The coexistence of local knowledge and gps technology: Looking for Things in the Water

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Abstract During the period 2000-2003, scientists from a prestigious research centre in Mérida, Yucatán set out to study benthic habitats and their relation to lobster fishing in Bahía de la Ascención on the Caribbean coast of México. They engaged local fishers in the task of finding predetermined sites where sea bottom samples would be collected. The scientists used geographical positioning systems (GPS) while the fishers steered their boats and followed precise indications from the researchers on where to travel. An unplanned and unexpected result of the original research agenda was the introduction of GPS technology into the local fishing practices. Drawing from sociocultural theory, this paper provides insights regarding how the fishers use new technology intertwined with local knowledge to navigate at sea and look for things in the water.

Introduction

In recent years, information and communication technologies (ICT) have become more affordable for small scale fishers. International agencies are promoting the use of cellular phones, hand held geographical positioning devices, radio, and internet based information as an avenue for enhancing livelihoods and reducing poverty (FAO 2007). This is not to say, however that there are not concerns about the effects of ICTS on local communities and culture. For example, Action Aid, a nongovernmental organisation based in London, has raised questions about how the introduction and distribution of different technologies might endanger cultural diversity or further exploitation. Others are concerned with local and indigenous peoples retaining the intellectual rights to the knowledge produced by their communities and passed on from one generation to the next (Agrawal 1994, 1995; Antweiler 1998; Murray, Bavington and Neis 2005).

There is a growing tendency to use local knowledge to expand scientific understanding of fishers' environment, improve management policies, follow species' behavior, and study life near the sea. Several studies discuss methodologies of how to integrate locally produced knowledge (Balram, Dragicevic and Meridith 2004; Freitas and Tagliani 2009; Hall *et al.* 2009) into geographical information

systems and use maps as representational tools that articulate information produced by both knowledge systems.

Many of these studies underline the importance of collaboration between local fishers and scientists, and report the various ways this may occur: local fishers taking scientists out in their boats, record keeping, and participating in interviews or discussions (Alejo-Plata, Guevara and González-Medina 2004; Close and Hall 2006; Lauer and Aswani 2006). In most of the cases where fishers work with scientists to map fishing grounds, it is the scientists who use the technological devices while the fishers drive the boats, dive, work their lines or traps, or provide information (Calamia 1999; Lauer and Aswani 2006). One exception is the Sustainable Fisheries Livelihood Programme, organised by FAO, where fishers in Guinea were specifically taught to use GPS technology to report sitings of poachers to authorities, using the positioning instruments for security purposes (Lowrey 2004). Another telling example, while it is not about fishers, is the case of indigenous people in Guyana, Suriname, and Venezuela using GPS technology to map their tribal lands as a way to defend their land rights. In this case, community members were assisted by local non governmental organisations who taught them to use the positioning technology for their own purposes, needs, and political agendas (Griffiths 2004).

Other than these, there are only a few mentions of fishers directly using GPS technology on their own when fishing (Corral 2008; Gaynor, Kendrick and Westera 2008; Maclauchlin 2006) but in the cited papers technology use by local fishers is not the focus of the discussion. Furthermore, how fishers found out about technological developments or how they learned to use them is not mentioned.

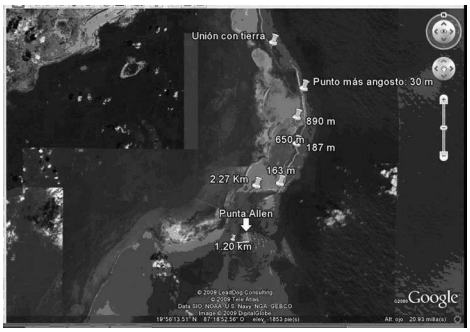

Figure 1: Punta Allen (Edited by Iran Guerrero)

In this paper we examine a community of fishers located in the Sian Ka'an Biosphere Reserve (SKBR) in Quintana Roo, México.[1] It is part of the Mesoamerican Barrier Reef System that extends from Isla Contoy on the north of the Yucatán Peninsula to the Bay Islands of Honduras (Walker *et al.* 2004). This narrow strip of land has been home to people living with the sea for centuries. The town where the fishers are located is currently known as Punta Allen and is located on a small appendix in the Bahía de la Ascensión in the State of Quintana Roo, México. As

you drive down the dirt road that stretches approximately sixty kilometers from one end to the other, its narrowest points are only thirty meters wide and its widest area is 2.27 kilometers from side to side. The recent changes in fishing technologies offer a different view of the dissemination of digital technology in traditional communities.

Our initial working premise is that before these artifacts and technology arrived, fishers developed practical knowledge about the space around them; how to navigate, and how to find specific locations and objects in the water (Scribner, Gauvain and Fahrmeir 1984). Long before their appropriation of GPS technology, the Mayan inhabitants of Punta Allen built roads across the peninsula and navigated at sea. They traded a variety of commodities such as salt, obsidian, exotic plumes, and ceramics, among others with people as far away as Cuba and Florida to the north and may have wandered as far south as Panamá. (Canter 2006; McKillop 1996).

We contend that knowledge and use of this particular digital technology does not replace traditional fishing practices or know-how; rather, the appearance and appropriation of new resources co exist with others already present. We analyse different situations and circumstances where object identifying activities take place —finding previously laid artificial habitats; recognizing marine life such as turtles, manatees, and manta rays swimming in the water or on the sea floor; and recovering artificial habitats after a storm. The purpose of this paper is indeed quite specific; our interest is to address the question 'how do fishers use traditional and digital knowledge to look for things in the water'?

The analysis that follows is situated at the crossroads of two research agendas. Both authors are researchers at one of the most prestigious centres in Latin America, but come from different fields and expertise. They have two sources of field information:

1) Liceaga is a mathematician whose main research interests are in the area of marine ecology. Through doing spacial-temporal analyses of marine ecosystems she has accrued important multidisciplinary experience. She did research in Punta Allen from 2000-2003 which had significant impact in the community and in decision making by the Comisión Nacional de Áreas Naturales Protegidas (CONANP). Her research methodology was quantitative and based on the use of remote sensing and image technology. In the process, she and her research team engaged fishers in her project. From this collaboration, a successful mediation process emerged: the researchers showed some of the local fishers how to use the GPS devices while traveling in their boats. From the collaborative relationship between the researchers and the fishers, an expert-novice encounter evolved around the use of geopositioning technology.[2]

2) Kalman is an educational researcher specialised in language and literacy, specifically the social construction of literacy practices in a variety of contexts (Kalman 1999; 2001a; 2005a; 2005b). Her most recent work has been on technology (Kalman 2001b) and the language of social change. She has recently begun fieldwork in Punta Allen, studying the use of written culture, technology, and multimodal representation in the community. In the overall project, the central interest is to study the dissemination of technology in this fishing town and the

emergence of literacy and technology generating spaces (Zboray 1993). She has begun to explore the presence of computers, radio, television, and GPS in Punta Allen, as well as reading and writing in public spaces such as the library, the schools, the street, and the health centre.

This paper grew out of their discussions and joint analyses of fishers' interactions with scientists regarding the use of GPS technology related to Liceaga's 2000-2003 project[3] and Kalman's initial reflections regarding the interaction of researchers and fishers as well as questions about GPS learning and use. They met for the first time in early 2006 and began corresponding. They held two work meetings in September and December of 2006 and had originally planned a field trip as part of the last meeting but it was postponed due to circumstances beyond their control. In February of 2009 they were finally able to visit the site together. The data presented here comes from conversations, meeting notes, correspondence between researchers and Kalman's field notes from the 2009 visit. For this reason the commentary regarding the recent field work is tentative while the information derived from Liceaga's project is more conclusive. At the end of the paper, rather than draw any final conclusions regarding traditional and digital knowledge, a series of reflections about the directions this research might take is presented.

Concepts for Understanding the Use and Coexistence of Local Knowledge and GPS Technology

This paper is located within a New Literacy Studies paradigm which posits that reading and writing are social practices rather than independent variables. Theoretical work from this perspective for the last twenty years or so has emphasised two previously omitted aspects of literacy: first, literacy is a multiple construct, and is best thought of as literacies and second, literacy is bound ideologically to institutional contexts, historical processes, and power relations that reach beyond the immediacy of situated reading and writing (Street 1984; 1993; 1995). Over the last five years, important conceptual considerations have been made to refine these aspects, reminding researchers working in this paradigm of the 'limits of the local' (Brandt and Clinton 2002).

Within this perspective, Warschauer has written a thought provoking analysis of the notion of access, by relating this term to new information and communication technologies (ICT) and literacy. He notes that the idea of access is often limited to the possession of technological devices, basically the ownership of a computer. He argues for a more complex notion, stressing the importance of social contexts of practice and the shifts in the use of technology, depending on historical, political, and sociocultural conditions. He recognises that while the presence of material artifacts is necessary; it alone does not lead to technological competence.

In her work Kalman (2005a) has distinguished access from availability, using the notion of availability to signal the material aspects of literacy (the physical presence of print materials, digital technologies, infrastructure for reading

and writing such as post offices, libraries, bookstores, newsstands, cybercafés, *et cetera*). Access, on the other hand, is useful for discussing the social conditions necessary for literacy learning and use. She notes that access involves the opportunity to take part in meaningful and authentic events where reading and writing are essential for participation, and the opportunity to interact with other readers and writers (Kalman 2001a, 2005a). She also found the presence of more expert readers who create contexts for reading, writing, and interacting with novices had an important effect on their interest in literacy and their appropriation of written culture.

The common denominator of the above theoretical discussions is the emphasis on social interaction rather than material conditions or individual attributes. Warschauer connects this discussion to the current debates on technology to literacy, noting the important parallels between the digital divide (the presence or absence of computer technology) and Goody´s notion of the literacy divide in the sixties presented in terms of the presence or absence of specific forms of reading and writing (Goody 1968). The current notion of access recognises the importance of material availability of literacy and/or technology, but defines it in terms of social interaction, discourse practices, and use.

The presence of others for access to literacy was carefully analysed by Deborah Brandt. In her 2001 study of literacy sponsors she portrays how newcomers to written language interact with more experienced readers and writers for learning specific uses and meanings of literacy. Mediators are particularly important social actors for literacy learning and use in community settings. They provide a needed service for others; they act as sponsors not only for reading or writing a specific document but also for navigating different contexts where literacy is used. They may have some schooling, but more important is their accumulated knowledge regarding specific literacy practices: letter writing, interactions with official agencies, accounting, and experience with discourses and their interpretation.

In many ways, digital technologies are an extension of other types of symbolic representation and some of the long standing issues related to reading and writing are relevant to new technologies. Much of what we find on the screen today exists in previous forms: texts, illustrations, crossed references, maps, and so on are also available in print versions. What digital technologies provide are dynamic representations, connectivity, synchronic communication, and multiple options to manipulate what appears on the screen (move in, reproduce, select and delete, transform in size, shape, and color) at high speed with relative ease. The use of digital technologies is one of many cultural options for constructing meaning. Kress (2003) has argued forcefully that meaning making is a multimodal enterprise; cultures offer language resources and representations and beyond for the construction of messages, their interpretation, and dissemination.

Many qualitative studies in literacy are inspired by anthropology and socio-cultural theory. Geertz (1983) notes that inquiries using an ethnographic perspective try to understand social phenomenon in local contexts rather than weaving them into broad frameworks that generalise cause and effect. To paraphrase Geertz, the question is not whether technology use in Punta Allen, Oaxaca, or Australia is universal; it is whether one can talk about GPS use in Punta Allen,

compasses in Oaxaca or echo sounders in Australia 'in a way as to cause them to shed some sort of light on one another' (1983: 11).

In this paper we examine the fishers' local knowledge - context bound and constructed through recurring practice in everyday life - and the use of GPS technology they learned to use through contact with researchers. We look at the use of GPS technology and local knowledge as a way the fishers configure meaning; and how their meanings shape social action. It is a way of understanding why they do the things they do (Geertz 1983). In our preliminary inquiries of community practices for finding objects in the water, we noticed the importance of mediation: activities mediated by others, mediated by different tools, mediated by different interpretative practices.

One of the issues of introducing new technologies, procedures, and cultural resources is understanding how people learn to use them (Lave and Wenger 1991; Rogoff 1990). Apprenticeship - not only in the formal sense - learning to do with more expert others through guided participation (Rogoff 1990) is at the centre of this line of inquiry. Through studying novice tailors, midwives, and others, Lave and Wenger (1991) have shown how learners begin to appropriate practices from the edges of activity. The experts are located in the centre and tend to assign peripheral tasks to their apprentices to engage them in authentic goal-directed actions. From this vantage point, learners collaborate with experts and contribute to completing their work. The experts engage the beginners in complete activities rather than fragment them into arbitrary bits based on an abstract notion of what is easy or difficult. Learners must solve complete and very real problems.

In her later work, Scribner studied practical knowledge developed in recurring tasks at work. For example, in warehouses where veteran workers had to fill large orders of dairy products, she observed how they used spatial knowledge to optimise the collection of objects located in refrigerators, freezers, and storage shelves placed at a distance. She also studied machinists in factories and compared those older workers who had designed machine parts without computer assisted designing software with their younger counterparts with little hands on experience, and with those who had migrated from designing by hand to using the software (CAD). She found in both cases that day to day activities weighed heavily on work decisions: the employees at the dairy consolidated collection routes based on their knowledge of space and the machinists who had direct experience working with materials such as steel for designing pieces used this knowledge to analyse their CAD pieces. These findings are particularly relevant to this article given the recent incorporation of GPS technology to fisher practices (Scribner, Gauvain and Fahrmeir 1984; Scribner and Sachs 1989). Previous to digital resources, the fishers had developed local know-how and knowledge of their surroundings for finding locations and objects in the water.

The meaning of *local knowledge* has been at the centre of several discussions in the environmental and resource management literature. To begin with, authors refer to it in a variety of ways: terms such as tacit knowledge (Rahman 2000), traditional knowledge (Grant and Berkes 2007), local ecological knowledge (Murray *et al.* 2005), traditional ecological knowledge (Grant and Berkes 2007), traditional indigenous knowledge (Lauer and Aswani 2006), among others, can be found.

Another common distinction (Hall *et al*. 2009) is scientific knowledge (SK) and traditional knowledge (TK) or Indigenous Knowledge (IK). For the rest of this paper, local knowledge and traditional knowledge will be used interchangeably to refer to what Clifford Geertz (1983) defines as 'vernacular characterizations of what happens connected to vernacular imaginings of what can' (215) and 'the explaining of why we do the things we do in the way that we do them' (233). More specifically, we use it to signal what fishers knew about navigating and object locating activities at sea before learning to use GPS technology.

Discussions in the fisheries literature centre ways local and scientific knowledges are constructed and expressed and the ways understandings from these two knowledge systems may (or may not) relate to each other. Differences between the two have been attributed to their format (scientific knowledge is said to be explicit while traditional knowledge is said to be implicit), on their methodologies (scientific knowledge is said to be based on 'objective' inquiry while traditional knowledge is said to evolve from subjective experience), and their level of abstraction (scientific knowledge is said to be abstract while traditional knowledge is said to be concrete and context specific) (Rahman 2000).

Underlying the above dichotomy is the history of human thought in western ideology: Berkes and Berkes (2009: 9) note that the

> Classical logic of precision, which forms the basis of Western science, was developed by the Greek philosophers, notably Aristotle, whose works gave rise to the so-called 'laws of thought'. One of these is the 'law of the excluded middle' which forms the basis of later Cartesian logic. This law states that every proposition has to be either true or false. It is thought that the tendency of Western science to regard matters as either black or white stems from this bivalent yes – no logic.

The 'law of the excluded middle' clearly leaves little room for recognizing or appreciating the different hues that make up everyday experience which is precisely one of the sources of local thought.

In line with their geopolitical agenda, nineteenth century colonial thinking extended the scientific-local knowledge dichotomy to distinguish what the Europeans considered to be the primitive from the civilised. The colonial authorities agreed that the thinking of the indigenous peoples they colonised was local, savage, concrete, subjective, implicit and irrational while their own thinking was was scientific, modern, abstract, rational and explicit (Agrawal 1994).[4] Although this view has gradually been refuted as more has been learned about how people from other cultures think (Geertz 1983), vestiges of the civilised/primitive dichotomy can still be found (Close and Hall 2006; Rahman 2000).[5]

As the example of nineteenth century thinking demonstrates, science is an activity embedded in the context in which it is produced. Chambers and Gillespie (2000: 235) maintain that

> Science, like any other social activity, bears the imprint of society which it is a part. All knowledge systems are 'situated' in power relationships, value

> assumptions, and historical frameworks. As a culturally specific system, albeit one with enormous power ... Western Science cannot be afforded a privileged status over indigenous knowledge. Far from being an abstract intellectual debate, this issue goes to the heart of how different cultures view one another.

And, we would add, how different people treat each other. Furthermore, some authors question the validity of the dichotomy all together (Berkes and Berkes 2009: 8; Agrawal 1996). They see knowledge in both systems as based on observations of the environment and natural phenomena; and they point out that both types of knowledge are the result of the process 'of creating order out of disorder'.

Before ending this brief review it should be pointed out that the notion of local knowledge is not without critique. Agrawal (1994) forcefully argues that a classification of knowledge into a indigenous and western dichotomy is bound to fail because it

> seeks to separate and fix - separate as independent, and fix as stationary and unchanging - in time and space systems that can never be thus separated or so fixed. Such an attempt at separation requires divorced historical sequences of change for the two forms of knowledge - a condition evidence simply does not bear out. According to Levi-Strauss, contact and exchange among different cultures, including between Asia and the Americas, was a fact of life from as early as thousands of years ago (1955: 253-60) Certainly, what is today known and classified as indigenous knowledge has been in intimate interaction with western knowledge since at least the fifteenth century. In the face of evidence that suggests contact, variation, transformation, exchange, communication, and learning over the last several centuries, it is difficult to adhere to a view of indigenous and western forms of knowledge being untouched by each other. (17).

Agrawal's discussion suggests that knowledge produced in everyday life and knowledge developed by the scientific community historically have been integrated through trade, interaction, and renovation. This leaves open the question of how the fishers in Punta might develop knowledge about the use of digital technology for their daily activities, once they learned to use them from the researchers.

Punta Allen: From Mayan Trade to Lobster Fishing with Casitas Cubanas

Punta Allen, situated within the Sian Ka'an Biosphere Reserve, was at one time home to the ancient Mayans. Several residential and ceremonial sites dating back to 1200 such as Chunyaxche, Vigía del Lago, Xamach, Tampak, and El Platanal are located within the reserve's boundaries. During Mexico's colonial period, continuous exposure to pirates settled in the nearby English colony of what today is Belize (CONANP 2002) led to the disappearance of permanent inhabitants. After independence in 1810, the area continued to be exploited mostly by the English.

During an armed uprising in 1847 known as the Guerra de Castas by the Mayan peoples in the Yucatán Peninsula, the English negotiated 'exploitation permits' (Canul-González 2004), paying the local peoples with arms in exchange for entering, hunting, and fishing. The port of Vigía Chico, where Punta Allen is located, was founded when the federal forces entered through the Bahía de la Ascensión to crush the rebellion. In the beginning of the twentieth century, it began to flourish. During the 1920s harvesting gum and coconuts for their meat became the main economic activity having important consequences for the area's economic development (Canter 2006; CONANP 2002).

Most of the inhabitants of Punta Allen today are Spanish speaking and many have emigrated there from other parts of southeast México. There are, however, neighboring areas in the region heavily populated with speakers of indigenous language such as Benito Juárez, Felipe Carrillo Puerto and Othón P. Blanco (INEGI 2005). In the municipio of Solidaridad, where Punta Allen is located, 21.68 per cent of the residents are speakers of a language other than Spanish (INEGI 2005). Mayan culture and practices are important and vibrant tributaries to local ways of life.

Throughout the first half of the twentieth century, the main economic activity of the inhabitants of Punta Allen was collecting and selling coconuts and a small amount of lobsters, caught by the traditional method of hooking them individually from crevices in the reef. According to one fisher that we recently spoke with, as recently as fifty years ago, Cuban sailors traded rum and sugar for local products, among them lobsters fishers harvested by hand.

An important turn of events occurred during the 1960s when Cuban fisherman showed Punta Allen inhabitants how to build '*casitas cubanas*' or '*sombras*' which are artificial habitats or refuges that create spaces similar to the small caves in the reef. This allowed the local fishers in Punta Allen to increase their lobster fishing capacity which in turn led up to the organisation of their cooperative (Pérez 2005). These man made shelters are approximately 1.20 to 1.50 meters long by fourteen centimetres high and currently built out of concrete.[6]

A second event also had important impacts on lobster fishing in Punta Allen. In 1968 the fishers organised a cooperative called 'Pescadores De Vigía Chico' which led to the parceling of the fishing grounds and paved the road for self governance.[7] This led to the sub-division of the bay which gave to origin to the distribution of fishing grounds in plots or *parcelas* (*campo langostero*), a traditional form of land division and community property rights among farmers in Mexico. Members of the fishing cooperative agreed to respect a fisher's claim to exclusive fishing rights to assigned areas. The size of the fields and the number of refuges placed on the seafloor vary from member to member. One fisher or a fisher and his family became responsible for their assigned areas: they were responsible for exploiting them and for following conservation regulations regarding seasonal bans, fishing season restrictions, throwing back lobsters under the minimum size and returning egg carrying females to the sea.

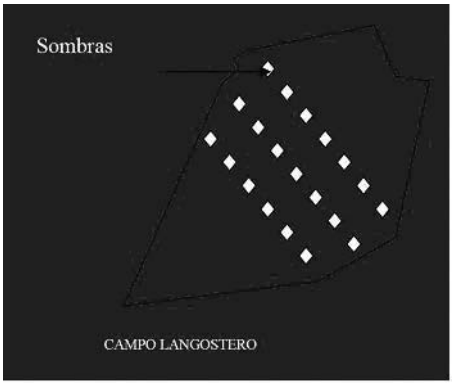

Figure 2: Lobster traps lined up in rows. http://www.pescadorapescador.net/SCPP_VIGIA.pdf

Artificial refuges are placed on the sea bottom in rows, similar to the ways farmers grow crops. The number of traps set depends on the fisher's economic resources and ability to invest in their construction, placement, and maintenance. Currently there are 120 existing lobster fields (Liceaga-Correa *et al*. 2006); fishers lay out their traps in rows in a way reminiscent to planting a field[8] and retrieve lobsters by diving with snorkels and masks and using small nets called *jamos* (with an aluminum handle and netting) to collect them.

Fishing Activities: Setting Traps, Relocating them, Harvesting Lobsters

Under normal conditions, lobster fishing entails producing artificial refuges, setting them on the sea bottom, and then checking for lobster on a regular basis. Before the appropriation of GPS technology, the fishers used onshore geographical landmarks (a particularly tall tree, a pier, or a jetty, for example) visible from the boat and *buoys* to mark their fields define the approximate location of their shelters. Because of the clarity of the water and its general shallowness, fishers recognise their location by the dark and light areas on the floor, spread out in front of them. The different shades and shapes of the combination of sea grass and sand make up an extended checkerboard that allows them to steer at sea.

Two of the fishers commented on how they 'read' the bottom of the bay and their surroundings (Berkes and Berkes 2009; Freire 2004):

Spanish	English
Pescador 1: Sabemos leer la costa, blanquizales, negrizales. Lo blanco es arena lo negro son algas.	Fisher 1: We know how to read the shoreline... the dark, and light spots. The white part is sand and the black parts are seaweed.
Pescador 2: Antes ubicamos los campos por boyas, por el árbol en la costa, por un barco hundido.	Fisher 2: Before we located our fields by the buoys, by a tree on the coast, by a sunken ship.

Fishers are able to make out a variety of shapes in the water from a distance: turtles, fish, eels, and manta rays. They do not have any difficulty distinguishing these different forms of sea life from the static forms of seaweed, even though untrained eyes such as the authors' see little difference between these dark spots and clumps of seagrass growing on the bottom.

The fishers became interested in GPS technology as part of their contact with researchers from the Department of Marine Resources at the *Centro de Investigación y de Estudios Avanzados* (CINVESTAV) located at the Mérida Campus. Under the academic leadership of María de los Ángeles Liceaga Correa, from 2000 to 2003 her group worked in Punta Allen, collecting data on several environmental variables. They preselected sites for data collection based on the statistical analysis of a satellite image of the bay;[9] these sites were then physically located in the field using a GPS device. This technology allows establishing a predetermined route to the specific points one wishes to visit. To travel to each one, the researchers hired some of the fishers who took them out in their boats. It was in this context that the fishers first saw the researchers use GPS.

Because Punta Allen is part of the UNESCO Biosphere program, and because of the success of its cooperative, the fishers have ample opportunities to meet and interact with people from outside their town: researchers from national and international organisations, activists in local non governmental organisations and members of other fishing cooperatives. In this sense, even though it is a two hour drive down an unpopulated dirt road to get to Punta Allen, it is not a completely isolated community. Before participating in the project with CINVESTAV, a few of the fishers had heard about GPS technology and apparently at least one of them had a GPS instrument. They also had seen others use a personal computer, while the members working in the Cooperatives used one for administrative activities and some of the young adults in town have some technical training or college degrees and have learned to use them as well.[10] However, it was through the extensive contact with the researchers and watching them use the devices sparked the fishers' interest in a way that it became plausible for them learn how to use the GPS technology.

The researchers from the Department of Marine Resources travelled to Punta Allen on a regular basis. At the height of data collection they went once a month for a week from October 2000 to June 2002. Approximately six fishers assisted them with their activities, and they were the first to become familiarised with GPS functioning. Some of the researchers would stand at the back of the boat with the fisher while he steered it. The researcher would turn on the GPS device and give the fisher precise indications where to head the boat. The fishers had the opportunity to observe the scientists operating their hand held geopositioners and to ask questions such as 'How does it work? How do you know which way to go? How do you know how far you have gone? How do you know you have arrived at your destination?' For each of these questions the researchers answered by showing the fishers the screen and interpreting the symbols and maps displayed on it.

As an informal situation for learning, these in situ demonstrations had an epistemological advantage: the researchers, acting here as expert GPS users did not just demonstrate technological use, they involved the novice fishers in experi-

mental situations, creating on the spot the opportunity to hypothesise about how the GPS works and the immediate conditions to validate or reject their conjectures. When the fishers did not understand what was displayed on the screen or not sure what to expect, the academics could ask them 'What do you think will happen if we change directions?' They could then redirect the boat with the GPS in hand to see if their expectations were correct or not. This allowed the novice GPS users to experiment and learn by trial and error under the guidance of more experienced others.

The above characterises the initial experience of some of the fishers with the GPS technology. It was not long before the members of the Cooperative asked the researchers from Mérida to teach the fishers how to operate GPS devices. Because of their involvement with the Cooperative and the RBSK, the course format is familiar to the fishers, despite the fact that many of them have not completed a formal basic education.[11] The *Comisión Nacional de Áreas Naturales Protegidas* (CONANP) offers certification for tour guides which requires attending a class and presenting an exam The local authorities use a similar format for licensing boat captains and giving them official documents that allow them to use their boats called Libretas de Capitania (SCT 1993; Canul-González 2004).

In the first few days of December in 2003 approximately fourty per cent of the fishers took a course organised by the researchers. It was attended mostly by younger fishers, many of whom were studying (or had studied) outside their town while. Many older fishers did not attend. The course lasted twelve hours, thirty per cent for a theoretical component and seventy per cent for a practical one. The first part included presentations on screen that briefly explained the satellite system, terminology, and the parts of the GPS and covered the topics such as:

1. Information transmitted by satellites to a GPS
2. Factors that effect the precision of GPS reception
3. Description and function of the GPS keys
4. Basic aspects of navigating with GPS
5. Configuration and basic GPS functions
6. Marking a waypoint
7. Defining a route

The practicum offered a series of activities using GPS devices on the ground (rather than in the water) to familiarise the fishers with the device and for them to learn how to record points, return to them, navigate, and use different GPS tools.[12] Besides the researchers from CINVESTAV, others from ECOSUR also participated and between the two groups of instructors several GPS devices were available to the fishers to use during the course.

The researchers first demonstrated how to operate the hand held device by introducing coordinates of a known site in town. The fishers then had to use the GPS to navigate to that precise location. They explained in detail how to define a *way point* in terms of how to name it and the procedure for sequencing coordinates. They also demonstrated how to navigate with the GPS, how to interpret from the screen the direction in which they were travelling, the distance to a given point of interest and speed at which they were travelling.

The fishers attribute their learning more to this course than to riding with the researchers in the boat. They contrast using GPS devices with previous procedures:

Spanish	English
CINVESTAV introdujo gps. Antes teníamos que arrastrar al buzo, es un uso eficiente, gasta menos gasolina, se trabaja más rápido Ponemos las trampas en filas, en hileras como las cosechas. Así no se tiene que seguir a los buzos. Antes uno iba atrás de ellos ahora le decimos: bajate aquí, y aquí están.	CINVESTAV introduced GPS. [In comparison with] before when we had to drag the diver, now the use of gasoline is more efficient, we use less gasoline and we work faster. We set the traps down in rows, like planted fields. That way we don't have to follow the divers. Before we had to go behind them, now we say, get in the water here, and the traps are there.
Yo aprendí la gps con los de CINVESTAV : lo aprendí en el curso, después preguntando a otros, cuando no sé le pregunto al señor de enfrente, él la usa bastante. A mi sobrino le he enseñado a usarlo.	I learned (to use the) GPS with the people from CINVESTAV... I learned in the course and then from asking others, when I don't know something I ask the man [who lives] in front; he uses it a lot. I taught my nephew to use it.

Dragging the diver refers to the way fishers located their refuges before GPS. Using buoys and landmarks as references, they would travel to an area and then tell the diver to get into the water. He would hang on to the side of the boat with his face mask in the water, as the fisher slowly piloted the boat. Both diver and fisher would be on the look out for the sunken shelters which are often hard to distinguish because of sea life growing on their surface.

There are, however, at least two circumstances when fishers still have to 'drag' the diver, both of them have to do with locating artificial habitats. Fishers use the maps displayed on their GPS screens and are able to return to the specific coordinates they previously saved in its memory. Once they arrive at the spot indicated on the screen, the fisher and the diver begin to look for the cement refuges under water. Currently, the fishers use a GPS device that has a margin of error of approximately five meters and they may not stop exactly next to the refuge. Given the dynamics of the waves, once the motor is cut or slowed to an idle, the boat still continues to move. Furthermore, artificial shelters that have been in place for a while begin to blend in with the surroundings as they become covered with sand and sea grass. One distinctive characteristic of the *casitas* is their regular, rectangular shape set in a background of asymmetrical forms, curves, and textures. Both diver and fisher look off the edge of the boat for the polygons. On many occasions, they spot them right away and the diver goes into the water to check them. But sometimes the fisher drives around and around without spotting them; the diver goes into the water and begins to look at the bottom through his face mask. When he finds the *casita*, the fisher trolls the boat to him so that he can handle him the *jamo*. But when the diver is unsuccessful, he holds on to the edge of the boat with his face in the water and the fisher slowly drags him along until he locates the artificial refuge.

Lobster traps are often displaced or damaged by storms and hurricanes. The fishers agreed that hurricanes 'mix up the fields, they take the refuges, they

move them'. After a major storm, fishers have to go to their fields, and find and retrieve their shelters. Because of their investment in them, they need to locate and salvage as many as they can, pick them up, and organise them into rows again. Under these conditions, they use the GPS to return to given coordinates but then have to look for their equipment using traditional means. In very severe cases, the GPS points are of little assistance and the fishers have to follow the divers as they look for the missing traps. In recent years, category five hurricanes such as Wilma (2005) and Dean (2007) caused severe damage to the fields and to the bay in general. During this period, the capture of lobster declined severely.

A final example of local knowledge is related to spotting marine mammals. In recent years there has been a rise in international tourism and many fishers are also tour guides, taking visitors out on the bay. The following is a comment by a fisher regarding how to recognise a manatee in the water. In this case, the fisher does not actually see the animal, what he sees is a *mancha de turbio* (a spot of cloudy water). The manatees feed on the sea floor and as they walk along grazing, they kick up the sand. In clear water such as that of the Caribbean, a trained eye can pick identify the manatees by contrasting the cloudy patches with the clear ones.

Spanish	**English**
Habían unos manatíes allá, al medio día. De aquí a la marina creo que los encontramos, allí los encontré allí cerca del cayo no muy lejos del mogote, tiene montones de unos mogotes, Así grandes está que tiene unos cayos hondos, tantito así donde se ven así unos blanquizales, allí andan comiendo, a veces está turbio una mancha de turbio y a veces no pero cuando están comiendo así queda turbio.	There were some manatees, I found them all together over by the marina, I think...near the cape, not far away from the mounds. I found them over there. There, in that spot where there are a bunch of mounds, big mounds...the dips are a bit deep, over there where you can see the white spots, sometimes it is cloudy, a stain of cloudy (water), sometimes its not, but when they are eating it gets cloudy.

In his description, the fisher refers to several types of local knowledge. He describes seascapes he is familiar with in terms of white and dark spots, mounds, and dips. He also uses local reference points such as the marina and places where there are a large number of '*mogotes*'. He describes how to recognise the presence of a manatee; one does not see it directly, what is visible is the spot where the mammal has stirred up sand on the bottom when grazing. In this particular activity, he depends on his ability to interpret his surroundings rather than guide his search by digital technology.

The Punta Allen fishers' observations regarding the employment of GPS coincide with others' perceptions of its use. Fishers in Australia, crabbers and shrimpers in Florida, and lobster harvesters in Nicaragua view GPS technology as offering possible economic advantages: traps are more easily relocated for resource collection and fishers can venture further out to sea because they no longer rely completely shoreline references for spatial orientation. Like the fishers in Punta Allen, some believe that this makes fishing more efficient and cost effective. However, the Australian fishers expressed concern that because relocating plentiful spots is easier, certain species will be quickly depleted while the Nicaraguan fishers did not necessarily see fishing further away from shore as beneficial, given the

extra fuel costs that it requires (Al-Masoori, Al-Oufi and Shane 2009; Daw 2008; Gaynor, Kendrik and Westera 2008; Rahman 2000).

Even as they pointed out some of the benefits of GPS use, the fishers did not speak of GPS technology replacing traditional know-how. Fishers in Tasmania, for example, could be considered 'high tech'; they have been using GPS, echo sounders, gear technology, and mobile phones, weather faxes, Very High Frequency (VHF) radio, satellite phones, and Vessel Monitoring System (VMS) for more than ten years. However, they also use 'tacit knowledge' which is 'common with fishers and processors in terms of fishing and processing operations and product handling. This knowledge is particularly used in determining quality of product at point of capture, unloading, receiving, processing, and dispatching. Fishers also use tacit knowledge during fishing operations. The experience and unique knowledge of the sea, their vessel, the coastline, and changes in the environment are extremely valuable for fisheries researchers and managers' (Richards 2006: 89).

Rather than one technology replacing another, there seems to be a distributed use of technological options. In certain contexts using GPS creates beneficial results but in others it may not: fishers in Florida use it to 'mark hazards, such as buoys or rocky areas', but not necessarily to collect crabs (Maclauchlin 2006: 44). Similarly, the fishers studied here use GPS technology for *certain* activities under *certain* conditions (trap setting under normal conditions), but its use may not be appropriate for other situations (retrieving traps after as storm or locating marine wildlife). In this sense, GPS technology is one more cultural resource fishers can select from a repertoire of possibilites for carrying out daily activities. What is interesting - and yet to be fully explored - is that while GPS technology was created by the scientific community and introduced into Punta Allen by researchers, knowledge about when to use it, how to best take advantage of its possibilities, how to articulate it with other types of know how or simply when it is not the best option, is knowledge that will be locally developed by the fishers. This suggests, as Agrawal (1994, 1995) pointed out, that the dichotomy between scientific and local knowledge discussed above may not be the most useful way of looking at how knowledge and understandings are produced by different knowledge systems. The data here, even though it is tentative, suggest that the boundaries between the two are permeable and not watertight. The fishers in Punta Allen use their hand held GPS to get to predetermined points, but often revert back to 'dragging the diver' to locate their traps when these are not readily visible.

Thoughts for Further Inquiry

Through exploring the question of how fishers use local knowledge and know-how and GPS technology for finding things in the water has led us down two interrelated paths: first, we have noted the coexistence of both practices and their usefulness in different situations and ways they also may be used together. Second, we have touched on the importance of mediation and collaboration as key activites for disseminating literacy and technological practices.

As we answered our question, we found that the fishers' access to GPS technology was the product of their interaction with the researchers. We have only begun to collect data on the specificieties of their encounters, but we do know that some of the fishers participated in situated practices: they observed the academics using the GPS technologies; they were able to ask specific questions and use the devices with the assistance of the researchers. The researchers made the technology accessible to the fishers by answering their inquiries in a variety of ways: they demonstrated the technology use, they explained how to interpret the screens, and they created experimental situations for the learners to learn by a guided process of trial and error. On the boats, these activities were 'whole activites' in the sense that demonstrating and experimenting with the devices included reading the screen, using the different functions, and exploring the buttons. The researchers also helped make the devices available: they prepared a brief course on using GPS and lent handhelds to the fishers to explore them.

The approach we have taken for understanding technology appropriation in Punta Allen privileges the relationship of technology users with others around screens and devices over the direct relationship between individuals and modes of representation. Evidently the fishers relate to GPS through reading the screen and registering data, but their knowledge and fluency for understanding, interpreting, and registering data is mediated by researchers and more expert others. Furthermore, it is situated mediation, technology use in specific contexts of use. Learning to do so is influenced by how the fishers position themselves to the other participants using the technology. They become independent as a result of their contact with others, through co-constructing knowledge and know-how together, not just from individually 'processing' digital procedures.

Conceptualizing collective practices in terms of mediation provides a frame for analysing how mediators and their partners spend time together, examine written and digital representations, interpret written texts and screens, deliberately create meanings, and share related know-how. Through interaction, social spaces emerge where participants mediate literacy and technology for each other and cooperate to accomplish a shared goal; spaces where participants make meaning from and around knowledge and its different modes of representation and where participants appropriate interpretive processes and symbolic forms. Social interaction is a crucial concept for understanding how learning takes place and how literacy and technology use is socially disseminated. It is there where knowledge is constructed by active participants who simultaneously organise their knowledge within themselves and with each other (John-Steiner and Meehan 2000).

From this theoretical point of view, there are several leads from the initial fieldwork that invite further inquiry. The spread of new technologies is in large part the result of accomplished users passing on information and practices to non-users (Sondergaard 2006), and coaching novices as they become more familiarised with it. In a study of traditional healers in the Bolivian Andes and Amazon, it was found that social networks supporting learning was the most important factor intervening in novice healers understanding of medicinal plants (Vandebroek *et al.* 2004). This suggests that face-to-face interactions and social conditions that at first may seem insignificant are in fact central to the dissemination of technology:

informal encounters, consultations, and mediation represent important opportunities for learning.

In her work, Kalman has found that a cordial and respectful relationship between mediators and apprentices is key for learning to take place. She refers to this as *convivencia*, a word in Spanish that signifies being with other people and implies human contact, mutual support, and an intimacy of sorts (Kalman 2009). This is echoed by Kurien (2002: 13):

> Self-interest exists, but it is not the overpowering motivation at work. The group or community of individuals, by their constant and intense interactions, evolves through channels of reciprocity and trust, mechanisms for communication, and information-sharing on both the wealth and welfare of its members. It is this interaction that gives the group or community the distinguishing characteristics, which cannot easily be identified with any one or all of its members.

Punta Allen is currently in a transition phase toward ICT use. There are signs of the growing distribution of technological devices and the dissemination of technology related social practices. It is a fertile scenario for understanding the multifaceted transformation processes underlying the appropriation of literacy and technology from several different literacy generating spaces: the schools, the health centre, the library, fishing and eco-tourism (Kurien 2002). There is evidence that GPS use is spawning interest in other technologies among the fishers, particularly personal computers.

A further line of inquiry suggested by the Punta Allen case is the co existence of local and scientific knowledge. In harmony with Agrawal, cited at the beginning of this paper, Murray (2005: 273) presents a complex view of local knowledge as 'a socio-ecological product, reflecting social and ecological times and places as well as culture and other institutions, and is mediated by labour processes, technologies, modes of management, economic, and ecological conditions'. The process of technology integration presented by the fishers in Punta Allen is a case in point: the ready acceptance of GPS technology into their fishing arts suggests openness to change and adaptability. The role of factors such as communication with other fishers, the pressures of the local and international markets, and national conservation policies in their learning and social practices has yet to be identified. And, what continues to be an open question, of course, is what did the scientists learn from the fishers?

The arrival of GPS technology cannot be divorced from other recent events in Punta Allen. New developments such as the opening of cybercafés and the introduction of technology into the local public primary and middle school are contributing to changing the technological landscape. Young students who wish to study high school and beyond must attend school outside Punta Allen. In these cases schooling plays an important role for technological dissemination; contrary to other environments many young people learn to use computers in classrooms rather than in out of school contexts (Gómez 2006). Their ongoing learning and

technology use is now contextualised by the daily use of GPS technology by the fishers in their town.

From the theoretical perspective presented here, reading, writing, and speaking about literacy - in both print and digital modalities - constitute essential activities of written culture. The coexistence of knowledge systems and their associated know-how enrich the symbolic and technological landscape. The presence of the researchers in the fishing community shows the power of well-informed and effective mediators and the potential effects of collaboration for learning and the dissemination of knowledge. The fishers were open to new practices and readily accepted the incorporation of GPS into their fishing arts. This has enhanced, but not replaced, locally construed ways of looking for things in the water.

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Notes

1 On January 20, 1986 Sian Ka'an became part of UNESCO's Man and the Biosphere Program. According to UNESCO, 'Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognised, nominated by national governments and remain under sovereign jurisdiction of the states where they are located. Biosphere reserves serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water, and biodiversity. Collectively, biosphere reserves form a world network: the World Network of Biosphere Reserves (WNBR). Within this network, exchanges of information, experiences, and personnel are facilitated' (UNESCO 2009).

2 Currently Liceaga continues to work in Punta Allen, working with a graduate student on the development of a mathematical model of the potential distribution of manatees (*Trichechus manatus manatus*).

3 Ma. de los Ángeles Liceaga was the principal researcher on the project *Caracterización ecológica, actual y retrospectiva, de los hábitats bénticos y su relación con la pesquería de langosta Panulirus argus. Bahía de la Ascención, Reserva de la Biósfera de Sian Ka'an*. Several research institutions participated and the project involved a number of researchers:
From the Centro de Investigación y Estudios Avanzados (CINVESTAV), Mérida: Dra. María de los Ángeles Liceaga Correa, Dr. Jorge I. Euán Avila, Ing. Héctor Hernández-Núñez, Bióls. Guadalupe Mexicana-Cíntora, Téc. Jorge Acosta Hernández.
From the Centro de Investigación Científica y de Educación Superior de Ensenada, B.C. (CICESE): Dr. Oscar Sosa Nishizaki, Bióls.William Aguilar Dávila
From El Colegio de la Frontera Sur (ECOSUR) Unidad Chetumal: M.C. Eloy Sosa Cordero, Bióls. Alma Angélica Ramírez González, Riger Borges Arceo.
The Project was funded by: Sistema de Investigación Justo Sierra (SISIERRA).
During their time in the community, Liceaga's team showed some of the fishers how to use GPS devices.

4 Geertz (1983: 148) refers to this line of thinking as 'the primitive form of the 'primitive thought formulation - that is, while we, the civilised, sort out matters analytically, relate to them logically and test them systematically as seen by out mathematics, physics, medicine or law, they, the savage, wander about in a hodgepodge of concrete images, mystical participations, and immediate passions as can be seen by their myth, ritual, magic, and art.'

5 In a report to the United Nations Conference on Trade and Development, Rahman (2000: 4) wrote that 'Traditional Knowledge (TK) needed to be formalised, since it is essentially of a fragmentary and provisional nature. It is in this formalisation phase that problems with respect to the application of TK are most likely to arise. This type of knowledge is still not as well known as the coded and circulated objective language and the printed products of scientific discourse'.

6 Map of lobster fields cited from http://www.pescadorapescador.net/SCPP_VIGIA.pdf

7 The fishers there have developed their own rules to regulate their use of the fishing areas. These rules determine when, how and in what way the fishing area will be divided amongst the members of this fishing cooperative (Arellano-Guillermo, 2004). See also (Sosa-Cordero, Liceaga-Correa and Seijo 2008; Townsend and Shotton, 2008)

8 http://www.pescadorapescador.net/SCPP_VIGIA.pdf

9 This work was done under Liceaga´s direction in the *Laboratorio de Percepción Remota y SIG del cinvestav-Mérida*; its purpose is to obtain the largest data variability possible.

10 According to municipal wide statistics, by 2005 thirty per cent of the population fifteen to twenty four years of age had twelve years of schooling while only nine per cent had post-secundary studies (INEGI, 2005).

11 According to data from the Secretary of Public Education, in 2002-2003 the average years of schooling for Punta Allen was 8.3 years, due in part to the influx of people from other areas and in part to some of the youth finishing secondary school and going on to technical training or college. Illiteracy rates are estimated at 6.5 per cent, and centred mostly among the indigenous Mayan population. (SEMARNAT 2008)

12 The hand held GPS device used by the fishers includes buttons marked with abbreviations in English such as *Nav* for navigation; G for go to way point; MOB man overboard (used for recording new coordinates). It also has a small screen where a digitalised schematic map appears as well as a pointer. The GPS operator has the option of seeing the map close up or at a wide angle, a view that shows a larger area but in less detail. The introduction of this technology simultaneously includes language issues such as learning terms in English, interpreting abbreviations, and learning new ways to speak about tecnololgy, all topics worth pursuing.

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