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Strategies for Sustainable Development of Natural and Cultural Resources in the Paipai Indian Community of Santa Catarina, Baja California

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Introduction

Baja California's native communities are among the poorest populations of the peninsula. Living in remote settlements—the few isolated enclaves that remain of the wide territory that was once their land—these groups struggle for daily survival, attempting to make a living raising cattle, farming, making traditional crafts, and occasionally harvesting some of their natural resources such as yucca, acorns, pine nuts, herbs, and flower seeds. Unfortunately, the ability of the communities to use these resources to create sustainable sources of income for tribal members has been severely limited by the lack of access to government permits. The process of carrying out the environmental impact studies, management plans, and paperwork required to acquire permits is prohibitively expensive for these marginalized populations. As a result, the communities continue to depend on economic activities like cattle ranching and marginally successful agricultural projects, which often cause significant environmental degradation.

Ironically, all of the communities are rich in terms of land base and natural, cultural, and human resources. Furthermore, over thousands of years they have developed traditional methods of managing their natural resources, many of which may be applicable to new patterns of resource use. The purpose of the research presented in this chapter was to work with one of these communities—Santa Catarina—to create strategies for long-term management of these resources that will encourage sustainable development within the unique natural, social, and cultural context of rural indigenous communities.

This project required the integration of data from a wide variety of disciplines and sectors to reach the following objectives:

- Compile all the necessary bibliographic and field data
- Create Geographic Information Systems (GIS) to organize geospacial data for the assessment and monitoring of natural and cultural resource inventories
- Design and carry out interviews to identify human resources and community priorities
- Analyze the development potential for proposed activities
- Identify legal configurations for facilitating the permitting process and assist the community in preparing the necessary paperwork
- Create a feedback loop with communities and their leaders throughout the process
- Propose strategies for sustainable development

Methodology

To compile all the information necessary to propose strategies for sustainable development, project investigators funded by the Southwest Center for Environmental Research and Policy (SCERP) worked closely with indigenous community members, students and faculty from Universidad Autónoma de Baja California (UABC), individual researchers, and private consultants.

Perhaps the most important contributions to this effort are the following documents:

- *Ecosystems Management Proposal for the Indigenous Community of Santa Catarina (Propuesta de manejo de ecosistemas de la Comunidad Indigena de Santa Catarina),* produced in 1999 by students from the UABC's Master's Program for Ecosystems Management, in coordination with the author
- "Sustainable Development in the Indigenous Communities of Baja California" (Wilken, et al. 1998)
- "Indian Groups of the California-Baja California Border Region: Environmental Issues" (Kilpatrick, et al. 1998)
- The Master's thesis of Erika Rivera, titled "Traditional utilization of vegetative species in the Kumiai Indian Community of San Jose de la Zorra, B.C., Mexico. Current situation, perspectives and management alternatives" (or "Explotacion artesanal de especies vegetales en la comunidad indígena kumiai de San Jose de la Zorra, BC Mexico. Estado actual, perspectivas y alternativas de manejo")
- The Field Report (Informe de Camp) of Judith Bravo

The creation of the GIS database was carried out through the expertise of Mtro. Martin Escoto, then-adjunct professor of the UABC Sciences Faculty. Escoto trained Paipai tribal members Andrés Albañez and Aracely Castro in the use of a Global Positioning System (GPS) to identify the locations of their community's resources. These technicians were also taught to transfer the data to a computer and work with GIS programs. This information became part of the permanent GIS database of Baja California's indigenous communities and is housed in the offices of Instituto de Culturas Nativas de Baja California (CUNA) for use by the communities themselves and for future research.

Interviews for the identification of human resources and community priorities were designed by Erika Rivera for her thesis work in San José de la Zorra. These were applied by community members trained for this purpose. The same basic format was then applied in the Paipai community of Santa Catarina by community member Carmen Gonzales.

The analysis of development potential for proposed activities—primarily traditional handcraft production and ecotourism—is based on field work carried out by ethnologist Judith Bravo, this chapter author's

personal experience promoting these activities on a small scale, and the experience of Lic. Francisco Detrell of Expediciones de Turismo Ecológico y Aventura, S.A. de C.V. A concurrent CUNA project, "Creating the Green Link for Sustainably Produced Indigenous Goods and Services," funded by the North American Fund for Environmental Cooperation, has also allowed CUNA to explore the economic feasibility of handcraft production and ecotourism and create marketing infrastructure that complements the proposals in the present study.

The identification of legal configurations to facilitate the permitting process was carried out by biologist Alfredo Acosta. Based on the recommendations of previous CUNA and UABC documents, the formation of a Conservation, Management and Sustainable Wildlife Utilization Unit (UMA) was proposed as a means of developing greater self-management of resources. Acosta compiled the data necessary to help the communities take that important next step.

Finally, to create a feedback loop with the communities and their leaders throughout the process, project supervisors and researchers met periodically with community leaders, presented preliminary findings for discussion at community meetings, and provided copies of GIS printouts and other information of special interest to the communities. A special day-long exhibit and interactive workshop was also held as part of the KURI KURI 2000 Indigenous Gathering held at San Miguel Village on July 15, 2000, for the purpose of disseminating information and demonstrating the powerful potential of GIS as a tool for environmental management. Indigenous community members who had received GPS and GIS training had the opportunity to share the information and their experiences with members of all of Baja California's indigenous communities and with the public in general. The results of these studies have also been integrated into Spanish and English posters that have been displayed at a variety of conferences and events.

It is the hope of all involved in this important project that the strategies proposed here may soon be put to work for the benefit of the communities themselves. This kind of multi-disciplinary, cross-sector approach can serve as a model and be applied to help other communities in their struggle to gain greater economic self-sufficiency through the sustainable use of natural and cultural resources.

Santa Catarina—Description

The Paipai Indian Community of Santa Catarina is located in the north-central portion of the state of Baja California, approximately 100 kilometers south of the U.S.-Mexican border. The 350-member community holds title to a total of 68,000 hectares, which are comprised of a variety of ecosystems from high plain to sierra to desert. This communally owned territory lies within the municipalities of Ensenada and Mexicali and is accessed from the city of Ensenada first by 92 kilometers along Mexico's Highway 3 (Ensenada-San Felipe) followed by 8 kilometers of dirt road to reach the main settlement of Santa Catarina. This center of population is situated between the coordinates of 31°30'30" latitude north and 115°49'30" longitude west, according to the official 1998 map of the National Agrarian Registry (Ahumada Cervantes, et al. 1999).

The predominant type of rock in the area is igneous with (Ts(B)) basalt of the late tertiary, sedimentary with (Q(al)) quaternary alluvium deposits, metamorphic with (Tpl(cg)) Pliocene conglomerates, and cretaceous (K(Gd)) granodiorite situated at the lower eastern slopes of the sierra (INEGI 1984; Carranza 1997).

The climate of this region is partially dry (Bwhs(e)) according to Koppen's climatic classification, modified by Garcia (1981), with an average temperature of 16°C to 18°C and precipitation levels measuring 200 millimeters (mm) annually. Winter precipitation levels range from 150 mm to 200 mm, with temperature lows of 0°C and highs of 15°C. Both regional and local dominant winds are north to south. In the summer, precipitation is about 50 mm, with low temperatures of 9°C and highs of 27°C. Regional dominant winds are north-to-south and local dominant winds are south-to-north.

The predominant type of soil is medium-textured regosol; in the higher regions it is coarse-textured litosol. The low to moderate terrain has fair agricultural capacity and average possibilities for drainage (INEGI 1984c; Carranza 1997).

Santa Catarina is located between Hydrological Regions RH4 and RH7. The principal stream in the western portion is Jactobojol (translated as "water splashing over rocks"), which flows through the main settlement and down to the agricultural plain and former settlement of San Miguel. This is the main source of water for the

Paipai, although several outlying ranches depend on springs or smaller creeks such as Agua Colorada. This watershed drains west to the Pacific Ocean near the town of San Vicente. On the eastern side of the community, several streams drain off the eastern escarpment of the Sierra Juárez and into the desert creating palm oases, some with hot springs, such as Agua Caliente (Meigs 1935; INEGI 1984).

The community is located in an ecotone between the San Pedro Martir chaparral and the microphile Sonoran desert scrub of San Felipe, which is known as desert or transitional chaparral (Carranza 1997). The desert chaparral is found in zones of highly arid conditions at higher elevations and occurs in places where the vegetation is transitioning to desert. This type of vegetation is characterized by various species of mountain coastal chaparral and elements of the Sonoran desert, and is located at elevations of 1,000 meters to 1,300 meters (Ahumada, et al. 1999).

The vegetation includes both conifer forests and deserts in the eastern section. Some species of chaparral include sugar bush *(Rhus ovata),* greasewood *(Adenostoma fasciculatum),* jojoba *(Simmondsia chinensis),* Mormon tea *(Ephedra californica),* flat-top buckwheat *(Eriogonum fasciculatum),* wild lilac *(Ceonothus greggii),* and two under special conservation status—juniper *(Juniperus californica),* considered rare, and piñon pine *(Pinus monophylla),* under special protection. Examples of the desert species are creosote bush *(Larrea tridentate),* mesquite *(Prosopis juliflora),* Mojave yucca *(Yucca schidigera),* prickly pear *(Opuntia prolifera),* and barrel cactus *(Ferocactus acanthodes* and *Ferocactus peninsulae)* (Delgadillo 1992 and field verified) (Table 1) (Ahumada, et al. 1999).

Table 1. List of Vegetation

Common Name	Scientific Name
Barrel cactus	*Ferocactus acanthodes*
Basin sagebrush	*Artemisia tridentata*
Brickellia	*Brickellia californica*
Broom	*Baccharis brachyphylla*
Carrizo	*Arundo donax*
Cattail	*Scirpus* sp.
Chamizo blanco	*Atriplex canescens*

Table 1. continued

Common Name	Scientific Name
Chia	*Salvia columbariae*
Cholla	*Opuntia acanthocarpa*
Chuchupate	*Tauschia arguta*
Chuparrosa	*Ipomopsis tenuifolia*
Coast live oak	*Quercus agrifolia*
Cottonwood	*Populus fremontii*
Creosote bush	*Larrea tridentata*
Deerweed	*Porophyllum gracile*
Elderberry	*Sambucus mexicana*
Estafiate	*Ambrosia psilostachya*
Flor de concha	*Centaurium venustum*
Golondrina	*Euphorbia micromera*
Gordolobo	*Gnaphalium purpureum*
Greasewood	*Adenostoma fasciculatum*
Heliotrope	*Heliotropium curassavicum*
Hen and chicks	*Dudleya pulverulenta*
Hen and chicks	*Dudleya lanceolata*
Hierba colorada	*Rumex violascens*
Hierba de la víbora	*Daucus pusillus*
Hierba del burro	*Isomeris arborea*
Hierba del empacho	*Mirabilis lavéis*
Hierba del pasmo	*Haplopappus juarezensis*
Hierba santa	*Eriodictyon trichocalix*
Hierba santa	*Eriodictyon angustifolium*
Hierba santa	*Eriodictyon lanatum*
Indian tobacco	*Nicotiana glauca*
Islay or California cherry	*Prunus ilicifolia*
Jimson weed	*Datura inoxia*
Jimson weed	*Datura discolor*
Jiuata	*Lotus scoparius*
Jojoba	*Simmondsia chinensis*
Juncus	*Juncus acutus*
Juncus	*Juncus cooperi*
Juniper	*Juniperus californica*

Table 1. continued

Common Name	Scientific Name
Laurel sumac	*Rhus laurina*
Lizard's tail	*Anemopsis californica*
Llámate	*Asclepias subulata*
Manrrubio	*Marrubium vulgare*
Manzanita	*Arctostaphylos glandulosa*
Mayflower	*Viguieria laciniata*
Mesquite	*Prosopis glandulosa*
Mezquite	*Prosopis juliflora*
Mohave yucca	*Yucca schidigera*
Monkey flower	*Mimulus brevipes*
Mormon tea	*Ephedra californica*
Moronel	*Lonicera subspicata*
Mulefat	*Baccharis glutinosa*
Nettles	*Urtica holosericea*
Nolina	*Nolina palmeri*
Oak	*Quercus chrysolepis*
Our Lord's candle	*Yucca whipplei*
Piñon pine	*Pinus quadrifolia*
Pitaya	*Echinocereus engelmannii*
Prickly pear	*Opuntia engelmannii* and *phaecanta*
Rabbit's pillow	*Baileya pleniradiata*
Romerillo	*Baccharis saratroides*
Romero	*Trichostema lanatum*
Royal sage	*Salvia pachyphylla*
Rush Chaparral-Star	*Haplopappus junceus*
Salvia	*Salvia californica*
Scrub oak	*Quercus dumosa*
Sugar bush	*Rhus ovata*
Sycamore	*Platanus racemosa*
Tofe	*Phoradendron bolleanum*
Water cress	*Nasturtium officinale*
White sage	*Salvia apiana*
Wild ash	*Fraxinus trifoliata*
Wild buckwheat	*Eriogonum fasciculatum*

Table 1. continued

Common Name	Scientific Name
Wild garlic	*Chaenactis tenuifolia*
Wild lilac	*Ceanothus cuneatus*
Wild peony	*Paeonia californica*
Wild tobacco	*Nicotiana atenuatta*
Willow	*Salix hindsiana*
Willow	*Salix laevigata*
Zorrillo	*Chorizante interposita*

Source: Ahumada Cervantes, et al. 1999

As in the rest of the state, this area is composed of a wide variety of vertebrates that do not have exact boundaries in their movements, particularly in this area of transition. Some of the species include squirrel *(Spermophillus bechei),* chipmunk *(Spermophillus* sp.*),* rabbit *(Sylvyllagus audubonii),* and woodrat *(Neotoma* sp.*)*. In some regions, there are occasionally migrant species like deer *(Odocoileus hemionus fuliginata)* and Bighorn sheep *(Ovis canadiensis cremnobates)*. Also, various predator species exist, such as coyote *(Cannis latrans),* fox *(Urocyon cinereoargenteus),* lynx *(Lynx rufus),* and California puma *(Puma concolor californicus)* (Garduño 1994). Bird species include quail *(Callipepla californica),* dove *(Zenaida asiatica),* white-winged dove *(Zenaida macroura),* white owl *(Tito alba),* falcon *(Falco* sp.*),* roadrunner *(Geocoxis californicus),* and five under special conservation status—the golden eagle *(Aquila chrysaetus),* in danger of extinction; the prairie falcon *(Falco mexicanus)* and purple finch *(Carpodacus purpureus),* which are threatened; the red-tail hawk *(Buteo jamaicencis),* under special protection; and the burrowing owl *(Tecolotillo serrano),* a rare species (Table 2).

Before the arrival of non-Indian cultures, the ancestors of the Paipai were semi-nomadic hunters and gatherers who developed a highly mobile way of life based on the use of a diversity of natural resources from a variety of ecosystems. Some aspects of this traditional lifestyle—such as gathering plant foods and medicines; hunting; and the use of soils, plants, and animals for manufacture of traditional arts—are still important in Paipai subsistence strategies.

Table 2. List of Wild Fauna

Common Name	Scientific Name
Aguililla migratoria	*Buteo swainsoni*
Bighorn sheep	*Ovis canadensis*
Black-shouldered kite	*Elanus caeruleus leucurus*
Bolsero parisino	*Icterus parisorum*
Calandria zapotera	*Icterus cuculiatus*
Camea	*Chamea fasciata*
Carbonero oregones	*Junco hyemalis*
Cardenalito	*Pyrocephalus rubinus*
Carpintero aliblanco	*Sphyrapicus thyriodes*
Carpintero alirojo	*Colapter cafer auratus*
Carpintero encinero	*Melanerpes formicivorus*
Carpintero nuttall	*Piccoides nuttallii*
Carpintero saucero	*Sphyrapicus ruber*
Carpodaco de cassin	*Carpodacus cassini*
Cascanueces americano	*Nucifraga columbiana*
Chara pechirrayada	*Aphelocoma coerulences*
Chipe celato	*Vermivora celata*
Chipe negrigris	*Dendroica nigrescens*
Chipmunk	*Ammospermophilus leucurus*
Colorín sietecolores	*Passerina ciris*
Common poorwheel	*Phalaenoptilus nuttaliii*
Contopus de chaleco	*Contopus borealis*
Contopus occidental	*Contopus sordidulus*
Copetón cenizo	*Myiarchus cinerascens*
Coyote	*Canis latrans*
Cuervo grande ronco	*Corvus corax*
Cuitlacoche	*Toxostoma radivivum*
Cuitlacoche ceniciento	*Toxostoma cinereum*
Dove	*Zenaida macroura*
Empidonax de wright	*Enpidonax wrightii*
Gavilán pajarero	*Accipiter striatus*
Gavilán pechirrufo	*Acciper cooperi*
Golden eagle	*Aquila chrysaetus*
Golondrina grande	*Progne subis*
Golondrina verde	*Tachycineta thalassina*

Table 2. continued

Common Name	Scientific Name
Gorrión barbinegro	*Spizella atrogularis*
Gorrión coronirrufo	*Spizella passerina*
Gorrión indefinido	*Spizella breweri*
Gorrión troglodita	*Amphispiza belli*
Gorrión vulpino	*Passerela iliaca fulginosa*
Gray fox	*Urocyon cinereoargenteus*
Gusanero	*Dendroica coronata*
Halcón cernícalo	*Falco sparverius*
Hare	*Lepus californicus*
Hummingbird	*Doricha eliza*
Hummingbird	*Calypte anna*
Hummingbird	*Archilochus alexandri*
Hummingbird	*Stellula calliope*
Jilguero canario	*Carduelis tristis*
Jilguero norteño	*Myadestes towsendi*
Jilguero pinero	*Carduelis pinus*
Lechuza barranquera	*Asio otus*
Lechuza blanca	*Tito alba*
Lesser nighthawk	*Chordeles acutippennis*
Mosquerito barranqueño	*Empidonax difficilis*
Mountain lion (puma)	*Puma concolor*
Mule deer	*Odocoileus hemionus*
Northern harrier	*Circus cyaneus*
Northern pygmy owl	*Glaucidium gnoma*
Northern roadrunner	*Geococcys californicus*
Papamoscas negro	*Sayornis nigricans*
Para cejiblanco	*Parus gambei*
Pelucilla	*Wilsonia pusilla*
Perlita piis	*Polioptila coerulea*
Picocruzado	*Loxia curvirostra*
Piquituerto común	*Coxia curvirrostra*
Prairie falcon	*Falco mexicanus*
Purple finch	*Carpodacus purpureus*
Quail	*Callipepla californica*
Quail	*Oreortyx pictus*

Table 2. continued

Common Name	Scientific Name
Rabbit	*Silvilagus bachmani*
Rabbit	*Sylvilagus audubonii*
Rascador pinto oscuro	*Pipilo erythrophthalmus*
Red-tail hawk	*Buteo jamaicencis*
Rellesuelo de rojo	*Regulus calendula*
Saltapared enano	*Sitta pygmaea*
Sastrecito	*Psaltriparus minimus*
Sharp-shinned hawk	*Accipiter striatus*
Sita pechiblanca	*Sitta carolinemsis*
Skunk	*Spilogale putorius*
Sparrow	*Carpodacus mexicanus*
Squirrel	*Spermophilus bechei*
Swainson's hawk	*Buteo swainsoni*
Tangara aliblanca	*Piranga lodoviciana*
Tecolotito chillón	*Otus kennicottil*
Tigrillo	*Pheucticus melanocephalus*
Tirano gritón	*Tyranus vociferans*
Tordo ojiclaro	*Euphagus cyanocephalus*
Tordo solitario	*Catharus guttatus*
Troglodita continental	*Troglodytes aedon*
Troglodita saltapared	*Catherpes mexicanus*
Urraca piñonera	*Gymnorhinus cyanocephalus*
Ventura azul	*Siala mexicana*
Verdugo cabezón	*Lanius ludovicianus*
Vieja	*Pipilo fuscus*
Vireo anteojillo	*Vireo solitario*
Vireo gris	*Vireo vicinor*
Vulture	*Cathartes aura*
White-wing dove	*Zenaida asiatica*
Wildcat	*Lynx rufus*
Zone-tail hawk	*Buteo albonotatus*
Zorzal pichirrojo	*Tordus migratorius*

Source: Ahumada Cervantes, et al. 1999

However, since the mission period beginning in 1797 and with the establishment of a sedentary way of life, livestock grazing—and to a lesser degree agriculture—have become increasingly important forms of land use. For the last century and a half, many Paipai have made a living outside of the community working as wage laborers for neighboring ranches, in mines (during Baja California's gold rush from 1860 to 1880), and in agricultural projects. Today, along with the these economic activities, many Paipai make a living from the manufacture and sale of traditional handcrafts, by extracting natural resources such as yucca and firewood for sale to outsiders, by working for state-run road maintenance projects, or by teaching in the local school.

A network of dirt roads crisscrosses the western portion of the territory, which is the area of Santa Catarina where most community members live and carry out a variety of economic and social activities. Currently, road improvement programs—a major source of employment for the Paipai—are focused on improving access to the eastern desert area of the community's territory.

Homes and ranches are constructed from a variety of materials, including traditional brush huts, adobe, stone, wood, cinder block, and recycled materials. During 2000, a solar-powered water system servicing the main settled area was installed through a collaboration between the non-governmental organizations AquaLink and CUNA, and the Baja California state government. During the same year, the state also provided small solar energy systems to each home or ranch because the community lacks a central energy system or access to Federal Energy Commission (in Spanish, Comisión Federal de Electricidad, or CFE) lines.

A primary school, cafeteria, and boarding facilities, as well as a "telesecundaria" (a secondary school with televised course components), provide basic education for approximately 50 children. The elusive goal of bilingual education (Spanish and Paipai) has proven difficult to attain, however it continues to be an official priority. Many children are exposed to both Paipai and Kuatl (apparently a hybrid of Kumiai and Paipai), and although these native languages are losing ground to Spanish, fluency is still much higher than in other Pai communities north of the border. Increased funding for expanded language preservation programs is critical and would rep-

resent an important investment in this rare and valuable cultural resource. Students who want to study beyond secondary school must move to Trinidad Valley, Ensenada, or other towns with high schools. Currently, CUNA's scholarship program provides basic support for the nine secondary students and 15 high school students from Santa Catarina.

Health services are provided to the community through CUNA's Medical Aid Network and the state health agency, Instituto de Servicios de Salud Pública de Baja California (ISSESalud). Many members of the community retain traditional knowledge of medicinal plants (Cortés 1994) and often prefer to self-diagnose and treat before resorting to biomedicine (Fleuriet 2002). A clinic in the community has recently been renovated by ISSESalud and a doctor has been assigned to make regular visits.

The community has no tribal office or infrastructure to support its elected officials, save a partially constructed meeting hall for monthly *juntas*, or gatherings where issues of interest to the community are discussed and decisions are made.

Environmental Management by Ecosystem Units

To assist the community with long-term environmental planning, students from the Ecosystems Management Masters program at UABC analyzed the possibilities for land use based on ecologically homogenous areas, taking into consideration their current and potential uses. These units were identified as chaparral with juniper, chaparral without juniper, pine forest, riparian vegetation, desert, and populated areas. Students evaluated several activities based on current or potential use, including agriculture, livestock, habitation, ecotourism, and conservation. Traditional use of plants and soils for the manufacture of handcrafts will be treated separately in this chapter. Traditional harvesting of flora and fauna for food, medicine, and other purposes was considered innocuous or beneficial at current levels, however at commercial levels, specific studies would be necessary on a species-by-species basis (Ahumada Cervantes, et al. 1999).

The students assigned values to the different activities in the context of each ecosystem unit depending on whether its impact would be favorable (+1), null (0), or unfavorable (-1). The value assigned represents the importance each factor had for each of the activities, depending on the biotic or abiotic components that the activity required to be carried out successfully. These were classified as very important (3), important (2), and less important (1). To evaluate impact on environmental quality in the community, the students created an environmental impact matrix allowing them to identify specific impacts on water, soils, air, vegetation, fauna, economy, and culture. The results of this system of quantification are presented in Table 3 and are the basis for the Ecological Management Ordinance proposed by the students (Ahumada Cervantes, et al. 1999).

Table 3. Ecosystem Capacity

Ecosystem Unit	Agriculture	Livestock	Settlement	Ecotourism	Conservation
Chaparral with juniper	1	1	23	17	13
Chaparral without juniper	1	1	23	17	13
Pine Forest	-10	-2	5	17	17
Riparian Zone	13	2	7	20	15
Town-habitation areas	7	2	23	2	-9

Source: Ahumada Cervantes, et al. 1999

The Ecological Management Ordinance is a planning tool for local development as articulated by the General Law for Ecological Equilibrium and Environmental Protection (in Spanish, Ley General del Equilibrio Ecológico y la Protección al Ambiente, or LGEEPA). As environmental policy, it is the duty of the federal, state, and local governments to comply with the priorities of established ordinances. Table 3 presents the basis for an ordinance for Santa Catarina based on the land use capacity of each ecosystem unit. Positive values indicate a high capacity for a particular activity, negative values indicate that the ecosystem cannot support a particular activity.

Both types of chaparral (with or without juniper) show similar results. Livestock grazing is not recommended because the soils in these areas are poor and extensive grazing requires fertile soil that

regenerates quickly. This land is not recommended for agriculture because of its uneven soils and lack of water. The recommended policy for this ecosystem is that of continued use for habitational, ecotourism, and conservation activities, as well as carrying out traditional activities such as the gathering of seeds, plants, and fruits. The extraction of certain resources such as yucca and juniper—which currently represents an important source of income for the community—should also continue with careful management and seek to add value wherever possible to the raw materials. This area also has a high capacity for ecotourism, as will be discussed later in this chapter.

Pine forest areas are also not suitable for agriculture and grazing due to the steep slopes and lack of water. The steep slopes also impede access for other types of development. These areas are recommended for ecotourism and conservation because they include many attractive landscapes and most of the species with some kind of protected status.

The best uses for riparian areas are ecotourism, conservation, and agriculture; the least appropriate is livestock grazing. Conservation is appropriate because drinking water and many of the most important materials for handcraft production (willow, palm, juncus, cottonwood, and clay) also come from these areas.

The habitational areas, most of which have been established on land that was cleared of chaparral, are best suited for continued use as human settlements. These areas have been most severely impacted environmentally, so reforestation of parts of them is recommended to reverse the impact of increasing soil erosion (Ahumada Cervantes, et al. 1999).

The desert areas in the eastern portion of the community are remote and practically uninhabited by humans, except for occasional cowboys who take cattle down from the mountains during the winter to graze in the warmer desert areas. Because little information is available about the desert ecosystem of the Paipai and the students were not able to visit the remote area, it was not included in this environmental evaluation. However, members of the Paipai community have expressed interest in the potential for ecotourism development of the palm oases and hot springs, as well as the development of mining for flagstone in this section of their land.

Environmental Issues

Water Quantity and Quality

The main stream of Jacotobojol provides the main settlement of Santa Catarina with an adequate drinking water supply through the newly functioning solar water pumping system. Outlying ranches at Jayuacahuatl (Agua Colorada) collect surface water in buckets, storage drums, or gravity-fed hoses. Many other springs throughout the territory provide water for single family ranches such as Rincón de Santa Catarina, Agua Escondida, Jamin, and San Miguel, or for seasonal camps such as Agua Caliente, La Parra, and El Alamito. In many cases, these springs have been dug out and small earthen dams formed to retain water.

Water quality is better than in other indigenous communities of the region, however, high nitrate levels may be the result of waste contamination or fertilizer runoff (Wilken-Robertson 1996). Livestock is often seen grazing in the riparian area upstream from the water system intake and the area has not been fenced to avoid contamination in the immediate area. Washing clothes in the stream and bathing may also affect water quality (Ahumada Cervantes, et al. 1999). The new water system pumps all water up to one central holding tank, offering the possibility of chlorinating or otherwise treating water. This measure has been proposed to the community, but there is resistance to the possible effect on the taste of the water and because the Paipai report they are already accustomed to the local water flora.

Currently, water for irrigation comes primarily from groundwater. An irrigation ditch diverted from the Jacotobojol stream, parts of which date from the mission period, has long been used to irrigate some of the fertile plains along the riparian area near the main settlement. During the last several years, several kilometers of hose have been used to irrigate crops in the former settlement area of San Miguel. The area also has at least two wells that are not currently functioning. According to a local hydrology map, the San Miguel area should have plenty of groundwater for irrigation. The eastern desert areas are also indicated as potential sources of groundwater that could be applied to agricultural projects. The Paipai have

expressed interest in developing their land's agricultural potential, but they have also pointed out the failed agricultural projects of neighboring communities where natural species have been cleared and the plots abandoned, leading to an accelerated process of desertification (Wilken 1997). Traditional and contemporary management of already established native plants such as yucca, jojoba, juniper, barrel cactus, and many other species has also been described by some researchers as a form of agriculture (Blackburn 1993) that may be preferable to large-scale irrigated agricultural development for the Paipai.

Air

Although no studies have been carried out in the community, air quality appears to be excellent; there is no visual or pathological evidence to suggest air quality problems. Clean air is itself an important resource that may be an added attraction for ecotourism in the community. According to the UABC study, the only possible sources of air pollution would be dust from wind erosion resulting from changes in land use, such as the loss of vegetative cover due to grazing and new roads, and the occasional burning of trash.

Soils

Contamination of soils does not appear to be a problem in Santa Catarina, but soil erosion appears to be increasing due to extensive livestock grazing, and this increases the volume of dirt roads, vehicular traffic (several major off-road races pass through the community each year), and clearing of land for habitation and agriculture. Much of the fertile soil formerly used for agriculture along the riparian areas has washed away during the floods of the last half century, perhaps due to changes in land use farther up the watershed. A small amount of clay is mined for the manufacture of traditional pottery, a topic broached later in this chapter.

Trash

The community has no centralized infrastructure for waste disposal. Trash often accumulates near living areas until it is burned. The UABC study recommends that the community designate a landfill area to which trash could be removed on a regular basis, possibly with the cooperation of the municipal government (Ahumada Cervantes, et al. 1999).

Cultural Resource Management Proposals

Santa Catarina is blessed with a rich diversity of cultural resources, perhaps more than any other native community of Baja California. Historic sites from ancient, mission, ranch, and modern periods; vast knowledge of the land, its flora, and fauna; living traditions of language and arts; native construction experience, including traditional housing and adobe manufacture; cowboy culture; and many other aspects of Paipai ways of life represent valuable resources for Santa Catarina. Community members often express their interest in preserving these aspects of their culture, especially since they help reinforce their identity as native Baja Californians. A highly effective means of ensuring the transmission of these components of indigenous culture is through revitalization of their value within the Paipai economy.

The revival of traditional handcraft production illustrates how this process can help native artisans preserve, practice, and reinterpret the knowledge passed on from their ancestors while at the same time strengthening and diversifying their tribal economy and self-sufficiency. Ceramics, agave fiber nets, bows and arrows, and other tools—originally indispensable utilitarian components of Paipai material culture and economy—were rapidly falling from use by the middle of the twentieth century due to the introduction of new materials (Michelson 1971). Twenty years ago, only four older women of Santa Catarina occasionally made pottery, mostly for sale to infrequent tourists who happened on the community. Younger women rarely took the time to learn the skills for what seemed to be a dying art. Today, however, this trend has been entirely reversed. Growing interest and emerging markets for their wares has allowed

many of the artisans to dedicate all their productive hours to traditional handcraft production. Daughters and granddaughters have learned the skills and become recognized artisans; older and younger men have also become specialists at making bows and arrows, wooden ladders, gathering buckets, rabbit sticks, and leather goods. They also specialize in providing raw materials to ceramicists. New forms like the pine needle and palm basket have been developed and quickly perfected, while traditional wares are also evolving in exciting and dynamic directions.

These developments have been greatly enhanced by the ability of artisans to access markets throughout the original territory of their Yuman ancestors, which includes California, Arizona, and Baja California. Over the last eight years, artisans have been invited to participate in events and gatherings in museums, on Indian reservations, and at schools, historic sites, state parks, and conventions. They are often asked to teach classes to students in related Indian communities of the United States, reinforcing the transmission and preservation of skills in areas where these ancient traditions had been lost. Clearly, both the knowledge and products of these skills have taken on a new value in the Paipai economy. Fortunately, most of the handcraft processes involve sustainable environmental management practices and, even at significantly higher commercial levels, they can continue to provide important economic benefits without sacrificing the integrity of the environment. This is especially useful because these and other culturally based activities allow the Paipai to replace environmentally degrading activities like poorly managed cattle and goat ranching with better-paying, environmentally friendly jobs.

Increasing Handcraft Production

The dramatic increase in quality and quantity of handcraft production reflects a variety of changing dynamics in the Paipai economy:

- Growing appreciation for traditional arts creates new markets
- Younger people choosing to stay in their communities to take advantage of new and more diversified economic opportunities
- The handcraft cottage industry providing better income than non-sustainable activities

- Increased initiative, empowerment, and self-sufficiency, especially for women
- Development of partnerships with outside organizations, communities, and individuals that assist or do business with artisans

Currently, the limits on handcraft production include:

- The need for wider and more consistent markets for products, improved infrastructure for the promotion and distribution of products, and training of apprentices by master artisans to increase quantity and quality of production
- The lack of legal permits for natural resources used in manufacture, long-term environmental management plans for resources used, and tribal members with advanced marketing, business administration, and foreign language skills

Fortunately, there are several concrete steps that can be taken by native community members and tribal governments and non-governmental organizations to overcome these limitations. The widening of markets and assurance of a more consistent income for artisans goes hand-in-hand with the improvement of infrastructure for production, promotion, and distribution of products. At a local level, one recommendation is to encourage the development of outlets for products within the communities themselves. A limited number of buyers occasionally visit the communities now, but many potential retail and wholesale customers might not even know the communities exist or may lack information about how to find them. For this reason, it is important to create a destination such as a community museum—which provides important contextual information about the handcraft traditions—with a marketplace space accessible to all artisans.

Artisans from both Santa Catarina and San José de la Zorra can take advantage of the proximity of a major highway (Mexico 3) with sufficient traffic to guarantee a certain level of sales. A small but highly visible booth with appropriate signs would require a minimal investment and could provide ongoing returns. Wholesale distribution to retail stores in the urban areas of the Baja California border

region is a strategy recently explored by enterprising young tribal members. However, the cost of fuel and vehicle maintenance limits the feasibility of this strategy.

The establishment of retail outlets specializing in native handcrafts with promotion through the Internet provides worldwide exposure for indigenous handcrafts. One example of this is Nativa Indian EcoArts in Ensenada, Baja California (http://www.nativa.netfirms.com.mx). This non-profit project of CUNA was designed to assist native artisans through the promotion and distribution of sustainably produced indigenous handcrafts.

Although the lack of legal permits for use of natural resources for handcraft manufacture is currently not a major limitation, it is an issue that will begin to affect artisans as their work becomes more widely distributed. This is because Mexico's Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) requires permits for the commercial use of most natural resources. Permits may also be required for the export and/or certification of handcrafts. Fortunately, the system of UMAs can help communities get the permits they need through the management of their natural resources.

For long-term environmental management planning, communities can benefit from partnerships with academic and research institutions such as UABC and Centro de Investigatión Científica y de Educación Superior de Ensenada (CICESE), and civil associations such as CUNA. These groups can collaborate with the communities to carry out studies of individual species and ecosystems, as well as create natural resource databases through GIS.

For indigenous communities to realize additional economic benefits from handcraft production, tribal members need to develop advanced marketing, business administration, and foreign language skills. Currently, few tribal members have had the opportunity to continue their education beyond the primary level. For this reason, it is imperative to identify and support native students interested in developing careers in these areas. Support is needed for long-term scholarship programs that help students complete their studies.

Programs for the training of apprentices by master artisans may be available through the Mexican government or international foundations and would be an excellent investment to increase the quan-

tity and quality of production. Furthermore, since most artisans are fluent in their native languages, classes could also encourage the transmission of this vital aspect of culture.

Management Design for Sustainable Pottery Production

Potters from Santa Catarina have identified at least two sources of clay in the vicinity of their community. These deposits have been mined for at least half a century and probably much longer, as evidenced by numerous potshards found throughout the area. Because relatively small amounts of clay are needed to support the small level of production, the impact on the deposits is minor; they still appear to contain a large amount of raw material for continued production. A small area of vegetative cover approximately 80 square meters in size appears to have been affected, but this impact is miniscule compared to that of cattle grazing, agricultural projects, and road construction.

As in the past, clay is mined with pick and shovel. One kilogram of raw clay yields approximately 500 grams of fine clay powder, which is hydrated and kneaded to make workable clay. A finished pot weighing 500 grams can be sold for approximately $4.50 (500 pesos)—more than 160 times the price paid for clay sold as adobes. Clearly, the cultural value added makes pottery the best possible use of clay soil resources.

Currently, eight artisans regularly make pottery, and many of their children are also learning the skills of the trade. For many of these ceramicists, pottery represents their primary source of income. Pottery is also a key element in Paipai cultural identity and in recent years has become an important link with other indigenous groups of Baja California, California, and Arizona as Paipai teachers are contracted to teach their skills throughout the Yuman region. Considering that the Paipai have more than 68,000 hectares of land and there are undoubtedly other clay deposits within their community, pottery represents an excellent option for years to come, even at increased levels of commercialization. The GIS developed for Santa Catarina may be useful for detecting potential deposits for mining clay.

Firing

The preferred material for firing pottery is the dead, dried stem of the Mohave yucca *(Yucca Schidigera)*, although cow manure can also be substituted. Yucca does not have a special conservation status. The firing is carried out in shallow pits and appears to generate a minimal amount of smoke. This simple firing process uses no glazes or potentially harmful chemicals.

Mitigation of Impact

Eventually, the mining of clay leaves a shallow depression between 40 centimeters (cm) and 110 cm over an area of about 8 square meters. The potters have pointed out that this is eventually filled in during flood conditions, erasing any signs of impact. As production increases, clay deposits should be inspected twice annually to assess the impact on vegetation. If the impact on large areas of vegetative cover appears to be adverse, other clay deposits should be identified while those that have been affected are allowed to fill in by natural processes.

Ecotourism Proposal

Carefully managed ecotourism can allow the community to use—and at the same time conserve—its most valuable resources: unique landscapes, pristine habitat, biodiversity, historic sites, knowledge of the environment and native peoples' roles in it, traditional indigenous culture, and cowboy culture, among many others. To take advantage of this potential, basic infrastructure needs to be established. Based on interviews with the Paipai tribal council, consultations with the community at their monthly assembly, and the experience of CUNA and EcoTour Adventures, S.A., a special area for ecotourism operations has been designated and the following infrastructure needs identified:

- An adobe or stone principal structure to include an office and registration area, a kitchen and dining area, and restrooms

- 12 traditional houses (six adobe cabins and six brush houses made from juniper, willow, agave stalks, and other local materials) with rustic beds, table, chairs, and chimney
- Camping area
- Shade ramadas
- A solar energy system to provide minimal electricity to the area
- Men's and women's restrooms with environmentally appropriate toilets and showers
- Picnic-type tables
- Campfire facilities
- Access roads
- Parking areas
- Fences
- Signs
- Protection of native flora and carefully planned landscaping with native plants to provide shade and screening of parking, water tanks, and other areas

Mission Santa Catarina

One of the outstanding historic sites in the community is the former mission of Santa Catarina, founded by the Dominicans in 1797. The excavation of this site could help lead to a better understanding of this critical period in the community's history and could provide many years of employment for local community members who could be trained as para-archaeologists. A full-scale excavation of the site, carried out in collaboration with the National Institute of Anthropology and History, could also attract students interested in archaeological field work and provide a basis for the construction of a replica and museum, thereby creating a more attractive destination for ecotourism, all of which would generate income for the community.

Museum

A community museum, possibly housed in or near the replica of the mission, would give the Paipai the opportunity to tell the story of their people and culture, including mythology, native ways of life, evolution of traditional handcrafts, ancient and recent history, language, and whatever else they consider important and appropriate to share. The museum could also include spaces where local artisans could exhibit their wares and demonstrate techniques of manufacture.

Suggestions for Further Study

Many other activities to promote sustainable economic development have been identified by the indigenous community, but further studies are needed to ascertain the feasibility and sustainability of these activities to ensure a dynamic, diversified economy for the community. To avoid the prohibitively high cost of paying private consultants for these studies, many of them can be carried out through the continued collaboration of the indigenous community with CUNA, UABC, the Southwest Center for Environmental Research and Policy (SCERP), and other foundations. Furthermore, the GIS database, which has been created for the community, can be used for and enhanced by future studies. Some priority research topics include:

- Long-term water planning
- Agricultural potential
- Establishment of nurseries for the production of fruit trees, native plants, and others with commercial potential
- Use of specific plant species (juniper, yucca, barrel cactus, cholla, etc.)
- Potential for a processing plant for making finished products from yucca, herbs, and other natural resources
- Production of furniture made from native plants and other local materials
- Collection and/or propagation of native flower seeds
- Development of the Agua Caliente hot springs location
- Addition of a water park to the Paipai EcoVillage
- Livestock management
- Extraction of flagstone

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