Chapter 13

There must be a catch: participatory GIS in a Newfoundland fishing community

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> While the land has been seen by cultural geographers and others as layered with proprietary rights, use rights and cultural symbols, the water has been seen as empty.
>
> Jackson 1995

> That's a good idea to get the fishing grounds down on the charts. You know, its like I've got a map of the grounds in my head.
>
> Newfoundland fisherman 1995

13.1 INTRODUCTION

Five hundred years ago when John Cabot explored the coast of present day Atlantic Canada, he lowered a basket into the sea and pulled it out full of fish. Today, there are hardly enough codfish left to grace the dinner table in Newfoundland, Canada's easternmost province. Eight years have passed since the Atlantic Groundfish Moratorium was declared in 1992 and there are still too few cod in much of the region to permit commercial extraction. Beyond the environmental degradation that this stock collapse represents, the social impact has been devastating for fisheries-dependent communities, particularly those reliant on the traditional small-boat inshore harvest. Confronted by the ominous spectre of rotting skiffs, closing hospitals and massive out migration, many groups are working diligently to conserve remaining fisheries, such as lobster, and the traditional way of life that now depends on them. Before the crisis, the knowledge and concerns of fishers and their families were often disregarded – indeed marginalized – by biologists and ocean-related agencies. Now, communities expect to participate actively in every facet of fisheries science and management, especially where spatial and temporal limitations to harvesting may be implemented. This chapter describes a GIS project that evolved to link harvesters and government organizations in central Bonavista Bay, a historically strong fishing area on the northeast coast of Newfoundland. I discuss a collaborative project intended to capture local fisheries knowledge through participatory mapping aided by emerging geographic information technologies, principally, GIS.

13.2 CASE STUDY OVERVIEW

The research described here occurred over a three-year period (1994–1997) when I worked at Terra Nova National Park (see Figure 13.1) to explore conservation measures and related information needs for Bonavista Bay. Through the course of my research and employment with Parks Canada, I was invited to participate in small-boat fishing activities with local harvesters. I also facilitated a series of community meetings to discuss conservation measures. As a reaction to industry demands that government managers and conservation agencies acknowledge and incorporate local knowledge, I began organizing a GIS project to capture traditional fishing patterns. The

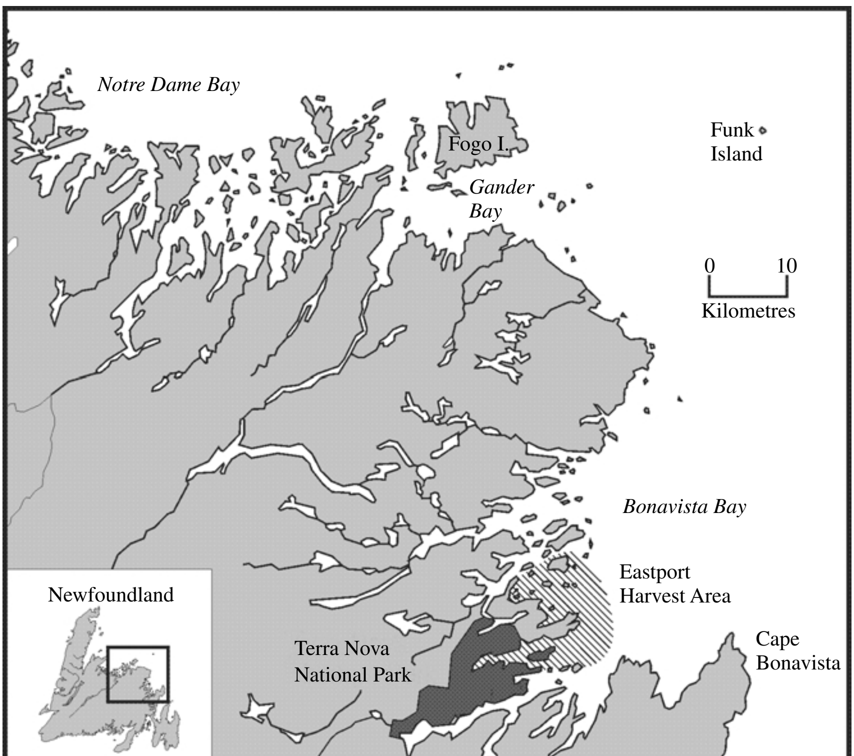

Figure 13.1 Bonavista Bay, Newfoundland.

project evolved as a collaborative effort with input from several government agencies, a local fishermen's committee, a GIS training programme and a software firm. Using digital topographic maps and newly collected hydrographic data, a prototype chart was customized for use in participatory mapping sessions where harvesters delineated fishing grounds, spatial management controls and local toponyms. Annotated charts were digitally rendered to produce composite maps that have since been used to help communicate fishing patterns.

13.3 BACKGROUND

13.3.1 Coastal Newfoundland and the collapse of a fishery

Typical of northeast Newfoundland, Bonavista Bay encompasses shoals and deep troughs, exposed shorelines, archipelagos and sheltered fjords. The cold waters of the Labrador Current support a wide variety of fish species as well as populations of North Atlantic seabirds, seals and whales. These resources have supported humans for over 7,000 years as evidenced by numerous archaeological sites. Europeans arrived for a seasonal fishery in the 1500s and settled permanently in the 1600s. Cod, the primary species harvested, was salted and dried for export markets by family enterprises until well into this century. Over time, larger fibreglass vessels replaced home-built wooden boats while monofilament nets supplanted hook and line gear. The intensification and expansion of the inshore sector was also accompanied by the imposition of an increasingly centralized management regime, new regulatory measures and scientific stock assessments. After Canada declared a 200-mile fishing zone in 1977, stern trawlers harvesting on the offshore banks delivered a welcome bounty to land-based processing plants.

All seemed fine until the early 1980s when fishers from the small boat inshore sector started to express concerns about declining catch rates and decreasing fish size (Neis 1992; Finlayson 1994). A considerable drop in biomass was finally detected in the offshore stocks towards the end of the 1980s (see Hutchings and Myers 1994; Finlayson and McCay 1998) and by 1992, the Atlantic Groundfish Moratorium was declared leaving close to 40,000 harvesters and plant workers without a livelihood. Life in post-moratorium Bonavista Bay carries on, but coastal communities' modern day dependence on the fishery has become painfully evident (e.g. see Woodrow 1998). The strengthening of other sectors such as aquaculture and tourism has been promoted, but many assert that coastal communities will survive only with a renewed fishery. Were it not for the lucrative lobster and crab fisheries that remain open, an entire way of life would be much eroded.

13.3.2 Dialogue on conservation

In the years immediately preceding the moratorium, Bonavista Bay was short-listed by Parks Canada as a candidate site for a national marine conservation area. Following some resource mapping and an 'experts workshop' the Bay was selected over three others to best represent the natural and cultural heritage of northeast Newfoundland (Mercier 1995). How would fish harvesters, the dominant stakeholder group in Bonavista Bay, react to such a proposal in a time of crisis? Would Newfoundland communities respond to participatory approaches successfully employed in other countries (e.g. Wells and White 1995)? Could local needs and priorities be reconciled with federal conservation goals? It became the responsibility of field staff to initiate local dialogue in an effort to answer these questions (see Macnab 1996; 1997).

From early discussions on the range of precautionary approaches available for marine resource management, no-take areas attracted considerable attention from harvesters, especially for the potential conservation of spawning fish, juveniles, sedentary species and supporting habitats. Instructive lessons from New Zealand and the tropics were conveyed by Parks Canada planning staff: resident species in areas set aside from harvesting will grow in size, increase egg production and replenish the surrounding fishery. The possibility that reserves could act as 'insurance policies' against overfishing (Ballantine 1995) received very little argument from fishers; however, where to establish such harvest refugia and how to make up for lost fishing space were questions not easily answered. Meanwhile, an assessment of marine resource data for the Bay showed that existing scientific knowledge was inadequate for a purely ecological approach to identifying and planning reserves. Information on human activities was also shown to be lacking. In particular, areas fished by small boats remained uncharted and unknown to those outside the fishery. To complicate matters, the existing nautical chart for the Bay, produced by the British Admiralty in 1869, was inaccurate, small-scaled and largely unsuitable for inventory purposes. Modern hydrographic surveys were in progress, but finished charts were estimated to be many years from publication.

Over time, it became evident that locally supported reserves would emerge through dialogue about conservation measures as they related to specific locations and fishing activities. On many occasions, fishers pointed to a spot on the chart explaining both the need for special protection and the likely displacement of fishing effort that would result. With very little scientific guidance available in the way of depth, bottom type or optimal placement, a group of fishers active in the waters adjacent to Terra Nova National Park began to discuss seriously the establishment of closed areas for lobster. Members of the Eastport Peninsula Inshore Fishermen's Committee eventually agreed that their fishery might benefit from trial closures. Harvesters started to discuss potential refugia based on local harvest patterns, observed oceanographic circulation and long-term knowledge of the lobster stocks.

13.3.3 Local marine knowledge

The rich knowledge base of resource users has been recognized as an important complement to scientific modes of inquiry for environmental management and protected area planning (e.g. Sadler and Boothroyd 1994; Pimbert and Pretty 1997). Mailhot (1993: 11) characterizes this knowledge as 'the sum of the data and ideas acquired by a human group on its environment as a result of the group's use and occupation of a region over many generations'. Johnson (1992) extends the definition to include 'nonindigenous groups such as outport fishermen' and describes three categories of knowledge: (i) a system of classification; (ii) a set of empirical observations about the local environment; and (iii) a system of self-management that governs resource use. Known by many names including traditional ecological knowledge (e.g. Berkes 1999), common sense geography (e.g. Egenhofer and Mark 1995) and indigenous knowledge (e.g. Warren *et al.* 1994), 'local knowledge' avoids some of the semantic and conceptual problems associated with other labels and is adopted here after Ruddle (1994).

Research on local knowledge systems in marine settings has been undertaken by a range of investigators, many of whom see it as essential for effective fisheries and coastal management regimes (e.g. Dyer and McGoodwin 1994; Jackson 1995; Neis and Felt 2000). The demands from non-governmental organizations, communities and scientists in Newfoundland are captured in the *Report of the Partnership for Sustainable Coastal Communities and Marine Ecosystems*:

> There is a neglect of fishers' information and an absence of serious efforts to use this to supplement scientific research. Partnerships should be established and supported between federal and provincial governments to develop appropriate databases for integrating scientific and traditional knowledge.
>
> National Round Table 1995: 32

What often goes missing in such broad calls, however, are the challenges of collection, veracity, analysis, application and ownership of local knowledge. Many researchers have suggested that local knowledge should be integrated or somehow blended with scientific forms of knowledge after collection and careful evaluation by 'outsiders' (e.g. DeWalt 1994; Murdoch and Clark 1994). Others argue that local knowledge is developed and transmitted *in situ*, and therefore must be captured and applied by people who live 'inside' the socio-cultural setting where it has evolved (e.g. Agrawal 1995; Heyd 1995; Chambers 1997). Is it really a 'black and white' case of scientific extraction versus community empowerment? Is there not some middle ground that could accommodate both of these perspectives? What if, as Fox (1990) argues for social forestry programmes, participatory research is conducted to help communities and outsiders 'learn about each other, develop a foundation for cooperation, and begin negotiating on the design and implementation of [resource] management plans' (120)?

13.3.4 Facilitated community inventories

Few would disagree that fishers and other customary users of marine resources have a substantial body of knowledge that could be useful for science and management, but if the information flow is only in one direction – knowledge extracted for use by outsiders – communities will most certainly be reluctant to contribute. If an inventory of local marine knowledge is to stimulate participant concern for resources and lead to stewardship activities, it must be community-based, and ideally, it should be community-driven: 'experience in Canada tells us that it is at the community level where the required actions to maintain coastal resources are implemented; it is from this level that the true effort springs' (Norrena 1994: 160). It is fine to have a conceptual notion of a community-driven inventory, but it is quite another thing to enable one. Unless such a plan originates at the community level, how is a community to become interested? There are also structural considerations. Communities should conduct their own studies, but with limited access to government information and cartographic production techniques, manual or digital, how can community groups best capture and display their own geographic knowledge?

Here, there is a definite role for collaborators, especially when it comes to technical assistance, project funding and linkages with scientific authorities. Where government participation is regarded with suspicion at the local level, academic researchers and NGOs have helped to gather and organize information with and for interested communities, often to support and reinforce traditional stewardship activities (e.g. see Fox 1990; Sirait *et al.* 1994; Berkes *et al.* 1995; Nietschmann 1995). A common element in many of these projects is the degree of control maintained by participating communities; coordination is provided by existing organizations (e.g. First Nation Elder Councils) and knowledge is often protected by some form of copyright. Problems of cross-cultural communication are lessened when local people collect knowledge and work as facilitators in their own communities (Brice-Bennett 1977). Outsiders might provide elicitation skills and technical support, but ideally, the knowledge is captured, held and applied by the community.

13.3.5 A role for geographic information technologies?

Local knowledge is often dismissed as being qualitative and unscientific, particularly within a positivist conservation paradigm that only considers opinion when it is stated in scientific terms (Pimbert and Pretty 1997). Does this hold true for the 'art, science and language' of cartography? Consider two case studies in which maps were used to depict local people's understanding of natural resources. Peluso (1995) describes constructive meetings between government mappers and Indonesian 'peasant groups' possessing legitimate and technically acceptable maps. Contrast the ready acceptance of these digitally enhanced forestry maps with the government rejection of sketch maps 'prepared by peasants' in an effort to claim lake portions of the Titicaca National Reserve in Peru (Orlove 1993).

When defined orally, or drawn without scale, orientation and formal grid reference, local knowledge remains anecdotal. Geographic information technologies provide a more technical and precise, if not more 'scientific', means of capturing the spatial components of local knowledge. When cognitive landscapes are inscribed and georeferenced in the field with affordable GPS, or merged with government maps and remotely sensed digital imagery, local knowledge assumes far more authority than possible with oral descriptions and simple sketch maps (e.g. see Bronsveld 1994; Conant 1994; Thomas 1994; Poole 1995; Dunn *et al.* 1997). Decreasing costs have permitted these technologies to be applied in ethnographic surveys and local knowledge documentation projects around the planet. Published applications include studies in forestry (Fox 1990; Cornett 1994; Sirait *et al.* 1994; Sussman *et al.* 1994; Peluso 1995), agriculture (Tabor and Hutchinson 1994; Gonzalez 1995; Harris *et al.* 1995; Lawas and Luning 1996) and indigenous land use (Duerden and Keller 1991; Poole 1995; Harmsworth 1998). In the marine realm, applications have been described for coral reef habitats (Stoffle *et al.* 1994; Nietschmann 1995; Calamia 1996), spawning fish (Ames 1997) and management regions (Clay 1996; Pederson and Hall-Arber 1999; St Martin 1999).

Suggesting that 'low quantitative salience' has prevented broad acceptance of social scientific data in fisheries, McGoodwin (1990) recommends that practitioners 'develop more rigorous techniques and the kind of data that will permit comparability, as well as integration, with other already formalized means of analysis' (187). GIS offers considerable promise in this regard. Information that was once dismissed by biologists as anecdotal (e.g. experiential knowledge of spawning sites) can be made more compatible with accepted 'scientific' forms of spatial knowledge (e.g. depth, temperature and salinity) through proper georeferencing.

13.3.6 The data challenge for coastal fisheries

Scientific mapping of the world's oceans and coasts has progressed remarkably in the last decade with the introduction of multi-beam hydrography, better remote sensing devices, enhanced digital processing equipment, GPS enabled navigation systems and GIS (Wright and Bartlett 2000). Generally though, our oceanic knowledge still pales by comparison with that of terrestrial environments. There are many reasons for this, not least of which are the challenges and expenses posed by a mobile ecosystem that demands mapping in four dimensions and a management regime that is administered by numerous agencies, each with distinct and at times redundant, conflicting and incompatible data collection programmes (Ricketts 1992; Furness 1994). Despite the limits to marine data collection and analysis, Bonavista Bay was subject to extensive surveying in the mid-1990s. Beyond the aforementioned hydrographic exercise, the Bay received a digital shoreline classification, hydro-acoustic and airborne stock assessments, visits by navy submersibles and telemetry tracking of fish implanted with acoustic devices. Still, with all of this ocean research and the proliferation of digital data that followed, there was minimal scientific knowledge of inshore fishing locations.

Fisheries scientists have adopted GIS for stock assessment and spatial analysis (e.g. Meaden and Chi 1996), but much of the newer work in fisheries GIS, particularly in Atlantic Canada, has been directed towards offshore areas where catch statistics and survey data are recorded with precise geographic coordinates (e.g. Mahon *et al.* 1998). Closer to shore, where small-boat fishers ply their trade over bottoms too rough for offshore sampling gear, GIS and related tools remain limited for the analysis of local fishing patterns. To begin with, harvesters report their catch by port of landing; logbook data recorded at this scale reveals little of fishing locations. Remote sensing instruments may help indicate fish stocks, important habitat (e.g. Simpson 1994) or boat locations, but they cannot detect how people are fishing or what they are catching. Similarly, land-use mapping, which relies upon the correspondence between land cover and land use (e.g. a field indicates agriculture), is not of much use for delineating fishing grounds – especially grounds which have not been fished since the moratorium was declared. Generally speaking, mapping human use of the world's oceans remains little practiced. Why? Activities on land are relatively fixed and basically two dimensional; by comparison, fishing activities are mobile and four dimensional (i.e. occurring at different times and levels in the water column). Furthermore, unlike a cut boundary or fence on land, or even a natural boundary, fishing territories cannot generally be detected, photographed or visited, and thus mapped, without some kind of local interpretation (e.g. Acheson 1979; Clay 1996). To collect such knowledge, two workable options appear to be available: (i) visit fishing locations and map the grounds with GPS and sounders (e.g. Nietschmann 1995); or (ii) map harvest areas from memory onto suitable hydrographic charts. The case study presented here details a project designed to work through the second option.

13.4 THE EASTPORT MAPPING PROJECT

13.4.1 Initiating the project

The idea for a fishing grounds inventory was discussed initially with the Chair of the Eastport Peninsula Inshore Fishermen's Committee. I had been investigating marine mapping for some time and had regularly communicated my findings to the Chair, so he was aware of recent hydrographic surveys and local mapping initiatives in other areas. While reviewing various charts with the Chair, his wide knowledge and local perspective were demonstrated with reference to specific locations. For example, while discussing some of the features that he had pointed out on an earlier lobster fishing trip, the Chair motioned to an inlet far too small for annotation on a government map. The inlet was known locally as 'Hospital Cove', named for a past fishers' practice of leaving sick and injured lobsters there to recover without the threat of capture. I suggested that we could relabel the maps with local names and add fishing patterns. My function, I explained, would be to provide the cartographic support necessary for such an undertaking; fishers would provide the information to be mapped.

The Committee Chair could see the value in documenting local knowledge, but would other fishers share his interest? To find out, the idea was presented at a committee meeting with a display of sample inventory maps from other jurisdictions. New hydrographic fieldsheets (1:20,000), which many fishers knew existed, but few had ever seen, were demonstrated alongside the familiar British Admiralty chart of the Bay. The inventory was presented not as an extractive government exercise or an impersonal academic survey, but as way for fishers to communicate their knowledge. Visualization by way of graphic display, I suggested, could demonstrate local concerns and help to identify conservation priorities to outside agencies. Attention was drawn to the copyright statement included on maps drawn by harvesters in Nova Scotia: 'This mapping series was compiled under the direction of the Guysborough County Community Futures Fisheries Sub-Committee and is now the property of the Guysborough County Inshore Fisherman's Association. The information and basemaps can only be duplicated or altered with permission of the Association.' The message was simple: fishers' knowledge leads to fishers' maps. The Chair borrowed these sample maps for the next committee meeting to gauge whether or not the larger membership agreed that harvest area mapping was a desirable undertaking. At that session, the committee discussed and endorsed the project. Afterwards, the Chair indicated formal acceptance of the inventory project and invited me to proceed.

13.4.2 Collaboration in GIS

The harvesters' proximity to Terra Nova National Park, a committee structure and keen interest, coupled with existing relationships and an established rapport made the Eastport group a strong candidate for collaboration. Initially, I believed that fishers could provide valuable information about sensitive areas and thus help to guide further scientific investigations and conservation planning efforts. Before long, the project focus shifted towards the committee's objective: harvest area maps for use in their own deliberations and in dealings with outside agencies. Parks Canada provided funding, computers, data and in-kind support for the project. The federal Department of Fisheries and Oceans, a central coordinating agency for coastal inventories, grew interested in the project and committed financial assistance; officials also wished to add the collected information to a Province-wide database. The research continued to evolve with digital contributions from several bodies including the Canadian Hydrographic Service and the Newfoundland Department of Natural Resources. Universal Systems Limited of Fredericton, New Brunswick, made available a complementary version of their CARIS software (Computer Aided Resource Information System), a GIS package that is installed and used widely in hydrographic offices and Canadian government organizations. Finally, instructors and displaced fisheries workers training for a GIS diploma provided technical assistance and plotting services.

13.4.3 Methods and procedures

As outlined earlier, I worked from Terra Nova National Park and met with fishers to explore their ideas for marine conservation. Participation in lobster and crab trips enabled me to see fishing patterns up close; it also demonstrated that I was genuinely willing to learn from harvesters. Spending time in boats with fishers also helped me become familiar with a substantial part of the seascape that was to be charted. Honesty, and perhaps my own experience as a commercial fisherman, led to an open exchange of ideas and information. In dry land map discussions involving digitally produced hydrographic data, which I was able to access easily through government sources, I was the specialist with something to contribute, but on the water, fishers were clearly the specialists possessed of their own unique brand of expertise.

Technical support was provided to the Eastport Fishermen's Committee in an interactive and adaptive fashion. It seemed opportune to take advantage of recent sounding data, digital topography and the possibilities enabled by GIS to create custom maps. Meetings were held with Committee members to review data sources, to demarcate the Eastport fishing territory and to determine basemap features. CARIS was then utilized to combine topographic and hydrographic data for the area. The intent was to build a geographic database that would reflect the members' worldview, a view that still relied on terrestrial features for navigation (e.g. Butler 1983) and experiential knowledge of water depths for fish detection and gear placement. By using the tools available within CARIS, it was possible to customize data according to the harvesters' wishes. For example, from metric soundings, depth contours were interpolated in fathoms, still the standard measure in the fishing industry. Successive topo-bathy maps were generated, plotted, reviewed by fishers and reworked to produce a 1:25,000 basemap depicting the Eastport harvest area.

To capture information about fishing grounds, individuals and small groups used Mylar to create thematic overlays. Knowledge elicitation and documentation methods were inspired by research in several fields including marine resource mapping (Butler *et al.* 1986), indigenous land-use and occupancy studies (Elias 1989; Usher *et al.* 1992; Robinson *et al.* 1994; Poole 1995; Huntington 1998), participatory rural appraisal (Chambers 1997; Townsley *et al.* 1997), toponomy (Canadian Permanent Committee on Geographical Names 1992; Gaffin 1994) and the bioregional movement (Aberley 1993). Many practitioners in these fields stress the importance of relaxed rapport and informal checklists of potential items to be mapped. As the outside 'specialist' in the Eastport project, I facilitated the mapping sessions, occasionally prompting for categories of information, but participants did the actual sketching and map delineation of features and activities. In most cases, fishers had a clear idea of what information they wished to capture. Mylar sheets were compiled for digitization and thematic entry. Draft place name and composite harvest area maps were then generated and laser-printed on 11″ × 17″ paper to enable low-cost reproduction and wide distribution. A set of these maps was returned to each participant for review and corrections.

13.4.4 Results and outcomes

Fishers were generally interested in the new hydrographic data and the potential of GIS, but for the most part, they were after printed maps that would portray traditional harvesting activities. Individuals and small-groups demonstrated tremendous above and below water environmental recall as they documented the harvest in water surrounding Eastport. Clearly, local knowledge – spatial, biological, technical, ecological and historical – continues to inform the cognitive basis of inshore fishing. There was a form of built-in peer review when mapping sessions were conducted by groups of fishers; as the information was filled in, the group automatically performed checks to make sure that the map was 'complete'. Group work also permitted those less comfortable with map reading to sit back and describe the fishing grounds while others charted the information. Longstanding fisheries such as those conducted for cod, lobster, squid and capelin received a considerable amount of attention. Amongst newer fisheries, skate, crab and lumpfish were easily charted. Emerging fisheries such as urchin and shrimp remain experimental and somewhat competitive. As a result, knowledge of these grounds was not shared. Women's impressions of fishing space and coastal environments were not captured in Eastport, though they have been elsewhere (e.g. Pocius 1992) and methods for gendered resource mapping are documented (e.g. Rocheleau *et al.* 1995).

Annotated maps showed that committee members continue to regulate fishing space within their communities by means of informal local boundaries, lottery-like draws for prime trap berths, individual tenure for lobster bottom and acceptance of local customs for net spacing. Much of this local area management is accomplished with toponyms used to denote bays, grounds, rocks, islands and landforms. That many of these smaller features are left unnamed on published maps came as no surprise to participants; however, that 24 names on the official topographic map were locally unrecognizable revealed as much about the cultural landscape as it did about government cartography. In many ways, the mapping process was far more valuable than the actual maps produced. The process helped government officials and harvesters move beyond concepts and theories to discuss real locations and pressing issues in the fishery. Combining information in an atmosphere of trust and openness helped to build common understandings of a shared marine environment. In the final analysis, maps and mapping were a catalyst for learning and action. A small number of government staff came to appreciate the complex psychological sea claim that fishers had in an area previously depicted as a series of crude ecological overlays (e.g. Mercier 1995). For harvesters, a certain pride evolved as the collective local knowledge base was revealed through mapping. The project maps were eventually used in community discussions and in meetings with scientists and managers to help establish lobster closures and to explain community-defined boundaries. Government agencies identified potential applications in coastal zone management such as oil spill planning and aquaculture siting.

13.5 LESSONS LEARNED

Collaboration, interaction and adaptation enabled people, knowledge and data to be assembled in this undertaking for far greater efficacy than would have been possible with individual efforts. Regrettably though, funding shortfalls, academic commitments, reporting deadlines, technical glitches and a variety of other factors limited the final outcomes of the exercise. There was a perception that mapping with digital data would somehow be quick and easy – this simply is not the case with multi-participant GIS projects. Government, community and educational collaborators had high hopes for the project. However, as with many GIS undertakings, the amount of lead-time in the Eastport project remained invisible. Participants asked the predictable question: 'We keep spending all of this time and money on GIS – why haven't we seen any useful maps yet?' Our collaboration with displaced fishery workers enrolled in a GIS training programme created additional problems. An informal partnership with the educational firm seemed cost effective and entirely appropriate at the outset, but when the company running the programme went bankrupt, staff and students dispersed without finishing the maps. A formal agreement requiring delivery of the maps might have prevented this unfortunate outcome. In summary, project champions must secure senior-level interest, funding support and staff commitments from one or more organizations if collaborative and participatory GIS projects are to succeed.

GIS provided for the adaptive improvement of basemaps, and in that fashion, it did assist in the documentation of local knowledge. We had the digital data and the right tools; it would have been a shame not to, as Tortell (1992) suggests, 'tailor-make' the printed map to meet the user's needs. Knowledge capture by and with fishers was faithful, but the filtering required to transfer the information into a GIS necessitated compilation and some interpretation. Generalization helped to produce a series of maps, but the subtleties of local context were inevitably lost as years of experience and layers of meaning were reduced to points, lines and polygons. Was the technical experimentation worth the effort? Yes, but a 'low-tech' approach utilizing existing paper charts would have freed up more time for participatory mapping and learning in the community. By drawing directly onto published basemaps and using manual compilation methods (e.g. Butler *et al.* 1986; Harrington 1999), an acceptable set of preliminary maps could have been generated quite quickly. Compilation sheets would have reproduced well on a blueprint machine and they could have been digitized at a later date for GIS treatment.

13.6 FUTURE OPPORTUNITIES

Now that the Eastport Fishermen's Committee has reviewed and corrected draft maps, additions and editing of the database can take place. Ideally, this would be followed by full-size colour plots annotated with appropriate copyright statements. Digital versions of the database are being considered for distribution on a CD. A growing number of harvesters operate home computers, so if the database is bundled with some form of shareware for viewing and simple queries, many more participants could access the collected knowledge. Several distribution issues remain, in particular, user agreements for electronic versions of the contributed local knowledge and the licensed government data. Given the shift towards new technology in the fishing industry (e.g. electronic navigation charts, GPS units, sounders) the potential for field truthing and continued documentation is unlimited. With due respect for potential conflicts, the project could also be expanded to include other user groups such as scuba divers and recreational boaters. Federal funding has been secured to undertake a larger inventory project in Bonavista Bay; if the agencies involved collaborate in an open and honest fashion, GIS and computer assisted visualization will continue to benefit inshore fishing communities.

POSTSCRIPT (JANUARY 2001)

Data access remains a challenge for inshore fishers in Eastport. The 500th anniversary of Cabot's arrival in Newfoundland accelerated the production of navigation charts for Bonavista Bay, but, unfortunately for resident fishers, the new charts (1:60,000) contain only a fraction of the information portrayed on the source-data fieldsheets (1:20,000). As it stands, the Parks Canada license to use hydrographic data does not permit further distribution of digital fieldsheets. A paper fieldsheet that cost approximately $16 in 1994 has recently jumped in price to $150, thereby making the set of five for Eastport prohibitively expensive and impractical for fishers. Some time after this GIS project was completed, Parks Canada launched a full study to assess the feasibility of a national marine conservation area in the waters of Bonavista Bay. The genuine two-way learning described here was difficult to continue at a community level once a formal advisory committee was established. The conservation area proposal met with growing opposition as locals grew suspicious of government agendas and in 1999, the feasibility assessment was terminated by the advisory committee. Eastport, however, has become a model for successful community-based fisheries management in Newfoundland (Rowe and Feltham 2000). Voluntary lobster reserves were eventually supported in regulations by the Department of Fisheries and Oceans. It is difficult to evaluate the role that mapping and GIS played in this process, but it is safe to conclude that information exchange and dialogue helped to create an environment where government could support community-driven conservation initiatives.

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REFERENCES

Aberley, D. (ed.) (1993) *Boundaries of Home: Mapping for Local Empowerment*, Gabriola Island: New Society Publishers.

Acheson, J. M. (1979) 'Variations in traditional inshore fishing rights in maine lobstering communities', in R. Anderson (ed.) *North Atlantic Maritime Cultures: Anthropological Essays on Changing Adaptations*, The Hague: Mouton Publishers, pp. 253–276.

Agrawal, A. (1995) 'Dismantling the divide between indigenous and scientific knowledge', *Development and Change* 26: 413–439.

Ames, E. P. (1997) *Cod and Haddock Spawning Grounds in the Gulf of Maine*, Island Institute, Rockland, Maine.

Ballantine, W. J. (1995) 'Networks of "No-Take" Marine Reserves are Practical and Necessary', in N. L. Shackell and J. H. M. Willison (eds) *Marine Protected Areas and Sustainable Fisheries*, Wolfville: Science and the Management of Protected Areas Association, pp. 13–20.

Berkes, F. (1999) *Sacred Ecology: traditional ecological knowledge and resource management*, Philadelphia: Taylor and Francis.

Berkes, F., Hughes, A., George, P. J., Preston, R. J., Cummins, B. D. and Turner, J. (1995) 'The persistence of aboriginal land-use: fish and wildlife harvest areas in the Hudson and James Bay lowland, Ontario', *Arctic* 48(1): 81–93.

Brice-Bennett, C. (ed.) (1977) *Our Footprints are Everywhere: Inuit Land Use and Occupancy in Labrador*, Nain: Labrador Inuit Association.

Bronsveld, K. (1994) 'The use of local knowledge in land use/land cover mapping from satellite images', *ITC Journal* 4: 349–358.

Butler, G. R. (1983) 'Culture, cognition, and communication: fishermen's location-finding in L'Anse-a-Canards, Newfoundland', *Canadian Folklore Canadien* 5(1–2): 7–21.

Butler, M. J. A., LeBlanc, C., Belbin, J. A. and MacNeill, J. L. (1986) *Marine Resource Mapping: An Introductory Manual*, Fisheries Technical Paper 274, Rome: Food and Agriculture Organization of the United Nations.

Calamia, M. A. (1996) 'Traditional ecological knowledge and geographic information systems in the use and management of Hawaii's coral reefs and fishponds', *High Plains Applied Anthropologist* 16(2): 144–164.

Canadian Permanent Committee on Geographical Names (1992) *Guide to the field collection of native geographical names*, Natural Resources Canada (http://geonames.nrcan.gc.ca).

Chambers, R. (1997) *Whose Reality Counts? Putting the first last*, London: Intermediate Technology Publications.

Clay, P. M. (1996) 'Management regions, statistical areas and fishing grounds: criteria for dividing up the sea', *Journal of Northwest Atlantic Fishery Science* 19: 103–126.

Conant, F. P. (1994) 'Human ecology and space age technology: some predictions', *Human Ecology* 22(3): 405–413.

Cornett, Z. J. (1994) 'GIS as a catalyst for effective public involvement in ecosystem management decision-making', in V. A. Sample (ed.) *Remote Sensing and GIS in Ecosystem Management*, Washington, DC: Island Press, pp. 337–345.

DeWalt, B. R. (1994) 'Using indigenous knowledge to improve agriculture and natural resource management', *Human Organization* 53(2): 123–131.

Duerden, F. and Keller, C. P. (1991) 'GIS and land selection for native land claims', *Operational Geographer* 10(4): 11–14.

Dunn, C. E., Atkins, P. J. and Townsend, J. G. (1997) 'GIS for development: a contradiction in terms?' *Area* 29(2): 151–159.

Dyer C. L. and McGoodwin, J. R. (eds) (1994) *Folk Management in the World's Fisheries: Lessons for Modern Fisheries Management*, Colorado: University Press of Colorado.

Egenhofer, M. J. and Mark, D. M. (1995) 'Naive Geography', in A. U. Frank and W. Kuhn (eds) *Spatial Information Theory: A Theoretical Basis for GIS*, Lecture Notes in Computer Sciences No. 988, Berlin: Springer-Verlag, pp. 1–15.

Elias, P. D. (1989) 'Rights and research: the role of social sciences in the legal and political resolution of land claims and question of aboriginal rights', *Canadian Native Law Reporter* 1: 1–43.

Finlayson, A. C. (1994) *Fishing for Truth: A Sociological Analysis of Northern Cod Stock Assessments from 1977–1990*, St John's: ISER Press.

Finlayson, A. C. and McCay, B. J. (1998) 'Crossing the threshold of ecosystem resilience: the commercial extinction of northern cod', in F. Berkes and C. Folke (eds) *Linking Social and Ecological Systems*, Cambridge University Press, pp. 311–337.

Fox, J. (1990) 'Diagnostic tools for social forestry', in M. Poffenberger (ed.) *Keepers of the Forest: Land Mangement Alternatives in Southeast Asia*, Quezon City: Ateneo De Manila University Press, pp. 119–133.

Furness, R. A. (1994) 'Data access for effective coastal zone management: a *cri du coeur* for openness', *Cartography* 23: 11–18.

Gaffin, D. (1994) 'The geographic identities of Faeroe islanders', *Landscape* 32(2): 20–27.

Gonzalez, R. M. (1995) 'KBS, GIS and documenting indigenous knowledge', *Indigenous Knowledge and Development Monitor* 3(1). Internet edition: http:// www.nuffic.nl/ciran/ikdm/3-1/articles/gonzalez.html.

Harmsworth, G. (1998) 'Indigenous values and GIS: a method and a framework', *Indigenous Knowledge and Development Monitor* 6(3). Internet edition: http://www.nuffic.nl/ciran/ikdm/6-3/harmsw.html.

Harrington, S. (ed.) (1999) *Giving the Voice a Land: Mapping Our Home Places*, Land Trust Alliance of British Columbia, Salt Spring Island, British Columbia.

Harris, T. M., Weiner, D., Warner, T. A. and Levin, R. (1995) 'Pursuing social goals through participatory geographic information systems: redressing South Africa's historical political ecology', in J. Pickles (ed.) *Ground Truth: The Social Implications of Geographic Information Systems*, New York: The Guildford Press, pp. 196–222.

Heyd, T. (1995) 'Indigenous knowledge, emancipation and alienation', *Knowledge and Policy* 8(1): 63–73.

Huntington, H. P. (1998) 'Observations on the utility of the semi-directive interview for documenting traditional ecological knowledge', *Arctic* 51(3): 237–242.

Hutchings, J. A. and Myers, R. A. (1994) 'What can be learned from the collapse of a renewable resource? Atlantic cod, *Gadus morhua*, of Newfoundland and Labrador', *Canadian Journal of Fisheries and Aquatic Sciences* 51: 2126–2146.

Jackson, S. E. (1995) 'The water is not empty: cross-cultural issues in conceptualising sea space', *Australian Geographer* 26(1): 87–96.

Johnson, M. (1992) *Lore: Capturing Traditional Environmental Knowledge*, Ottawa: IDRC.

Lawas, C. M. and Luning, H. A. (1996) 'Farmers' knowledge and GIS', *Indigenous Knowledge and Development Monitor* 4(1). Internet edition: http://www.nuffic.nl/ciran/ikdm/4-1/articles/lawas.html.

Macnab, P. A. (1996) 'Fisheries resources and marine heritage in Newfoundland: crisis, conservation and conflict', *Environments* 24(1): 106–115.

Macnab, P. A. (1997) 'Exploratory planning for a proposed national marine conservation area in Northeast Newfoundland', in G. Nelson and R. Serafin (eds) *National Parks and Protected Areas: Keystones to Conservation and Sustainable Development*, NATO ASI Series G, vol. 40, New York: Springer, pp. 133–143.

Mahon, R., Brown, S., Zwanenburg, K., Atkinson, B., Buja, K., Claflin, L., Howell, G., Monaco, M., O'Boyle, R. and Sinclair, M. (1998) 'Assemblages and biogeography of demersal fishes of the east coast of North America', *Canadian Journal of Fisheries and Aquatic Sciences* 55: 1704–1738.

Mailhot, J. (1993) 'Traditional ecological knowledge: the diversity of knowledge systems and their study', Background Paper No. 4, Montreal: Great Whale Public Review Support Office.

McGoodwin, J. R. (1990) *Crisis in the World's Fisheries: People, Problems and Policies*, Stanford: Stanford university Press.

Meadon, G. J. and Chi, T. D. (1996) 'Geographical information systems: applications to marine fisheries', Fisheries Technical Paper No. 356, Rome: Food and Agriculture Organization of the United Nations.

Mercier, F. (1995) 'Report of a workshop to identify a potential national marine conservation area on the NE coast of Newfoundland', in N. L. Shackell and J. H. M. Willison (eds) *Marine Protected Areas and Sustainable Fisheries*, Wolfville: Science and the Management of Protected Areas Association, pp. 240–248.

Murdoch, J. and Clark, J. (1994) 'Sustainable Knowledge', *Geoforum* 25(2): 115–132.

National Round Table on the Environment and the Economy (1995) *The Report of the Partnership for Sustainable Coastal Communities and Marine Ecosystems in Newfoundland and Labrador*, Ottawa: NRTEE.

Neis, B. (1992) 'Fishers' ecological knowledge and stock assessment in Newfoundland', *Newfoundland Studies* 8(2): 155–178.

Neis, B. and Felt, L. (eds) (2000) *Finding Our Sea Legs: Linking Fishery People and Their Knowledge with Science and Management*, St John's: ISER Press.

Newfoundland fisherman (1995) Comment from an inshore fisherman at a meeting convened by the author on Fogo Island, Newfoundland, Winter 1995.

Nietschmann, B. (1995) 'Defending the miskito reefs with maps and GPS: mapping with sail, scuba, and satellite', *Cultural Survival Quarterly* 18(4): 34–37.

Norrena, E. J. (1994) 'Stewardship of coastal waters and protected spaces: Canada's approach', *Marine Policy* 18(2): 153–160.

Orlove, B. (1993) 'The ethnography of maps: the cultutral and social contexts of cartographic representation in Peru', *Cartographica* 30(1): 29–46.

Pederson, J. and Hall-Arber, M. (1999) 'Fish habitat: a focus on New England fishermen's perspectives', *American Fisheries Society Symposium* 22: 188–211.

Peluso, N. L. (1995) 'Whose woods are these? Counter-mapping forest territories in Kalimantan, Indonesia', *Antipode* 27(4): 383–406.

Pimbert, M. P. and Pretty, J. N. (1997) 'Parks, people and professionals: putting "participation" into protected-area management', in K. B. Ghimire and M. P. Pimbert (eds) *Social Change and Conservation: Environmental Politics and Impacts of National Parks and Protected Areas*, London: Earthscan Publications Ltd, pp. 297–330.

Pocius, G. L. (1992). *A Place to Belong: Community Order and Everyday Space in Calvert, Newfoundland*. Montreal: McGill-Queen's University Press.

Poole, P. (1995) 'Indigenous peoples, mapping & biodiversity conservation: an analysis of current activities and opportunities for applying geomatics technologies', Biodiversity Support Program Discussion Paper Series, Washington: WWF; The Nature Conservancy; World Resources Institute.

Ricketts, P. J. (1992) 'Current approaches in geographic information systems for coastal management', *Marine Pollution Bulletin* 25(1–4): 82–87.

Robinson, M., Garvin, T. and Hodgson, G. (1994) *Mapping How We Use Our Land: Using Participatory Action Research*, Calgary: Arctic Institute of North America, University of Calgary.

Rocheleau, D., Thomas-Slayter, B. and Edmunds, D. (1995) 'Gendered resource mapping: focusing on women's spaces in the landscape', *Cultural Survival Quarterly* 18(4): 62–68.

Rowe, S. and Feltham, G. (2000) 'The eastport lobster project', in B. Neis and L. Felt (eds) *Finding Our Sea Legs: Linking Fishery People and Their Knowledge with Science and Management*, St John's: ISER Press, pp. 236–245.

Ruddle, K. (1994) 'Local knowledge in the folk management of fisheries and coastal marine environments', in C. L. Dyer and J. R. McGoodwin (eds) *Folk Management in the World's Fisheries: Lessons for Modern Fisheries Management*, Colorado: University Press of Colorado, pp. 161–206.

Sadler, B. and Boothroyd, P. (eds) (1994) *Traditional Ecological Knowledge and Environmental Impact Assessment*, Vancouver: University of British Columbia.

Simpson, J. J. (1994) 'Remote sensing in fisheries: a tool for better management in the utilization of a renewable resource', *Canadian Journal of Fisheries and Aquatic Sciences* 51: 743–771.

Sirait, M., Prasodjo, S., Podger, N., Flavelle, A. and Fox, J. (1994) 'Mapping customary land in East Kalimatan, Indonesia: a tool for forest management', *Ambio* 23(7): 411–417.

St Martin, K. (1999) 'From models to maps: the discourse of fisheries and the potential for community management in New England', Unpublished dissertation, Clark University.

Stoffle, R. W., Halmo, D. B., Wagner, T. W. and Luczkovich, J. J. (1994) 'Reefs from space: satellite imagery, marine ecology, and ethnography in the Dominican Republic', *Human Ecology* 22(3): 355–378.

Sussman, R. W., Green, G. M. and Sussmen, L. K. (1994) 'Satellite imagery, human ecology, anthropology, and deforestation in Madagascar', *Human Ecology* 22(3): 333–354

Tabor, J. A. and Hutchinson, C. F. (1994) 'Using indigenous knowledge, remote sensing and GIS for sustainable development', *Indigenous Knowledge and Development Monitor* 2(1). Internet edition: http://www.nuffic.nl/ciran/ikdm/2-1/articles/tabor.html

Thomas, G. (1994) 'Traditional ecological knowledge and the promise of emerging information technology', *Nature and Resources* 30(2): 17–21.

Tortell, P. (1992) 'Coastal zone sensitivity mapping and its role in marine environmental management', *Marine Pollution Bulletin* 25: 88–93.

Townsley, P., Anderson, J. and Mees, C. (1997) 'Customary marine tenure in the South Pacific: the uses and challenges of mapping', *PLA Notes* 30.

Usher, P. J., Tough, F. and Galois, R. (1992) 'Reclaiming the land: Aboriginal title, treaty rights and land claims in Canada', *Applied Geography* 12: 109–132.

Warren, D. M., Brokensha, D. and Slikerver, L. J. (eds) (1994) *Indigenous Knowledge Systems: The Cultural Dimension of Development*, London: Intermediate Technology Publications.

Wells, S. and White, A. T. (1995) 'Involving the community', in S. Gubbay (ed.) *Marine Protected Areas: Principles and techniques for management*, London: Chapman and Hall, pp. 61–84.

Woodrow, M. (1998) 'A case study of fisheries reduction programs during the Northern Cod Moratorium', *Ocean and Coastal Management* 39: 105–118.

Wright, D. J. and Bartlett, D. J. (2000) *Marine and Coastal Geographical Information Systems*, Philadelphia: Taylor and Francis.