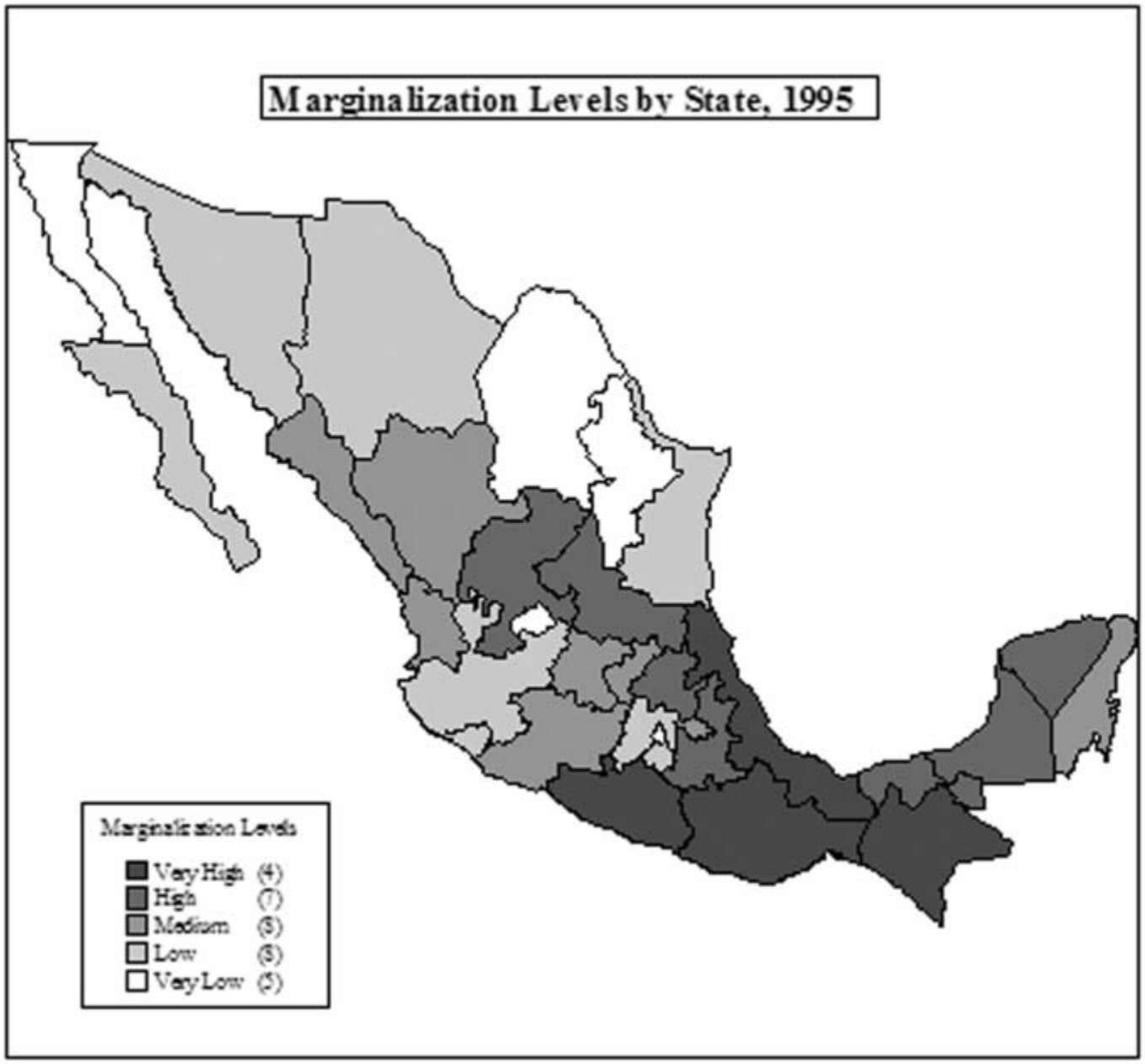
Marginalization levels provide the frame of reference of survival strategies of individuals, families or entire communities, and they may foster the adoption of short term survival strategies which may ignore long term environmental concerns (Larson and Bromley 1990; Perrings 1989). Thus, the concept of marginalization is of greater usefulness for the analysis of potential sources of pressure on NPA's than simple poverty indicators.

Although marginalization is a multifaceted concept, some of its dimensions and intensities can be captured through the proportion of a given population without access to basic goods and services. Using techniques of multivariate analysis the National Population Council (CONAPO 1998) prepared a composite index measuring marginalization by state, *municipios* and towns for 1995. This index measures relative deficits over a set of social and economic conditions required to attain minimum well-being levels.[15] The index strata and their range values, as well as marginalization levels for states and *municipios* are shown in the Table 7.

Table 7
Note. Numbers in parentheses denote negative coefficients. Source: CONAPO (1998)

Index Ranges and Marginalization Rankings		
State	**Municipios**	**Marginalization Levels**
2.36 – 1.13	3.15 – 0.91	Very High
1.00 – 0.39	0.91 – 0.35	High
0.13 - (0.23)	0.35 - (0.76)	Medium
(0.55) - (0.85)	(0.76) - (1.32)	Low
(1.05) - (1.74)	(1.32) - (2.44)	Very Low

The regional distortions marking Mexico's socio-economic landscape are replicated in terms of social marginalization in Map II. Marginalization is pervasive in the southeastern states. Four states (Chiapas, Oaxaca, Guerrero, Veracruz) exhibit very high marginalization indexes, while three other (Yucatán, Campeche and Tabasco) have high marginalization indexes. This segment of the country's territory is connected with four other important states in central Mexico with high marginalization indexes (Puebla, Hidalgo, San Luis Potosi and Zacatecas).



Map 2

Source: Prepared by author with data from CONAPO (1998).

Table 8 shows that the surface of natural protected areas in three states (Chiapas, Oaxaca, Veracruz) with very high marginalization indexes exceeds 1.4 million hectares. NPA surface in five other states (Campeche, Michoacán, Puebla, Tabasco and Yucatán) with high marginalization indexes is greater than 1.8 million hectares. Thus, states with very high or high marginalization indexes host NPA's with a total surface of 3.3 million hectares, equivalent to 34% of total non-marine NPA surface.

Two additional states have medium level marginalization indexes. Quintana Roo, hosts Sian Ka'an, a critical biosphere reserve with unique wetlands and coastal ecosystems, and a vast tract of tropical rain forest. Querétaro hosts the Sierra Gorda reserve which covers ecosystems ranging from temperate to semi-humid forests.

In total, NPA surface in these ten states

with medium to very high marginalization indexes surpasses 4.4 million hectares, a surface roughly equivalent to 45% of all terrestrial NPA surface. All of the NPA's sheltering tropical ecosystems are located in these states.

Table 8 Marginalization Indexes by States with NPA's
Source: CONAPO (1998) and INE (2000).

State	Marginalization index	Natural Protected Areas	Surface (hs.)
Chiapas	**2.36**	Montes Azules, La Sepultura, La Encrucijada, El Triunfo, Lacan-tun	824,429
Oaxaca	**1.85**	Tehuacán- Cuicatlán	490,186
Veracruz	**1.13**	Los Tuxtlas	155,122
Yucatán	**0.80**	Ria Lagartos, Ria Celestun	119,477
Puebla	**0.80**	Tehuacán-Cuicatlán	
Campeche	**0.78**	Calakmul, Laguna de Términos	1,428,201
Tabasco	**0.67**	Pantanos de Centla	302,707
Michoacán	**0.39**	Mariposa monarca	16,110
Queretaro	**-0.19**	Sierra Gorda	383,567
Quintana Roo	**-0.22**	Sian Ka an, Yum Balam	682,052
Morelos	**-0.55**	Corredor biológico Chichinautzin	37,302
Jalisco	**-0.60**	Sierra de Manantlán	139,577
Colima	**-0.71**		
Estado de México	**-0.74**	Mariposa monarca	
Chihuahua	**-0.78**	Cañon de Santa Elena, Maderas del Carmen	485,590
Baja California Sur	**-0.84**	El Vizcaíno	3,481,546
Sonora	**-0.85**	El Pinacate y Desierto de Altar, Bahía de Loreto, Cajón del Diablo	1,068,137
Coahuila	**-1.18**		
Baja California	**-1.27**	El Vizcaino, Alto Golfo de California, and Delta del Río Colorado	
Nuevo León	**-1.50**		
Distrito Federal	**-1.74**		

rural poverty and marginalization will generate additional pressure on the resources of protected areas. This is supported by evidence that forests and their resources represent the only safety net for poor populations (Byron and Arnold 1999). Under conditions of economic duress, at least some types of survival strategies at the household level may imply greater stress for NPA's.

Because marginalization indexes at the state level sometimes mask significant intra-state regional disparities, it is important to examine marginalization indexes with a finer degree of resolution. Table 9 presents the ranking of marginalization indexes at the municipal level, showing that 75% of the *municipios* in and around terrestrial NPA's have high and very high marginalization indexes.[16] Only a small number of *municipios* have low and very low marginalization indexes. Thus the vast majority of NPA's is located in regions where both poverty and marginalization are strong.

Table 9 Marginalization Index Ranking by Municipio in NPA's (1995)
Source: See Table V

Index Ranking	Number of *municipios*
Very High	65
High	36
Medium	17
Low	9
Very Low	6
n.a.	2
Total	135

Marginalization indexes for states and *municipios* are not strictly comparable due to the variables considered and their relative weights in the construction of the indexes. However, their comparison provides a rough approximation of differences in intensities at the two levels because the variables used are the same, with the exception of education and population dispersal. This comparison reveals that 82% of the *municipios* appear to have *lower* marginalization indexes than the overall state index, and 15% show marginalization indexes above the state level.

It is important to note that in both indexes, the component measuring access to basic education has a greater weight. If there is inward migration into these *municipios*, and if these migrants are younger persons (something which is normally expected in migrants), our hypothesis is that this younger population probably had greater access to basic education and their illiteracy rates will be smaller. In this case, because of the weight of the education component the entire marginalization index improves.

On the other hand, the fact that marginalization indexes in *municipios* in and around NPA's are inferior than at the state levels is not necessarily good news for NPA's. These *municipios* could become migration attractors because at the margin, potential migrants might perceive greater opportunities inside the NPA *municipios* aggravating existing problems.

To examine this hypothesis we consider a recent estimate of migration rates at the *municipio* level by Salas (2000).[17] The data from this study show that 94 out of 132 *municipios* in or around the twenty five NPA's studied here show potential positive immigration rates in the period between 1990 and 1995. In other words, these *municipios* are potential migration attractors. The other 38 *municipios* for which there is data show they have positive out migration rates.

Table 10 displays data regarding potential immigration coefficients in *municipios* in and around the twenty five NPA's considered in this study. Sixteen areas show a high share

a critical and difficult question is whether anti-poverty programs are strong enough to redress the distortions arising from this panorama of inequality.

of *municipios* with a positive immigration potential (attractors), and four areas have 50% of their *municipios* with a positive immigration potential.[18] If these numbers provide an accurate indicator of future migration trends, and if social and economic conditions do not improve, new pressure on NPA resources could build up.

Table 10 NPA Municipios with Positive Migration Potential

Source: Prepared by author with data from Salas (2001) and INE (2000 a)

Number of NPA's	NPA's	Share of Municipios with Positive Migration Potential
6	Calakmul, Cañón Santa Elena, La Encrucijada, Ría Lagartos, Sierra Gorda, Yum Balam	100%
3	La Sepultura, Sierra de Manantlán, El Triunfo	More than 80%
7	Alto Golfo de California, Laguna de Términos, Mariposa Monarca, Pantanos de Centla, El Pinacate, Tehuacan-Cuicatlán, Los Tuxtlas	More than 60%
4	Cajón del Diablo, Celestún, Corredor biológico Chichinautzin, Montes Azules	50%
3	Lacan Tun, Maderas del Carmen, Vizcaíno	Less than 50%
2	Loreto, Sian Ka'an	n.a.

To summarize, a plausible hypothesis is that rural poverty and marginalization will generate additional pressure on the resources of protected areas. This is supported by evidence that forests and their resources represent the only safety net for poor populations (Byron and Arnold 1999). Under conditions of economic duress, at least some types of survival strategies at the household level may imply greater stress for NPA's.

Of course, rural poverty and marginalization could also provoke out migration from *municipios* in and around NPA's, reducing pressure on protected areas. But recent data (CONAPO 2000) suggest this is not a dominant trend for the time being. The coefficients of migratory intensity to the United States for the 135 *municipios* in and around the selected NPA's are distributed as follows: very low, 67; low 40; medium 11; high 9; null 7.[19] Thus, 80% of the *municipios* considered in this study have very small or small coefficients of migratory intensity to the United States. Five of the high coefficients are concentrated in the Manantlán Biosphere Reserve which is located in Jalisco, one of the states with high intensity migratory flows to the United States.

Various studies suggest that migration is lower in the poorest segments of population (Tuirán 2000; SRE 1997). This is due to increasing costs that impose a higher barrier to migration flows. The data on out migration in *municipios* around NPA's would appear to confirm this pattern. In this case, pressure on NPA's will not diminish as a result of out migration. In a nutshell, under conditions of acute poverty the cost of migration will largely exceed the costs of tapping the resources of nearby protected areas.

The net effect of out migration is difficult

to evaluate. In general terms, out migration from *municipios* in and around NPA's can alleviate pressure as demographic intensity diminishes. But in other cases, out migration may undermine social institutions maintaining resource usage rates compatible with long terms sustainability. Examples of this abound in rural México (see for example, García Barrios et al 1991). Migration may undermine the capacity of communities to meet environmental threats through adequate management of soils and genetic resources. This example confirms the insight in Munasinghe (1997) concerning dwindling populations and resource management patterns. When migration helps degrade local institutions, both the composition and the authority axioms defined in the property rights literature break down (Larson and Bromley 1990), affecting the capacity for good environmental stewardship.[20] If this process takes place in *municipios* close to NPA's, out migration's positive effects (reduced demographic intensity) can be offset by its negative effects (reduced capacity for adequate resource management).

Finally, a critical and difficult question is whether anti-poverty programs are strong enough to redress the distortions arising from this panorama of inequality. A detailed assessment of Mexico's anti-poverty programs is beyond the scope of this paper, but some numbers can provide helpful insights.

Figure 5. Puerto Escondido, Mexico.
(© Tommy Huynh 2001)

Between 1998 and 2001, total resources devoted to anti-poverty programs have increased from 40 to more than 62.5 billion pesos. In real terms, however, the increment is much more modest. And even in nominal terms, considering that official estimates put the share of total population living in conditions of extreme poverty at 22 million (INEGI 2001), these resources amount to approximately 7.8 pesos (or .78 US dollars at the current exchange rate) per person per day. This amount may mitigate some of the worst implications of extreme poverty, but it is clearly insufficient to help extricate people in extreme poverty from their plight.

In addition, some components of anti-poverty campaigns pose serious threats to the health of natural protected areas. A striking example is the provision of micro credits to household for the purchase of small animals, such as sheep and goats, in a large area of the state of Oaxaca. The grazing patterns of these animals now pose a direct threat as they contribute strongly to denudation of land and facilitate soil erosion (Nadal 2000). This explains why the Tehuacán-Cuicatlán biosphere reserve is suffering from the threat of overgrazing by sheep and goats (see Table 2).

In a nutshell, under conditions of acute poverty the cost of migration will largely exceed the costs of tapping the resources of nearby protected areas.

The Context Of Agricultural Policy

Because natural protected areas compete with other possible land uses, the expansion of the agricultural frontier may pose a serious threat to the integrity of NPA's. Expanding Mexico's agricultural frontier is difficult because of limitations in total arable land. However, some expansion can still be carried out at the margin, albeit with adverse results in terms of yields. Protected areas can be as vulnerable as any other part of Mexico's territory. A plausible hypothesis is that for the population of *municipios* in and around NPA's, the expansion of cultivated surface could be carried out at the expense of these protected areas.

Figure 6. Sotano de las Golondrinas ,one of the largest open air pits in the world. 1200 feet from base to upper rim. Near Aquismon, Mexico. *(© Tommy Huynh 2001)*

On the other hand, agricultural policies have important implications for habitat conservation and they might spell the difference between a viable protected area and an ill-fated one. A hypothesis that has gained acceptance is that price-distorting subsidies may promote deforestation (Barbier and Burgess 1996; Deininger and Minten 1999; Glomsrød *et al* 1998; Pagiola *et al* 1998). Because protected areas include forested areas in many cases, price-distorting subsidies would also threaten protected areas.

It is possible that opening new land for agriculture through deforestation is less likely in the case of protected areas because of the legal and institutional obstacles involved. Simply put, the marginal cost of opening land located within a protected area may be higher than the discounted returns from agricultural activities in this new land.

Other studies suggest reductions in producers' prices caused by trade liberalization may lead to income loses which might be compensated by increased deforestation (Bluffstone 1998) or extraction of resources from protected areas (Stedman-Edwards 1997). In what follows we examine these hypotheses in the context of Mexico's agricultural policies. Our analysis focuses initially on corn because it is the critical crop for survival strategies where rural poverty is predominant.

Between 1990-1998 cultivated surface devoted to corn increased from 7.9 to 8.5 million hectares, representing more than 53% of total cultivated surface in 1998. Cultivated surface allocated to corn production increased at a rate of 4% per annum during those years, but most of the expansion took place after 1993. Total corn output increased during that period from 14.6 million tons, to an all time high of more than 18.5 million tons in 1998, then dropped to 17.7 million tons in 2000.

Table 11 shows growth rates for cultivated surface, output, and yields in thirteen states where important NPA's are located for the

period 1990-1998. The data cover a sufficiently long period so that variations in yields due to climatic conditions can be ignored with some degree of confidence. Terrestrial NPA's in these states cover

Table 11 Rates of Growth for Cultivated Surface, Output and Yields in Corn Production, 1990-1998 (%)
Source: Sistema de Información Agropecuaria, SIACON. Secretaría de Agricultura y Ganadería, México, 2000.

	Cultivated Surface	Output	Yields (tons/hs.)	NPA Surface (hs.)
Baja California	2	13	0.04	1002765
Baja California Sur	5	9	5	2872919
Campeche	9	12	2	1429332
Chiapas	4	6	3	853966
Chihuahua	3	3	3	287784
Morelos	1	0	0	93250
Oaxaca	2	6	2	28814
Quintana Roo	4	3	-2	771834
San Luis Potosí	2	0	-4	48464
Sonora	12	14	5	954446
Tabasco	9	2	-4	302707
Veracruz	1	1	1	230887
Yucatán	2	0	2	120016

8,997,184 hectares, approximately 80% of the entire surface of terrestrial marine NPA's.

In all of these states growth rates in cultivated surface are positive and greater or equal to growth rates in yields. In the states where NPA's cover humid tropic ecosystems (Campeche, Quintana Roo, Tabasco, and to a lesser degree Chiapas) cultivated surface shows significant growth rates. In all of these cases, the expansion of cultivated surface together with the presence of lower or negative growth rates in yields could indicate greater pressure on land, or the expansion into land of inferior quality.

The increase of cultivated surface devoted to corn was not offset by reductions of cultivated surface in other crops. Table 12 shows that twelve of the thirteen states experience positive growth rates in cultivated surface when all crops are considered. In addition, growth rates of cultivated surface for all crops in these twelve states are greater than the national average in all but three states (Chihuahua, Sonora and Veracruz). The

Table 12 Expansion of Cultivated Surface All Crops Thirteen States With **NPA's (Hectares).**
Source: Same as Table 11.

	1990	1998	Growth Rate (%)
Baja California	164,919	227,519	4%
Baja California Sur	67,561	35,716	-8%
Campeche	111,544	190,971	7%
Chiapas	836,142	1,177,101	4%
Chihuahua	859,934	949,152	1%
Morelos	110,330	114,402	0%
Oaxaca	597,869	709,682	2%
Quintana Roo	63,768	89,524	4%
San Luis Potosí	419,773	511,062	2%
Sonora	516,217	545,754	1%
Tabasco	76,128	133,662	7%
Veracruz	755,089	805,194	1%
Yucatán	161,715	206,438	3%
National Total	15,952,226	17,065,647	1%

average growth rate in these twelve states is three times greater than the national average.

The highest growth rates of cultivated surface for all crops correspond to Campeche, Chiapas, Quintana Roo and Tabasco, states with the largest and perhaps more strategic natural protected areas from the viewpoint of biodiversity. The surface of these NPA's covers roughly 35% of terrestrial NPA's and more than 74% of the entire protected surface of humid tropic regions. The protected areas that are at stake here are Calakmul and Laguna de Términos (Campeche), Montes Azules, La Sepultura, El Triunfo, La Encrucijada (all in Chiapas), Centla (Tabasco), Sian Ka'an and Yum Balan (Quintana Roo). This expansion of cultivated surface may have been associated to land clearing activity by rural poor. This could be accompanied by increased extraction of timber and plants, woodfuel, illegal trade in endangered species.[21]

Figure 7. Pelicans perched on the remains of a pier in Campeche Sound, Campeche State, Mexico. *(© Tommy Huynh 2001)*

Subsidies have been singled out as an important source of distortions and perverse incentives for the expansion of cultivated surface. But agricultural subsidies in Mexico suffered significant drops during this period.

Subsidies have been singled out as an important source of distortions and perverse incentives for the expansion of cultivated surface. But agricultural subsidies in Mexico suffered significant drops during this period. PROCAMPO, the income support mechanism introduced in 1994 had lost 40% of its value in real terms by 1999. Public investments in agricultural infrastructure and R&D stagnated and credit for agricultural activities dropped to almost negligible levels, while interest rates increased (Nadal 1999).

As a direct consequence of trade liberalization, corn imports increased and prices dropped by 50% between 1994 and 1996. Data from Nadal (2000) shows that the relative prices of other crops also declined, and in most cases at a faster rate than corn. This suggests it was difficult for corn producers to find profitable alternatives in other crops.

Maintaining constant output levels and expanding cultivated surface in the context of cuts in subsidies and price reductions may be the result of risk minimizing strategies favoring tried practices and traditional products even when they are of low value. In Mexico this bias is exacerbated because corn is the main staple food and thus provides security to the household. Besides, the price of tortillas, the baked corn pancakes critical

Expansion of cultivated surface may be associated with increased deforestation, and the drop in yields may indicate cultivation on marginal lands, but there is no firm data to corroborate these trends.

in rural diet, increased by 483% during the first six years of the NAFTA due to market imperfections. Clearly, from the viewpoint of corn producers the rational choice is to increase production in order to minimize the purchase of tortillas at high market prices.

This suggests that production may be taking place in the context of pervasive rural poverty that could lead to greater resource degradation. Loss of income due to cuts in subsidies and price reductions may cause households to put greater pressure on resources available for survival. If this is not enough to cope with income losses, additional pressure is placed on adjacent resources. Even if opening of new land to agriculture is not an immediate consequence, pressure on NPA's may also be exerted initially through poaching, the illegal capture of animals and collection of plants, and even felling of trees (Byron and Arnold 1999).

If lesser quality land is opened for cultivation, this can lead to the type of process described in Perrings (1989) as immiserizing growth that may bring about further deterioration of land quality.[22] This process may lead to increased degradation of the natural resource base and more specifically of land, exacerbating poverty and putting households under even greater stress. If the cycle is not arrested, households living in proximity of NPA's will look for resources within their premises. Even if a costly system for monitoring natural protected areas is put in place, it may be easily overwhelmed.

It is possible that opening new land for agriculture through deforestation is less likely in the case of protected areas because of the legal and institutional obstacles involved. Simply put, the marginal cost of opening land located within a protected area may be higher than the discounted returns from agricultural activities in this new land. However, there is a limit to this line of reasoning because maintaining high entry barriers may more difficult if poverty maintains its grip on rural populations (Southgate 1997). Data showing expansion of cultivated surface in states with heavy presence of NPA's is certainly a warning that needs to be carefully considered.

Concluding Remarks

The Federal NPA Program encounters three very difficult problems. The first concerns poverty and marginalization. As long as poverty continues at the scale and intensity of present conditions, it will be very difficult to guarantee the long term viability of natural protected areas as a means to ensure biodiversity conservation.

Already pervasive poverty in rural areas poses a serious threat because survival strategies inevitably lead to additional pressure on land, water resources, timber, flora and fauna. The erratic performance of the Mexican economy in recent years does not provide grounds for optimism. In the near future, prospects for growth and the reduction of inequality are not bright, especially considering the impact of the US economic slowdown. In addition, as long as monetary policy maintains its restrictive posture in order to harness inflation, and as long as fiscal policy insists on attaining an economic surplus, the economy will not be able to maintain adequate growth rates

As long as poverty continues at the scale and intensity of present conditions, it will be very difficult to guarantee the long term viability of natural protected areas as a means to ensure biodiversity conservation.

and inequality will persist.[23]

The second problem concerns policies for the agricultural sector. Agricultural prices have experienced sharp reductions over the past ten years and the drop in producers' income will persist. The drop in prices did not lead immediately to reductions in output, and total cultivated surface even expanded until 1999, especially in the basic grains sector, where yields dropped in many states where important NPA's are located (Nadal 2001). Expansion of cultivated surface may be associated with increased deforestation, and the drop in yields may indicate cultivation on marginal lands, but there is no firm data to corroborate these trends.[24]

Protected areas left without adequate custody become de facto open commons, without any social institution to oversee resource management and usage rates. Under these conditions, the resources of a natural protected area will be destroyed.

The third problem concerns the program's internal deficiencies. Financial resources need to be expanded significantly and at a rapid rate to ensure adequate support for personnel, infrastructure, and above all, sustainable production projects and community welfare.

Especially damaging for the health of NPA's is the lack of resource management programs and viable income-yielding projects. This is critical because conventional conservation will not deliver long-term biodiversity protection (Pearce 1999). Without these resources, natural protected areas may become paper parks. Protected areas left without adequate custody become de facto open commons, without any social institution to oversee resource management and usage rates. Under these conditions, the resources of a natural protected area will be destroyed.

Action needs to be taken on these three levels. Macroeconomic policy has to be reoriented towards objectives of growth and inequality-reducing development. This in turn is the key to allow agricultural policy a more flexible role to reduce marginalization levels. Finally, this will have to be supplemented by adequate funding of a more robust NPA program. International sources of finance, as well as greater involvement by the domestic private sector, are required.

Mexico's natural protected areas are invaluable biodiversity reservoirs. But they are both fragile and vulnerable. Unless viable alternatives are generated for rural poor, biodiversity conservation will represent a desirable policy objective, but not necessarily a tangible success.

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Notes

[1] Two major floristic kingdoms converge in Mexico and their component regions and provinces intersect along the length of the country (Rzedowski 1978). The Nearctic king-

dom is made up of two regions: the North American Pacific region in the Baja California peninsula, and the Mesoamerican Mountain region of the sierras and uplands from Chihuahua to Chiapas which comprises four provinces. On the other hand, the Neotropic kingdom which is made up of two regions: the Mexican desert region with four provinces ranging from sea level to the central plateau; the Caribbean region along the Atlantic and Pacific coasts and penetrating the adjacent lower inland drainages.

[2] Woodfuel is an especially important resource for rural poor. Recently published data on poverty in Mexico shows that 88.6% of households in Mexico's poorest *municipios* rely on woodfuel for cooking (INEGI 2001).

[3] In some cases, where NPA's are located downstream of urban or industrial centers, water pollution and impacts of infrastructure projects are other pressures. Some of the NPA's included in this analysis are affected by these sources of pressure. However, the central focus of this paper is on pressure stemming from poverty and marginalization.

[4] This official terminology is inaccurate. There are no regions in Mexico in which the "original environment" has not been affected by human activities.

[5] Mexico's Law for ecological equilibrium and environmental protection (LGEEPA) includes the legal definitions of these NPA. Biosphere reserves cover biogeographic regions representative of ecosystems not significantly altered by human activity and providing the habitat of endemic or threatened species. The core zone excludes economic activities. Special biosphere reserves are conceptualized in the same terms but correspond to areas smaller than ten thousand hectares. National parks are mainly forested areas more apt for recreational activities than for biodiversity conservation, although the latter element should not be minimized. Marine parks cover areas where activities are restricted to research and conservation of marine habitats, although some recreative and other economic activities can be authorized. Areas for the protection of flora and fauna are designed to safeguard specific habitats or threatened species. Natural monuments are specific sites that have exceptional scientific, aesthetic or historic value. Approximately 90% of the total surface of protected areas in Mexico belongs to biosphere reserves.

[6] This appears small in percentage terms when compared with countries such as Chile (21%), Costa Rica (25%) and Guatemala (30%). However, in absolute terms, the surface covered by Mexico's NPA program is comparable to protected surfaces in Chile (15.9 million hectares) and much greater than the protected surface in Costa Rica and Guatemala (1.25 and 3.2 million hectares respectively).

[7] For example, Mexican alpine habitats are considered too dispersed and fragile. Protected areas in these ecosystems, even if they are reduced in terms of total surface could easily protect at least 100 rare plant species from extinction (McDonald 1993).

[8] This type of process has already been reported in the literature on biodiversity conservation. In the Machalilla National Park in Ecuador environmental degradation has accelerated since public sector protection was established in the early 1970's. Previous resource users who had an ownership stake in the reserve have regarded the area as a free or open access resource (Southgate 1997:106).

[9] Various sources of information are used by INE to complete this list: specific on-the-ground scientific studies, direct observation by NPA administrators and NGO's, meteorological data, etc.

[10] The intensity of these regional disparities increases if only manufacturing GDP is taken into consideration. The contribution of the eight states to national manufacturing GDP was only 7.9% in 1993, and this share dropped to 6.9% in 1999. If we ignore the weight of the big refining centers in Veracruz the share of the eight states drops to 3.2%. On the other hand, if we consider agricultural GDP, the share of the eight states is 22.5%. Agricultural productivity in these states is low, and this percentage is associated to large scale agricultural employment in these states.

[11] Tourism development along the coastline south of Cancun is a fast growing activity and may improve employment opportunities there, but this poses its own problems for biodiversity conservation, specially for some endangered species and the coral reef barrier. In the case of Guerrero, per capita income would also drop significantly without the effect of tourist enclaves in the coast (Acapulco and Zihuatanejo).

[12] Localities are classified by size in two categories (more or less than 2,500 inhabitants). This part of our analysis considers monetary income instead of total (monetary and non-monetary) income. Procedures to make value imputations for several non-monetary income headings, such as "rent" imputed for households which own their dwellings, are marked by serious limitations. Normally, an overestimation of total income occurs when these non-monetary components are included for households in rural areas. As a proxy for rural areas we use the information for localities with less than 2,500 inhabitants.

[13] Rural income distribution was less skewed in 1992 because poverty was more equally distributed in rural areas. By 1998, inequality had increased (together with poverty) in rural areas.

[14] In Table 6 households were first divided into income deciles. Then each decile was further divided into households in towns of more or less than 2,500 inhabitants. Thus the number of all households in each decile is 10% of the national total, but within each decile the number of households by size of towns varies.

[15] The index components at the state level are the following: education (illiteracy and incomplete primary education), dwellings (dwellings without water piping, sewage, or electricity, with dirt floors, and congested household space), population dispersal (proportion of population living in towns with less than 5,000 inhabitants), and monetary

income (proportion of employed population earning up to two minimum wages). At the *municipio* level, population dispersal is not included and access to education is captured only through illiteracy rates. Briefly, the index uses a set of weights that are the first principal component that results from a factor analysis on eight variables.

16 Our analysis centers on *municipios* that are within the surface covered by NPA's or that are contiguous to NPA's.

17 The migration potential for each *municipio* is calculated through a comparison of population growth rates at the state level and at the *municipio* level between 1990 and 1995. If a *municipio* shows a higher (lower) growth rate than the state rate it is considered to have a positive (negative) potential as a migration attractor. Although this is not an exact measurement, it does provide a rough indicator of possible migration trends in the future.

18 In the case of Loreto there are no data because of changes in nomenclature of municipios between 1990-1995. For Sian Ka'an, one of the two municipios involved has a positive potential, while there is no data for the other *municipio*.

19 Data was not available for one *municipio*. CONAPO constructed the coefficients using a principal component technique and using a Dalenius optimal stratification.

20 The composition axiom states that complete control of a resource must be vested in a "well-defined group" for socially efficient use. The authority axiom states that this well-defined group must also act with a unified purpose.

21 In the case of Laguna de Términos and Celestún, in Campeche, additional pressure may arise from overfishing.

22 The model presented in Perrings (1989) describes a process by which open agrarian economies suffer losses of income because input and output prices are determined in the international market. If agrarian incomes are limited, when terms of trade turn against these economies there may be few alternatives to intensifying production regardless of the environmental risks involved.

23 According to some analysts (for example, Tisdell as quoted in Pearce 1999) the set of macroeconomic policies associated with structural adjustment leads to enhanced conservation. The central assumption is that this policy mix leads to greater growth and that the standard environmental Kusnetz' curve reasoning applies. Recent performance of Mexico's economy does not seem to justify this conclusion: per capita income in 2001 is marginally higher than in 1981. For an analysis of recent macroeconomic policy and economic performance in Mexico see Nadal (2001). For an additional reference concerning macroeconomic policies and environmental degradation, see Stedman-Edwards (1998).

24 Some models in the literature on deforestation show lower agricultural prices may induce producers to reduce output and cultivated surface, reducing pressure on forests (see for example Angelsen *et al*, 1999). But lower prices may also incite poor producers to expand production in order to compensate for income losses, especially if there are few perceived opportunities in other sectors of the economy. A strategy to intensify agricultural production on a sustainable basis in existing arable land is both required and feasible in Mexico. This would involve the diffusion of vegetative technologies (minimum tillage, integrated pest management, rotation, better soil and water management techniques, etc.)

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