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THE USE OF PARTICIPATORY MAPPING IN ETHNOBIOLOGICAL RESEARCH, BIOCULTURAL CONSERVATION, AND COMMUNITY EMPOWERMENT: A CASE STUDY FROM THE PERUVIAN AMAZON

Michael P. Gilmore and Jason C. Young

This paper describes in detail a community-based participatory mapping project that was carried out in collaboration with the Maijuna of the Peruvian Amazon. We use this project as a case study to explore the role that participatory mapping can play in ethnobiological studies and to examine the rich and diverse range of data that this methodology can generate, ultimately shedding light on how indigenous and local communities use, perceive, and interact with their environment and resources. Additionally, participatory mapping can be a powerful tool for biocultural conservation and community empowerment. This is especially critical given that many ethnobiologists work with marginalized indigenous and local communities experiencing enormous sociocultural and environmental change and challenges. Given the great potential of this methodology we strongly feel that participatory mapping can and should play a more significant role in ethnobiological studies.

Key words: *Maijuna, Peruvian Amazon, participatory mapping, ethnobiological methods, biocultural conservation, community empowerment*

Este artículo describe en detalle un proyecto comunitario basado en el mapeo participativo que se elaboró en colaboración con los Maijuna de la Amazonia Peruana. Usamos este proyecto como estudio de caso para explorar el papel que el mapeo participativo puede tener en los estudios etnobiológicos y para examinar la amplia y rica gama de datos que se pueden generar con esta metodología para determinar cómo las comunidades indígenas y locales usan, perciben, e interactúan con su medio ambiente y sus recursos. Además el mapeo participativo puede ser una poderosa herramienta para la conservación biocultural y el fortalecimiento comunitario. Esto es especialmente importante, ya que muchos etnobiólogos trabajan con comunidades indígenas y locales marginalizadas que están experimentando enormes cambios y retos socioculturales y medioambientales. Dado el gran potencial de esta metodología creemos firmemente que el mapeo participativo puede y debe tener un papel más relevante en los estudios etnobiológicos.

Introduction

The group of individuals crowded around the hand-drawn map included men and women, hunters and fishers, elders and children of the community. The map was taking shape and the network of rivers and streams in their ancestral territory stretched out in a braided pattern over the paper, each twist and turn carefully drawn. They were discussing and debating the placement of culturally and biologically important sites on the map, the areas that they consider especially significant and memorable –animal mineral licks, fruit collecting sites, special fishing zones, historical areas, fields and houses, sacred sites. This map represents the collective knowledge of the community, stretching from the

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present day back to an unknown time in the distant past. As the map took shape, there was a buzz and excitement in the air and an incredible sense of communal pride and ownership over the final product.

This scene, which took place in the Maijuna indigenous community of San Pablo de Totoya (Totolla) in the northeastern Peruvian Amazon in 2009, is a short yet revealing example of the process of participatory mapping and the type of information that this methodology can generate. Given that ethnobiology has been described as ''investigating culturally based biological and environmental knowledge, cultural perception and cognition of the natural world, and associated behaviours and practices'' (Pieroni et al. 2005:1), we feel that participatory mapping can provide a wealth of information to ethnobiologists working with indigenous and local communities throughout the world. However, for all of its potential, participatory mapping has been underutilized. Although Cunningham (2001) and Tuxill and Nabhan (2001) provide discussions of participatory mapping and its uses, most other major ethnobiological and ethnobotanical field or methods manuals (e.g., Alexiades 1996a; Cotton 1996; Martin 1995) make little or no mention of it. Additionally, a survey of the current ethnobiological literature has also revealed that few ethnobiological projects utilize this methodology.

This paper examines the important role that participatory mapping can play in ethnobiological studies by using our community-based mapping research with the Maijuna as a case study. Additionally, we go beyond a discussion of the utility of this methodology to the field of ethnobiology and explore the use of participatory mapping in biocultural conservation and community empowerment to further delve into its true power. To provide the reader with the proper context, we first give a detailed overview of participatory mapping and its history and describe the Maijuna mapping project and the methods that we used.

What is Participatory Mapping?

Broadly speaking, participatory mapping can be described as a form of counter-mapping, a technique used to ''contest or undermine power relations and asymmetries in relation to cartographic products or processes'' (Harris and Hazen 2006:115). While various forms of counter-mapping have existed throughout the history of colonial cartography (e.g., Sparke 1995), its manifestation as participatory mapping is more recent. From the 1980s onward, geographers and others initiated a sustained epistemological and ontological critique of maps as representations of the world (Harley 1989; Harris and Hazen 2006; Kitchin and Dodge 2007; Pickles 2003). These criticisms sought to demonstrate how maps often act to represent the world in ways that privilege very particular ways of viewing the world, thus reinforcing certain power relations (Pickles 2003). By disrupting the notion that maps are neutral and objective depictions of the world, these critiques helped make room for alternative voices to be included in the map-making process (Pickles 2003). Participatory research methodologies, and mapping in particular, are one way for these voices to be represented (Corbett and Rambaldi 2009; Rambaldi et al. 2006).

Herlihy and Knapp (2003:304) define participatory research as an endeavor that ''recognizes the knowledge and wisdom of local peoples. It elevates them to a collateral position with researchers, whereby each respects the other's knowledge and abilities to meet a given objective.'' Following this logic, participatory mapping is a methodology ''that recognizes the cognitive spatial and environmental knowledge of local peoples and transforms this into more conventional forms'' (Herlihy and Knapp 2003:306). Although the exact methodology certainly varies between projects, there are several general characteristics of participatory mapping exercises: (1) the involvement and collaboration of indigenous or local peoples in the project, (2) the determination of the project's goals and motives, (3) the production of maps, by indigenous or local peoples, that represent their traditional spatial knowledge, and (4) a dialectical exchange between the participants and researchers (Herlihy and Knapp 2003).

More recently researchers have added another stage of work –translation of the participatory map into a geographic information system (GIS). As Dunn (2007:619) defines it, this participatory GIS (PGIS) work can be understood as ''a means of integrating local and indigenous knowledge with 'expert' data.'' When used alongside participatory mapping, a PGIS approach involves indigenous or local participants in the acquisition of Global Positioning System (GPS) data points. This allows researchers to accurately plot the locations on the participatory map with GIS software. Often researchers also digitally record traditional knowledge corresponding to the locations, in the form of photographs, audio recording, and video, so that these can be included in the final GIS product (Caquard et al. 2009). Ideally, this produces a digital map that gives users a rich understanding of the spaces and narratives represented.

While few ethnobiological studies incorporate participatory mapping, numerous studies within geography and political ecology have documented its successes in indigenous political movements (e.g., Herlihy 2003; Herlihy and Knapp 2003; Nietschmann 1995; Rambaldi et al. 2006; Smith et al. 2003). By encoding traditional knowledge within an official cartographic form, these methodologies help confer more legitimacy upon indigenous land claims (Duncan 2006; Dunn 2007). While participatory projects may make use of western technologies like GIS, they also stress methodological techniques that promote indigenous needs and knowledge. Because researchers are very careful to recognize the community's role in producing knowledge (Dunn 2007), they often make heavy use of performative methods of knowledge sharing, such as story-telling and other personal narratives (Caquard et al. 2009; Crampton 2009). Many times, these projects are also designed to empower participating communities through capacity building, so that the community can continue to use its knowledge to its own benefit over the long term (Elwood 2002). Thus, they produce the necessary infrastructure to protect and promote traditional knowledge into the future.

Not surprisingly, much of that traditional knowledge relates directly to various biological and cultural conservation issues; after all, these projects are often designed to promote indigenous rights to land or natural resources. Thus, in addition to political empowerment, participatory mapping techniques have also been used to achieve a myriad of goals, including the preservation of traditional knowledge (Chapin and Threlkeld 2001; Poole 1995), the illustration of customary land-use systems and management strategies (Chapin and Threlkeld 2001; Sirait et al. 1994), and to establish and set priorities for resource management plans (Chapin and Threlkeld 2001; Jarvis and Stearman 1995; Poole 1995). This makes participatory mapping and GIS techniques an excellent methodology for ethnobiological projects and biocultural conservation. By recognizing and prioritizing traditional forms of knowledge, participatory methodologies help to ensure that all data produced is strongly linked to, and understood within, its traditional context. Additionally, the resulting map is a representation that visually connects traditional knowledge about the environment to the spaces, land, and resources from and/or about which this knowledge was derived. This explicit, visual link is powerful in both research and practical applications, and the remainder of this paper traces what that methodological potential meant for our work with the Maijuna.

The Maijuna Participatory Mapping Project: Overview and History

The Maijuna, also known as the Orejón, are a western Tucanoan people of the northeastern Peruvian Amazon (Bellier 1993, 1994; Steward 1946). Approximately 400 Maijuna individuals live in four communities: Puerto Huamán and Nueva Vida along the Yanayacu River, Sucusari along the Sucusari River, and San Pablo de Totoya (Totolla) along the Algodón River (Figure 1). These three river basins are part of the ancestral territory of the Maijuna and no other communities, indigenous or otherwise, are located within this area (Gilmore 2010). The Maijuna traditionally lived in the interfluvial area between these three rivers and, according to Bellier (1993, 1994), they lived in large pluri-familial houses that were surrounded by small sleeping houses (''mosquito houses''). These clusters of houses were spaced approximately a day's walk from other groups of houses, and inhabitants living in each group of houses, considered a residential unit, conducted their subsistence activities within their own territory. This residence pattern lasted until the early 1900s when the Maijuna began to slowly migrate downriver, due to influence from missionaries and *patrones* (colonists and their descendants who exploited indigenous labor to harvest forest resources), to where they eventually formed their current communities (Bellier 1993, 1994). The building of schools and the Maijuna desire to be in better contact with outside communities and services have served to perpetuate and reinforce current settlement patterns.

Today, the Maijuna communities are composed of smaller mono- and pluri-familial houses that are arranged according to kin ties and which exchange products and services amongst themselves. Community members employ a variety of subsistence and income generating strategies, including swidden-fallow agriculture, hunting, fishing, and the gathering of various forest products. The four Maijuna communities are recognized as *Comunidades Nativas* (Native Communities) by the Peruvian Government and each has been granted title to land surrounding their communities (Brack-Egg 1998). Unfortunately, that land is a small portion of their ancestral territory and therefore hundreds of thousands of hectares remain outside of direct Maijuna control and are unprotected (Gilmore 2010).

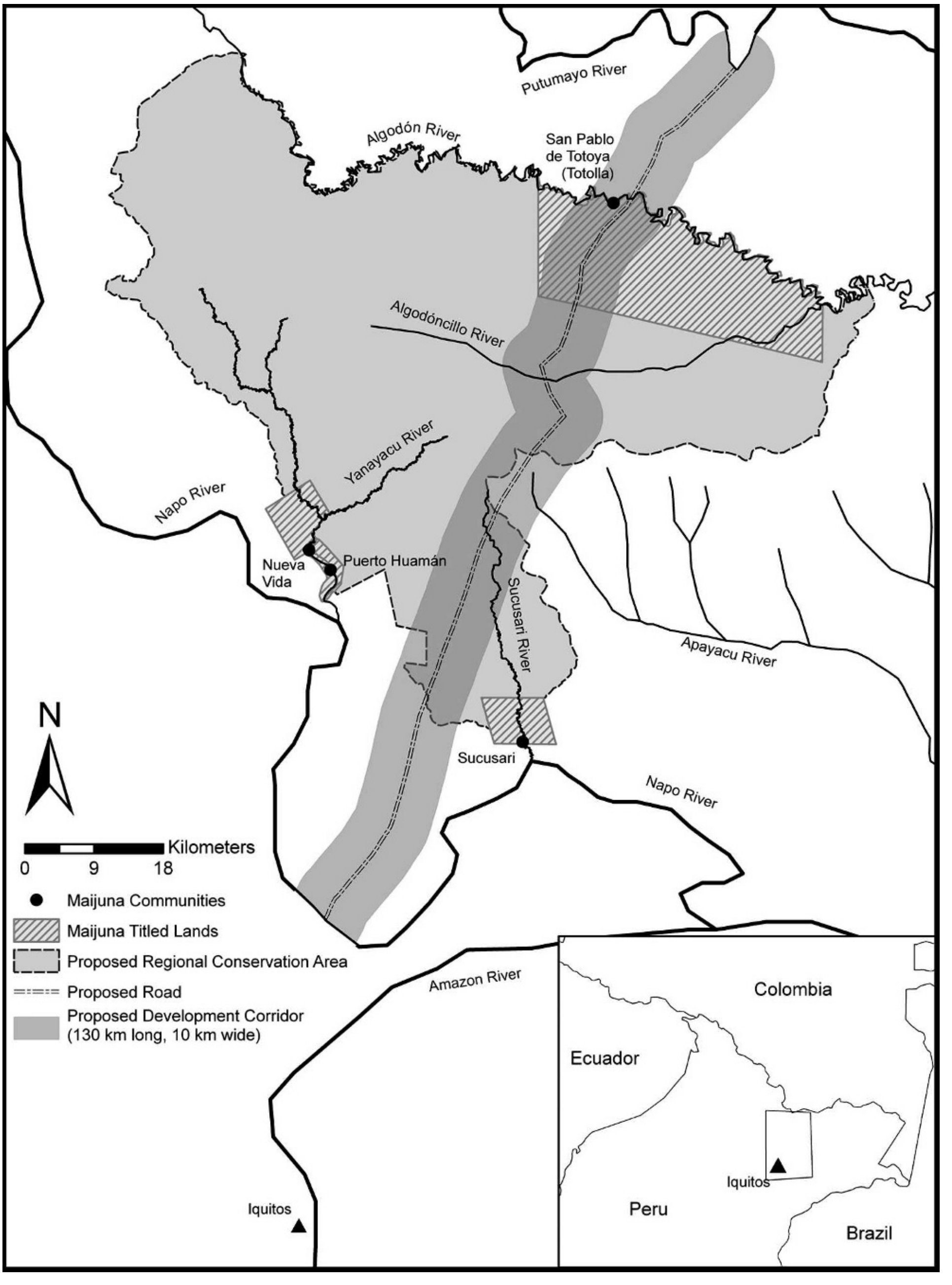

Figure 1. Location of the four Maijuna communities along with the proposed road, proposed development corridor, and proposed regional conservation area.

The vast majority of Maijuna traditional lands within the Yanayacu, Sucusari, and Algodón river basins, over 300,000 ha, is intact primary rainforest (Gilmore et al. 2010). Similar to the rest of the Peruvian Amazon, this is a relatively flat area with an elevation that varies little (from 80 m to 200 m above sea level). This general region is tropical, humid, and warm, having a mean annual precipitation of almost 3100 mm per year and a mean annual temperature of 26° C (Marengo 1998). Maijuna ancestral territory is incredibly biologically rich and culturally important (Gilmore et al. 2010). For example, Maijuna traditional lands contain a complex of high terraces –an extremely unique and previously unreported habitat– that shelters a flora and fauna with new, rare, and specialized species. Additionally, this area also contains critically important hunting, fishing, plant collecting, and historical sites that help to sustain and nourish the Maijuna culture.

Unfortunately, there are currently a wide variety of challenges to Maijuna biocultural resources (Gilmore 2010). For example, due to the intact nature of Maijuna ancestral lands and the biological resources within them, they are under threat from illegal incursions from loggers, hunters, fishers, and resource extractors from outside communities. Even more serious is the Peruvian government's plan to build a 130 km long road directly through the heart of Maijuna ancestral territory (Figure 1; Gilmore et al. 2010). Additionally, a development corridor extending 5 km to either side of the proposed road is envisioned with a focus on biofuels production (e.g., oil palms). The direct effects of highway construction and the associated impacts from an influx of colonists and subsequent deforestation would irreversibly alter the ecological fabric of this currently roadless area. Furthermore, given that the Maijuna are a forest dwelling people who rely on the forest for sustenance and survival, building this road would negatively impact their livelihood and traditional culture.

Regrettably, and perhaps not surprisingly, the Peruvian government has not properly consulted the Maijuna on the construction of the road, nor has it accurately described its biological and cultural ramifications (Gilmore 2010). The Maijuna are adamantly against the construction of this road and its associated development scheme, and are asking the Peruvian government to alter its path. Additionally, they are also calling on the *Gobierno Regional de Loreto* (GOREL), the regional government of the Peruvian Amazon, to create a regional conservation area (*Área de Conservación Regional*) that would formally protect over 336,000 ha of their ancestral lands and the critically important biological and cultural diversity found there (Figure 1).

In 2004, in response to threats to their biocultural resources, Maijuna elders and leaders established the *Federación de Comunidades Nativas Maijuna* (FECONAMAI), an indigenous federation representing all four Maijuna communities (Gilmore 2010). Since its inception, the principle goals of FECONAMAI have been to conserve the environment and Maijuna culture and improve Maijuna community organization. Notably, before the establishment of FECONAMAI, in recent history the Maijuna of the Yanayacu, Sucusari, and Algodón river basins had very little contact, formal or informal, with each other; they were economically and politically independent and not linked by formal or recurrent exchange resulting in the Maijuna communities of the different river basins being effectively isolated from each other (Bellier 1993, 1994; Gilmore 2010).

Given its organizational objectives, it is not surprising that FECONAMAI is leading the Maijuna charge against the construction of the proposed road and for the creation of the proposed protected area. In fact, of a wide variety of projects and initiatives targeting the conservation of biocultural resources that FECONAMAI is currently collaborating on (e.g., the development and implementation of resource management plans, a Maijuna language documentation and revitalization project, etc.), the Maijuna consider the creation of a protected area that would formally and legally protect their ancestral lands in perpetuity to be their number one goal and priority (Gilmore 2010). As Gilmore (2010:233) states, the Maijuna ''strongly feel that their survival as a people and the survival and maintenance of their cultural practices, unique traditions, and traditional subsistence strategies depend on a healthy, intact, and protected ecosystem.'' To help facilitate the protection of Maijuna lands and biocultural resources, we developed and carried out a community-based participatory mapping project with FECONAMAI (see Gilmore and Young 2010), which ultimately formed part of a Rapid Biological and Social Inventory of Maijuna lands completed by the Field Museum of Chicago (see Gilmore et al. 2010).

Methods

Field research took place in all four Maijuna communities over the course of four field seasons from 2004 to 2009. Before initiating mapping activities in each community, we clearly explained the project's objectives and methods and discussed the potential advantages and disadvantages of this type of work (Chapin and Threlkeld 2001). We also showed several examples of maps completed in other participatory mapping projects to the Maijuna to help them better understand the mapping process and potential end results of this project (Kalibo 2004; Medley and Kalibo 2005). This was important because the process and methods of mapping, and maps in general, were by and large unfamiliar to participating individuals. For example, although some Maijuna had limited experience and knowledge in reading maps due to their time in school, none had created or drawn maps of this scale. Mapping work then commenced after prior informed consent (PIC) was obtained from each community and participant (Gilmore and Eshbaugh 2011).

After designating a scribe, each community began their mapping session by drawing the key geographical and hydrological features of the watershed that they inhabit, including features such as rivers, streams, and lakes, on large sheets of easel paper. This provided a base map from which to build a more detailed map. Next, each community was asked to identify, locate, and map biological and cultural sites that they deem significant. Not surprisingly, one of the first things that each community did was to identify the location of their respective community and map its various houses, which ultimately helped to orient and anchor them throughout the rest of the mapping exercise (Gilmore and Young 2010). In the end, each community came up with their own biologically and culturally significant sites to map and symbology to represent each category of areas.

During mapping sessions, we also used semi-structured interviewing techniques (Alexiades 1996b; Cotton 1996; Cunningham 2001; Martin 1995; Tuxill and Nabhan 2001) to document traditional cultural knowledge pertaining to the biologically and culturally significant sites and their associated resources. It is also significant to note that the mapping sessions were dynamic and vibrant, as the locations, names, categories, and symbols of mapped geographical features and important sites were constantly discussed and debated, helping to ensure that the final map was both as accurate as possible and agreed upon by negotiated consensus. Ultimately, the methods described here are a modified version of those detailed in Chapin and Threlkeld (2001).

Community mapping sessions typically lasted several days. The majority of the work took place in the morning, and we provided both breakfast and lunch as a form of reciprocity and compensation. This is very similar to the structure or format of *mingas* or communal work parties that the Maijuna use to construct houses, build canoes, or clear agricultural fields (Gilmore 2005; Gilmore et al. 2002), and we specifically did this to empower and respect cultural norms, communal institutions, and systems of exchange. Additionally, we made a conscious attempt to be as inclusive as possible in terms of representation from the different groups that are present within each of the communities (e.g., women, men, elders, children, clans, extended families, healers, farmers, fishers, and hunters). Active participation from each of these groups helped to ensure that the final maps were truly representative of the entire community. In addition to being dynamic, the mapping sessions were also respectful with a wide variety of opinions and voices both heard and acknowledged.

After finalizing each community map, a team of Maijuna that included individuals well-known for their expertise in traditional cultural, historical, ecological, and geographical knowledge was formed in each community to work with the researchers to visit and fix the location of as many of the mapped sites as possible using hand-held GPS units (Chapin and Threlkeld 2001; Sirait et al. 1994). Additional interviews with members of the Maijuna team documented key traditional cultural knowledge about the different biologically and culturally significant sites, including the ethnohistory, traditional stories and songs, place-names, and the resource-use and management strategies associated with each area and its resources. All field interviews and site visits were documented using cameras, voice recorders, and/or video cameras. Physically visiting the sites in each river basin required the field teams to travel hundreds of kilometers by boat, canoe, and foot for several weeks at a time often in very remote and isolated areas. Given that the work was often physically grueling and required participants to be away from their families for extended periods of time, Maijuna team members were monetarily compensated for their work. After this fieldwork was completed, we used ArcGIS, a GIS software package by ESRI, to organize, analyze, and spatially represent the GPS data collected in the field (Corbett and Rambaldi 2009; Duncan 2006; Elwood 2009; Sirait et al. 1994). We are currently developing a multimedia PGIS database from the information collected, including the taped ethnographic interviews and photos.

Participatory Mapping and Ethnobiology

Each community mapping session generated a wide, rich, and diverse range of information of interest to ethnobiologists. Key features that the Maijuna mapped included rivers, streams, and lakes (Figures 2 and 3). Along with carefully

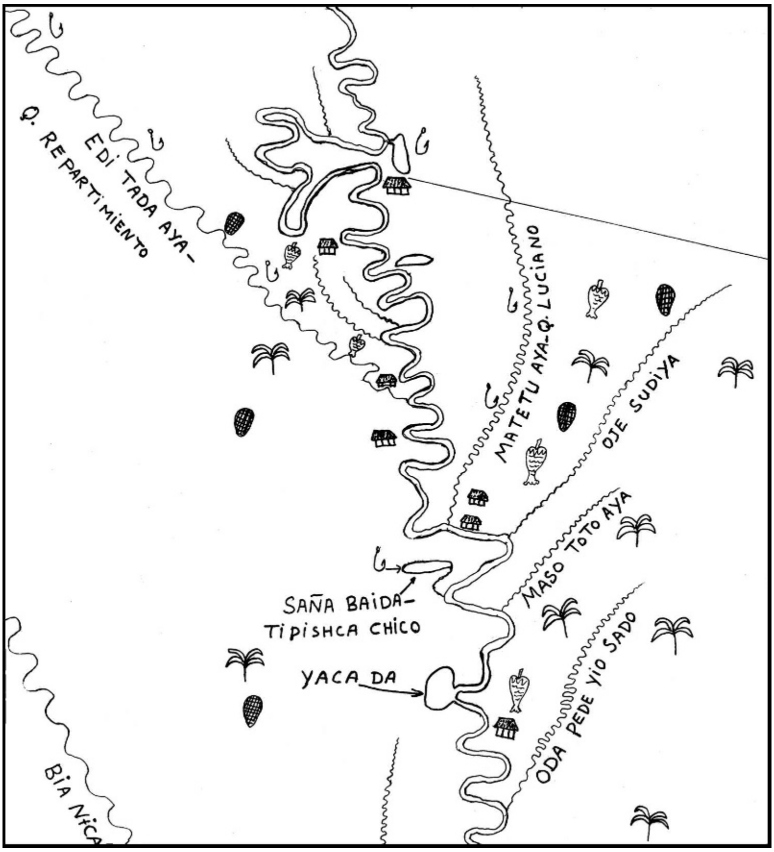

Figure 2. Example of a hand-drawn Maijuna map (from Gilmore and Young 2010). Only a small portion is reproduced here to protect Maijuna biocultural resources and intellectual property. Reproduced with Maijuna permission.

noting the locations and courses of these water bodies, the Maijuna also labeled them with their traditional names, which are based on the size of the water body, key historical events, people, substrate, water color, or plant and animal species present in or around the area. The Maijuna also indicated the locations of over 900 biologically and culturally significant sites throughout their ancestral lands in the study area. These included hunting and fishing sites, historical areas, non-timber forest product (NTFP) collecting sites, houses and fields, important trails, and sacred sites, among other things.

Ultimately, this information provides a window into how the Maijuna perceive and interact with their environment. It facilitates an understanding of the boundaries of current and traditional lands and a general appreciation of the reach of communal subsistence activities. It also provides detailed insight into the spatial use and distribution of biologically and culturally salient resources. For example, over 130 NTFP collecting sites were identified, including *Mauritia flexuosa* palm swamps (***ne cuadu***[1] in Maijuna; *aguajales* in Spanish), forests with an understory dominated by the palm *Attalea racemosa* (***edi nui nɨcadadi*** or ***edi coti***;

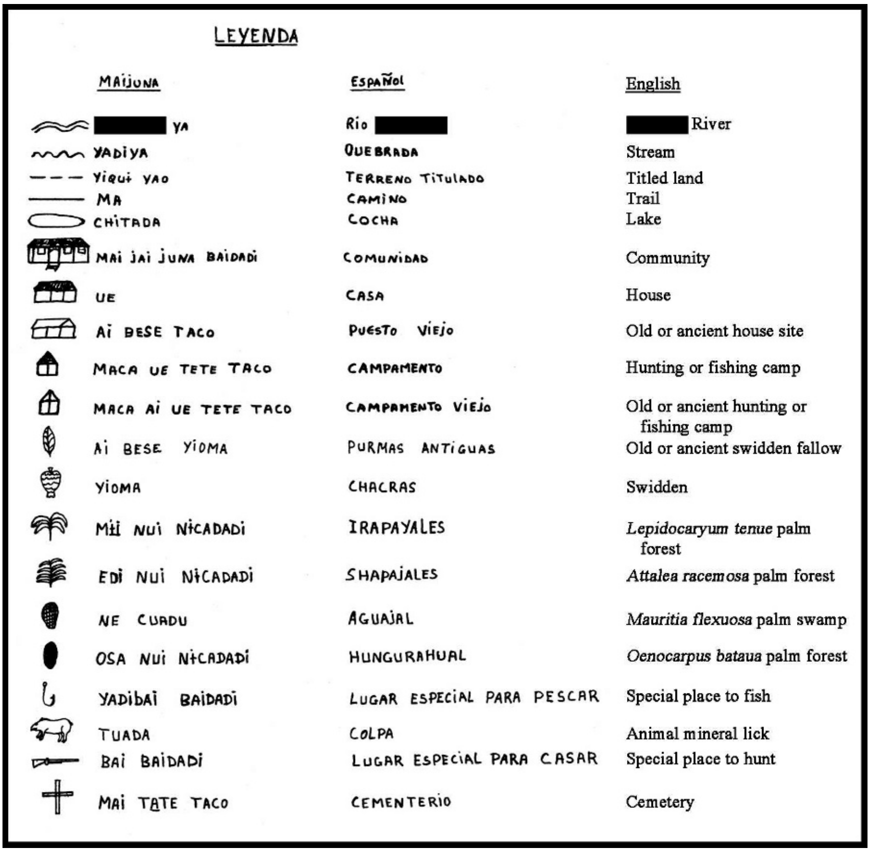

Figure 3. Legend for entire map represented in Figure 2 (from Gilmore and Young 2010). The name of the river basin has been blacked out to protect the Maijuna. English translations added.

shapajales), forests dominated by the palm *Oenocarpus bataua* (***bosa nui nɨcadadi*** or ***osa nui nɨcadadi***; *hungurahuales* or *ungurahuales*), forests with an understory dominated by the palm *Lepidocaryum tenue* (***mɨɨbɨ*** or ***mɨɨ nui nɨcadadi***; *irapayales*), and riverside areas dominated by the plant *Myrciaria dubia* (***atame nui nɨcadadi***; *camu camales*) (Gilmore and Young 2010). All of these collecting sites correspond to Maijuna classified and named habitat types, and all plant species that dominate these areas are useful to the Maijuna in a variety of ways (Table 1; Gilmore 2005). It is important to note that pairing Maijuna mapped areas, such as NTFP collecting sites, with ethnobotanical or ethnobiological data regarding resource use has provided a more in-depth understanding not only of *what* areas communities are using spatially over the landscape but also of *how* they are actually using these areas.

The participatory mapping of ancestral lands within the study area also provided us with insight into how resource use differs among individuals and family units. Additionally, we found that different individuals and/or families had different types of local knowledge. For example, some individuals and families specialize in fishing and therefore provided critical information regarding

Table 1. Ethnobotanical information for plant species dominant at non-timber forest product (NTFP) collecting sites mapped within the Yanayacu, Sucusari, and Algodón river basins (Gilmore 2005; Gilmore and Young 2010).

Taxon [voucher number][a]	Maijuna name	Spanish name	Use	Harvesting method	Time of harvest[b]
Arecaceae					
Attalea racemosa Spruce [594]	***edi sa***	*shapajilla*	fruits: older fruits host beetle larvae that are eaten and used as fishing bait	collected from ground	year-round
			leaves: thatch for temporary shelters and the ridges of roofs	cut from plant (plant not felled)	year-round
			seeds: food	collected from ground, picked	year-round
			seeds: used to smooth and/or polish clay during the production of ceramics	collected from ground, picked	year-round
Lepidocaryum tenue Mart. [414, 536]	***mɨ̱i ñi***	*irapay*	leaves: thatch for houses; the most popular and important plant for thatch; occasionally sold	cut from plant (plant not felled except when tall)	year-round
Mauritia flexuosa L. f. [321, 529]	***ne ñi***	*aguaje*	fruits: eaten, processed into an oil, and used to make a beverage and fishing bait; sold	collected from ground and by climbing or felling tree	~May-August
			leaves: old, dry leaves used as a fuel for drying canoes and starting fires in newly cleared and dried agricultural fields	old and hanging leaves cut off of tree	year-round
			petioles: strips of fiber used to make mats and used as a form for weaving palm fiber bags	cut from plant (harvested from small plants)	year-round
			trunk: hosts two species of beetle larvae that are eaten and used as fishing bait	from trees felled to promote larval growth and natural tree falls	year-round
Oenocarpus bataua Mart. [324, 555]	***bosa ñi, osa ñi***	*hungurahui, ungurahui*	fruits (ripe): eaten, used to make a beverage, and processed into an oil; occasionally sold	collected from ground and by climbing or felling tree	~November-March and June-August
			fruits (unripe): processed into a medicine (tuberculosis)	collected by climbing or felling tree	~year-round
			leaves: used to make temporary baskets	cut from plant (harvested from small plants)	year-round
			leaves: thatch for temporary shelters	cut from plant (plant not felled except when tall)	year-round
			trunk: hosts beetle larvae that are eaten and used as fishing bait	from trees felled to promote larval growth and natural tree falls	year-round
			leaf base fibers: sharpened and used to pierce men's ears for ear disks[c]	collected from plant (plant not felled)	year-round
			leaf base fibers: used as kindling[c]	collected from felled tree	year-round

Table 1. Continued.

Taxon [voucher number][a]	Maijuna name	Spanish name	Use	Harvesting method	Time of harvest[b]
Myrtaceae					
Myrciaria dubia (Kunth) McVaugh	***atame ñi***	*camu camu*	fruits: occasionally eaten and used to make a beverage; rarely, if ever sold	picked	unknown

[a] Specimens were collected by Michael Gilmore (with the help of various field assistants). All voucher specimens are deposited in the Herbarium Amazonense (AMAZ), Universidad Nacional de la Amazonia Peruana, Iquitos, Peru and the Willard Sherman Turrell Herbarium (MU), Miami University, Oxford, Ohio. Preliminary identifications were made by César Grández Ríos and Michael Gilmore with final determinations by Rodolfo Vásquez.

[b] Harvest times are preliminary and approximate, based on consultant testimony and not independently verified by the researchers.

[c] Not currently used in this way by the Maijuna.

culturally important fishing areas whereas others specialize in hunting, farming, or plant collecting. Throughout the mapping process it became very clear that different individuals and families not only held differing levels of knowledge regarding subsistence activities and associated resources but that they also varied in their knowledge of different areas or zones of the ancestral landscape, shedding light on traditional land and resource tenure systems. It was not uncommon for one individual or family group to defer to another when mapping biologically or culturally important sites because this differential knowledge base was both recognized and respected by the Maijuna. This highlights the need to include a variety of different specialists (e.g., hunters, fishers, farmers, traditional healers, plant collectors, etc.) and family units in mapping sessions if a complete, clear, and unbiased view of a community's relationship with their environment is to be obtained.

Collecting the correct data during participatory mapping also allows for an understanding of a community's temporal relationships with its environment on a daily, seasonal, or historical scale. With the use of ethnobiological data collected during mapping sessions and previous research (see Gilmore 2005), for example, we were able to better understand how Maijuna hunters interact with mapped animal mineral licks (***tuada*** or ***onobɨ***; *colpas*). Along with being biologically significant, these areas are incredibly culturally and economically important to the Maijuna as there are nine different mammal and bird species that are encountered and hunted in these areas year-round (Gilmore 2005; Gilmore and Young 2010). These species are either nocturnal or diurnal, therefore, Maijuna hunters target mineral licks both day and night revealing an important temporal relationship with these areas (Table 2).

Important seasonal variations in Maijuna resource and habitat use were also elucidated by coupling new and previously collected ethnobotanical data (see Gilmore 2005) to the hand-drawn community maps. For example, some NTFP collecting sites are used year-round whereas others are primarily accessed only during certain seasons based on the availability of resources (Table 1). Thus, forests with an understory dominated by the palm *L. tenue* are targeted year-

Table 2. Mammal and bird species encountered and killed by the Maijuna at animal mineral licks within the Yanayacu, Sucusari, and Algodón river basins (Gilmore 2005; Gilmore and Young 2010).

Species	Maijuna name	Spanish name	English name	Time encountered (day/night)	Use
Birds					
Pipile cumanensis	***uje***	*pava*	blue-throated piping-guan	day	eat, sell (meat), used to make fans for fires (feathers), adornment (make "paint" from legs)
Mammals					
Agouti paca	***seme*, *oje beco*, *pɨbɨ aco***	*majaz*	paca	night	eat, sell (meat), tourist crafts (teeth)
Alouatta seniculus	***jaiquɨ***	*coto mono*	red howler monkey	day	eat, sell (meat), tourist crafts (bony pouch or hyoid bone from throat)
Coendou prehensilis	***toto***	*cashacuchillo*	Brazilian porcupine	night	eat, tourist crafts (spines)
Dasyprocta fuliginosa	***ma̲i̲taco*, *moñeteaco*, *codome***	*añuje*	black agouti	day	eat, sell (meat), tourist crafts (teeth)
Mazama americana	***bosa*, *mɨi̲bɨ aquɨ***	*venado colorado*	red brocket deer	night, rarely during day	eat, sell (meat), medicinal (antlers), adornment of houses (antlers), used to make drums (hide)
Tapirus terrestris	***bequɨ*, *jaico***	*sacha vaca*	Brazilian tapir	night	eat, sell (meat), medicinal (hooves), tourist crafts (hooves)
Tayassu pecari	***se̲se̲*, *bɨdɨ***	*huangana*	white-lipped peccary	day	eat, sell (meat and hide), tourist crafts (teeth), used to make drums (hide)
Tayassu tajacu	***caoco̲a̲*, *yau***	*sajino*	collared peccary	day	eat, sell (meat and hide), tourist crafts (teeth), used to make drums (hide)

round as they are important thatch collecting sites and there are no seasonal restrictions on this resource. Notably different are *M. flexuosa* palm swamps whose dominant and namesake species produces, as its most important resource, an economically, ecologically, and culturally important fruit that is only available from May to August. During this time, the Maijuna target these areas for fruit collection and for hunting game species that also consume the fruit. These examples illustrate how the Maijuna interact with different areas and resources seasonally.

Significant historical variations in the interactions between the Maijuna and their environment were also highlighted during the course of community mapping sessions. For instance, very old house and field sites that the Maijuna were able to remember and map were found in the interfluvial region toward the headwaters of the Yanayacu, Sucusari, and Algodóncillo rivers which is considerably upriver from current community sites. These findings help to confirm that the Maijuna traditionally lived in this interfluvial region until they slowly migrated downriver to their current communities (Bellier 1993, 1994). The maps, along with ethnohistorical data and documents, show significant shifts in Maijuna settlement patterns and resource extraction sites over time. Although linking participatory mapping with the ethnohistorical record was not a major theme of our research with the Maijuna, it may be a rich and important line of inquiry for certain projects. This may prove to be an especially significant and powerful direction of work with indigenous groups who hope to (re)claim ancestral rights over areas that do not persist in living memory but exist in the ethnohistorical record.

Participatory mapping can also allow ethnobiologists to investigate topics such as traditional resource management strategies, threats and challenges to resource conservation, and oral traditions associated with culturally and biologically important sites. For example, community mapping sessions allowed us to further understand how the Maijuna traditionally manage *L. tenue* palm forests, which are sources of thatch for their houses. An average sized Maijuna house, which is 8 m $\times$ 5 m (40 m^2), requires approximately 11,250–12,000 *L. tenue* leaves for its roof, which lasts between 4 and 7 years depending on how densely the leaves are interwoven and how closely the palm leaf panels are hung together. Therefore, the Maijuna of Sucusari gather approximately 225,000–240,000 *L. tenue* leaves every 4 to 7 years to thatch their 20 houses (Gilmore 2005). The community mapping sessions allowed us to better understand, both spatially and temporally, how they rotate use of the various *L. tenue* palm forests in their ancestral lands to reduce the chances of overharvesting this critically important resource.

Participatory mapping has also facilitated the collection of Maijuna oral traditions that are associated with both biologically and culturally significant sites. Over 160 culturally and biologically important historical sites were identified and mapped by the Maijuna within the study area and many of these have associated traditional stories, songs, and oral histories which are key to more fully understanding the past and present relationship that the Maijuna have with their ancestral lands and resources. For example, traditional stories and oral histories were collected concerning culturally significant areas related to their past enslavement by *patrones* which shed significant light on past resource use and extraction.

In short, participatory mapping can be an incredibly powerful tool for ethnobiologists. As highlighted above, it can be used to better understand geographical knowledge and perceptions, document the spatial and temporal use and distribution of resources and habitats, investigate land tenure systems, study traditional resource management strategies, document threats to resource conservation, and facilitate the examination of oral traditions associated with biologically and culturally important sites and resources. However, ethnobiologists can also use participatory mapping to locate populations of endangered plant and animal species, track the flow of natural resources from source to destination, and investigate gendered knowledge and resource use, among many other things. Significantly, much of this information cannot be easily obtained via the sole use of more standard and widely used ethnobiological research methods (e.g., participant observation, semi-structured interviews, structured surveys, focus group interviews, market surveys, and free listing), and therefore we view participatory mapping as a key methodology to enhance ethnobiological studies.

Additionally, we feel that participatory mapping is a great way to begin an ethnobiological research project as mapping can provide a concrete process and product for the community to engage in, making research less abstract and more accessible, and it can also help to identify key holders of traditional knowledge within communities. Even more basically, it allows ethnobiologists to efficiently gain a good understanding of crucial landscape features, place-names, and biological and cultural resources which helps to facilitate research that references and targets this type of local knowledge. And, as we have learned firsthand, research can be significantly more difficult and challenging without a firm grasp of this essential information.

Participatory Mapping and Biocultural Conservation

Participatory mapping serves as a tool for gathering critically important information that can be applied toward the conservation of biocultural resources. For this project, participatory mapping has provided a detailed understanding of the geographical boundaries of Maijuna ancestral territory within the Yanayacu, Sucusari, and Algodón river basins as well as an extensive appreciation of the historical connection and traditional knowledge that the Maijuna have regarding this area. The hand-drawn and ArcGIS maps irrefutably support their claim to these ancestral lands (Gilmore and Young 2010) and strengthen the hand of the Maijuna in pushing for its protection as a regional conservation area. The maps are also being used to make certain that the final boundaries of the proposed regional conservation area accurately reflect the spatial and temporal resource use patterns and cultural history of the Maijuna, ensuring that the proposed protected area contains as many of the Maijuna identified biologically and culturally significant sites as possible.

Participatory mapping can also help to illuminate and clarify how proposed development projects will impact biocultural resources and their conservation. In this case, overlaying the route and location of the previously discussed proposed road and development corridor in ArcGIS over the geographically fixed locations of Maijuna biologically and culturally significant sites, dramatically illustrates the potential biocultural ramifications of this development project. Not only will this proposed development project bisect Maijuna ancestral territory, but it will cut directly through one of the Maijuna communities, hundreds of biologically and culturally significant sites, and the headwaters of the Yanayacu, Sucusari, and Algodóncillo rivers, ultimately compromising the biocultural integrity and value of Maijuna lands (see Gilmore et al. 2010). Thus, participatory mapping can help to defend indigenous and local communities from ill-conceived development programs and it can also help to more effectively engage policy makers to mitigate as much as possible the potential environmental degradation and destruction from these projects.

Additionally, participatory mapping can also be used to help establish resource management plans and strategies for biocultural resources. Based on the results from participatory mapping sessions done in each of the Maijuna communities, we have recommended that the central core of the proposed regional conservation area –where the headwaters of the Yanayacu, Sucusari, and Algodóncillo rivers meet– receive the strictest possible protection (Gilmore and Young 2010). Through mapping it was determined that the Maijuna currently very rarely enter and use this area, and it can serve as a key ''source area'' and breeding ground for culturally, economically, and biologically important plant and animal species. This is also the area with the unique and previously unknown complex of high terraces, so a strict level of protection will also safeguard this habitat without much sacrifice from the Maijuna.

Besides helping to inform larger scale management strategies and decisions via the zoning of the proposed protected area, participatory mapping can help establish management plans for specific salient and important biocultural resources. For example, participatory mapping provided a more detailed understanding of the Maijuna use of *L. tenue* palm forests and threats to these areas from illegal harvesting by individuals from outside communities. The community maps allowed us to identify and pinpoint the trails and resource extraction routes used by these people. Using this information, the Maijuna and their allies can work to restrict outsider access to these palm forests by establishing community patrols and work to strengthen traditional community-based management strategies.

The maps were also critical for understanding past and present threats to other resources such as timber, game animals, and palm fruits. During mapping sessions and site visits we found that many of the *M. flexuosa* palm swamps located closest to the communities have been degraded by destructive harvesting of female palms which are cut down to access their fruits. The depletion of female palms negatively affects this culturally and economically important resource as well as the valuable game species which rely on *M. flexuosa* fruits, such as ungulates (e.g., tapirs and peccaries), primates (e.g., red howler monkeys), and fish, which in turn, are ecologically vital seed dispersers (Beck 2006; Bodmer 1991; Henderson et al. 1995; Zona 1999). Knowledge of the spatial distribution of these palm swamps, including how and when their dominant species is utilized (Table 1), is critically important because it can allow the Maijuna and their allies to effectively target these areas for management and restoration. In fact, this has already begun; community-based management plans for *M. flexuosa* palm swamps in Maijuna lands have been gaining strength since 2009 resulting in more and more Maijuna collectors learning how to safely climb these palms to harvest their fruits, instead of cutting them down. Conservation and management actions can be taken for other culturally, economically, and biologically important resources such as timber, game animals, fruit tree species, and sacred sites, that are similarly threatened or in need of protection.

The hand-drawn maps completed in each of the Maijuna communities and the multimedia PGIS database that we are currently developing can also serve as reservoirs of traditional knowledge. For example, multiple copies of all of the hand-drawn maps have been returned to each community and the Maijuna are using them to teach their children the geographic and traditional knowledge embedded within them. Two different versions of each map have been provided to the Maijuna at their request. One version contains all of the information drawn on the original, while the other omits information that they have designated as bioculturally sensitive (i.e., hunting sites, fishing areas, and sacred sites, among others). According to the Maijuna, the maps with the sensitive information will only be made available to Maijuna individuals, whereas the altered versions may be shared with people from outside communities. This helps to protect against the misappropriation of this information by outside resource extractors and other nefarious individuals.

Additionally, the PGIS database will eventually include all of the taped ethnographic interviews, photos, and other important cultural and biological information collected for each mapped site, allowing users to click onto a given site and watch a video of a Maijuna elder speaking or singing about the site, or see photos of the area and its resources, among other things. Since all of the interviews were completed in both Maijuna and Spanish, the PGIS database will be bilingual. Although the Maijuna are not currently computer literate, we envision that this database can serve a significant role in future cultural conservation and revitalization activities by saving in perpetuity Maijuna traditional knowledge that typically has been passed on orally from individual to individual and generation to generation. This is critically important given that the Maijuna language is currently endangered, Maijuna oral traditions (stories, songs, oral histories, etc.) are rapidly being lost, and Maijuna biological, ecological, and geographical traditional knowledge is disappearing (Gilmore 2010). In the meantime, to protect against the misappropriation of this database and its corresponding information, we will password protect the database and only share it with individuals or organizations that the Maijuna deem appropriate, giving them ultimate say and control over their traditional knowledge.

Participatory Mapping and Community Empowerment

The process and products of participatory mapping can be empowering to indigenous and local communities in a wide variety of ways (Crampton 2009; Dunn 2007; Elwood 2002; Herlihy and Knapp 2003; Jarvis and Stearman 1995), which is especially significant given that ethnobiologists regularly work with marginalized indigenous and local communities (Alexiades and Laird 2002; Cunningham 1996; Gilmore and Eshbaugh 2011). During the Maijuna mapping project, it became increasingly clear that the act and process of map making was politically empowering to the Maijuna, as highlighted by the fact that they would frequently engage in conversations about the political importance of the maps that they were producing. Through these conversations the Maijuna revealed that they viewed the process of mapping as a performance of ownership, a statement of identity, and a demand to be recognized and heard by outsiders. The ArcGIS maps produced during this project (see Gilmore et al. 2010) also increased Maijuna political agency because GIS encodes traditional knowledge within a scientific medium deemed legitimate by many politicians and policy makers (Elwood 2002; Pickles 2003, 2006). Importantly, the Maijuna and their allies are now using these ArcGIS maps to support their calls to alter the path of the proposed road and its associated development scheme, and to press the regional government of the Peruvian Amazon to create the regional conservation area in the Yanayacu, Sucusari, and Algodón river basins.

Participatory mapping can also foster the transfer of traditional knowledge within and between communities. In this case, the Maijuna mapping sessions provided an opportunity for building bridges between generations. During the sessions, Maijuna children and teenagers would crowd around the map listening attentively to the traditional stories and knowledge of their elders, often learning for the first time about place names, Maijuna ancestors, and historically significant sites, among other things. These younger individuals would frequently ask questions trying to clarify key points that they did not understand, making this a dynamic and interactive learning process. Younger individuals not only increased their understanding of Maijuna traditional knowledge but also increased their appreciation for this knowledge as they heard and understood its political and cultural importance. This is especially significant because the value of traditional knowledge must be appreciated and understood if it is ultimately to be passed on.

Participatory mapping also became a vehicle for elders and other knowledgeable individuals to share their knowledge and expertise amongst themselves. It was not unusual for one elder to defer to another during the community mapping sessions due to a general understanding that the other individual knew a particular area or story better. Individuals took great pride in the amount of traditional knowledge that they knew, ultimately garnering respect for themselves and their knowledge.

Sharing knowledge and experiences among communities is quite rare yet very powerful. The Maijuna mapping project created a venue for transferring knowledge between Maijuna communities of the different river basins as they had opportunities to share their completed hand-drawn maps with each other. Maijuna individuals were able to learn about the stories and histories of other river basins –not just their own– providing them with a more complete picture of Maijuna traditional knowledge. This has ultimately helped the Maijuna to view and conceive of their ancestral lands more holistically instead of just on a per river basin basis, which was previously the case.

The Maijuna mapping project also allowed for significant capacity building for participating individuals and communities which are key and integral elements of any ethically grounded ethnobiological research project (Gilmore and Eshbaugh 2011; ISE 2006). For example, a Maijuna elder from the Sucusari community, who was present at all of the community mapping sessions, gained a detailed understanding of the methods of participatory mapping. In fact, many times he helped to lead and facilitate community mapping sessions, ultimately demonstrating his leadership, commitment, and knowledge of the project. This also highlights his feelings of ownership over the project and the highly participatory and community-based nature of it. In addition, many Maijuna members of the research teams who physically visited the locations of the mapped sites were trained in the use of GPS devices and cameras. This facilitated the research as it allowed groups of Maijuna team members to split away from the researchers at times to independently visit and geo-locate biologically and culturally significant sites. In a very real sense, the Maijuna now possess much of the knowledge and skills necessary to carry out future participatory mapping initiatives, or other similar community-based projects, on their own.

Conclusion

For all its strengths and potential, we do not wish to paint participatory mapping as completely unproblematic and solely positive; like all methodologies, it requires a high degree of rigor and self-reflexivity in its application to be effective and successfully carried out. During the mapping process, researchers can easily privilege certain community members or groups over others (Elwood 2002; Schlossberg and Shuford 2005). In this case, the project and the resulting map have the potential to ignore, mask, and perpetuate pre-existing, negative power relationships within communities, or, worse, produce new divisions and forms of marginalization both within the community and between the community and other political organizations (Cruz 2010; Schlossberg and Shuford 2005). To avoid this, it is absolutely critical to create an atmosphere during the mapping process that is as welcoming and inclusive as possible of all community members, groups, and stakeholders to ensure that all voices are both heard and respected. Ultimately, it is important to remember that any map, as a representation, both reveals and conceals portions of the world based on the desires of the mapper(s) (Harley 1989). These issues can be further compounded by the technologies and technical methodologies that the researchers use in the communities, both during the mapping process and when returning the results of the project to participants (Corbett and Rambaldi 2009). While we have returned the participatory maps to the Maijuna communities, we continue to grapple with how to deploy the final PGIS database in a way that can be fully utilized by all community members, but not exploited by others.

It is also critical to understand how the use of counter maps interacts within larger legal and political structures (Corbett and Rambaldi 2009; Crampton 2010; Pearce and Louis 2008; Rundstrom 1995). Wainwright (2008) points out that many counter-mapping efforts implicitly accept and work within the same legal structures that originally colonized and oppressed indigenous peoples. This desire for working within the system may prevent researchers from thinking about how current laws continue to perpetuate inequality and foreclose more radical methods of empowerment. In a North American context, Sparke (1998) points to how the use of indigenous spatial knowledge is often marginalized within the Canadian judicial system (thus preventing counter-mapping projects from being effective) or co-opted by a national narrative of multiculturalism which attempts to hide past colonial violence (thus minimizing the likelihood that future social movements will be motivated to seek justice). However, with Wainwright (2008), we ultimately conclude that we cannot afford to ignore the potential benefits of this methodology. Instead, we must ''counter-map, and yet relentlessly critique those maps, always reading towards the concepts and strategies that will produce the strongest and most radically open, anticolonial modes of worlding the world'' (Wainwright 2008:272).

The Maijuna case study demonstrates that participatory mapping can be an incredibly powerful tool for ethnobiologists to investigate how indigenous and local communities use, perceive, and interact with their resources and environment. Significantly, it allows ethnobiologists to generate and visually represent information that is often difficult to obtain otherwise via the sole use of interviewing techniques and other more widely used ethnobiological research methods. Therefore we feel that participatory mapping can be a key methodology to augment and enhance ethnobiological studies over a wide range of subject matters. It is in this spirit, then, that we offer participatory mapping as a powerful methodology for use in ethnobiology. Only by discussing it within the discipline will ethnobiologists be capable of harnessing its potential benefits and grappling with its shortcomings. In this paper we focused on the benefits, in an effort to bring others into the discussion.

It is also important to stress that participatory mapping can be done on a variety of scales and with different degrees of participation, depending on the overall project objectives, budget, and schedule. For example, participatory mapping can be done on a small scale to locate the populations of an endangered and culturally important plant species, on a medium scale to investigate the layout and decision making processes that factor into agroforestry plots, or on a larger scale to investigate and document the traditional knowledge and cultural ties that an indigenous group, like the Maijuna, has with their ancestral territory and resources. In addition, mapping projects may or may not include GPS and GIS components. Use of these technologies increases detail and allows for more quantitative analysis, but it invariably requires a much larger investment of both time and financial resources.

Participatory mapping can also contribute in a very real and significant way to biocultural conservation and community empowerment. The unprecedented decline and loss of global biocultural diversity highlights the need for ethnobiologists, who often work in areas and communities experiencing enormous sociocultural and environmental change and challenges, to do more applied, participatory, and community-based research projects (Gilmore and Eshbaugh 2011). We strongly feel that participatory mapping is a great way to do this given its utility for biocultural conservation, including establishing the boundaries of current and ancestral lands, forming the basis of land claims, defending lands from development projects, developing resource management plans, and documenting and conserving traditional knowledge, among many other things. Similarly, because ethnobiologists regularly work with marginalized indigenous and local communities we strongly feel that they need to critically reflect on how the methods that they utilize affect and empower communities and not just generate knowledge from or about them. Unfortunately, in our opinion, this reflection by ethnobiologists has been all but absent to date in the development and discussion of ethnobiological research methods, as researchers tend to focus almost entirely on the ability of their methods to generate data and little else. Significantly, participatory mapping can lead to political empowerment, the valuing and transfer of traditional knowledge, the building and strengthening of cultural and community cohesion, the development of individual and communal pride, and the building of individual and community capacity.

Even if mapping the ancestral or communal lands of a host community is not the focus of an ethnobiological research initiative, incorporating it into the research process is still highly encouraged given the type of empowerment that mapping can engender and the fact that the maps produced are concrete products that collaborating communities can ultimately use for biocultural conservation in the present and/or future. It should be noted that the amount of time and resources needed to facilitate this type of mapping work is relatively small compared to the power and usefulness of the end products to the on-the-ground needs of communities. For example, the mapping sessions in each of the

Maijuna communities lasted only 4–5 days and cost relatively little. Ethically and morally, there is a pressing need to make ethnobiological research projects more accountable to the needs, challenges, and priorities of host communities (Gilmore and Eshbaugh 2011), and we strongly feel that the process and products of participatory mapping are an excellent way to do this. Given the power of participatory mapping when properly carried out, we strongly feel that it can and should play a more significant role in ethnobiological studies in the future.

Note

[1] Transcription of Maijuna words was accomplished with the help of S. Ríos Ochoa, a literate and bilingual Maijuna individual, using a practical orthography previously established by Velie (1981).

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