Secretariat of the Pacific Community

ISSN 1025-7497

Issue 33 – June 2014

TRADITIONAL

Marine Resource Management and Knowledge

information bulletin

Inside this issue

Editor

Kenneth Ruddle
Asahigaoka-cho 7-22-511
Ashiya-shi
Hyogo-ken
Japan 659-0012
Email: mb5k-rddl@asahi-net.or.jp

Production
Fisheries Information Section
SPC, BP D5, 98848 Noumea Cedex
New Caledonia
Fax: +687 263818
Email: cfpinfo@spc.int
www.spc.int/coastfish

Produced with financial assistance from Australia, France and New Zealand

Editor's note

This edition contains three contributions. The first, "Developing a common understanding of taxonomy for fisheries management in north Vella Lavella, Solomon Islands," Philippa Cohen and seven co-authors document the local language names and etymology of marine fishes and invertebrates. Such studies are important because it is essential that partners in any management undertaking share a comprehensive working knowledge of local nomenclature and etymologies. Otherwise, it would not be hard to imagine that effective management, good collaboration and participatory action research would all likely be undermined. However, documenting local language names and etymologies is neither quick nor simple, as exemplified by the work presented here and described succinctly in the authors' section on methodology.

I would like to take this opportunity to encourage both more field research on local language names and etymology throughout the region and, to ensure prompt dissemination, suggest that the results be submitted for publication to this Information Bulletin. Such research might seem a bit "quaint" and, therefore, be hard to publish in more academically oriented Western journals. In contrast, this Information Bulletin circulates research results quickly within the region where they will be put to immediate practical use and hopefully serve to benefit various types and aspects of fisheries management.

The second article, "Research design and data collection for land use and occupancy mapping", by Terry Tobias, is based on his two decades of highly practical cartographic work with aboriginal communities in Canada and more recently in Australia. This article addresses various issues and problems related to the collection of interview data on the traditional use of resources and occupancy of lands, and the presentation of those data cartographically. In other words, it deals with the geography of oral tradition and the mapping of culture and community resources, which is of great direct relevance to the design and management of community projects in Pacific Islands. Through a discussion of some key factors that lead to successful community mapping, this contribution provides many ideas and recommendations for producing good quality and useful maps. In particular, the concepts of "map biography" and "thematic map" are introduced, and obtaining quality data and avoiding the "museum approach" to mapping are emphasised. Obtaining and training good personnel, taking control of research designs and respecting workers' limitations are examined. Some characteristics of projects are discussed, along with the principles that guide research design and implementation, the measures of quality, and the culture of research.

In the third article, "Maximum sustained yield: A policy disguised as science", Carmel Finley and Naomi Oreskes present historical evidence that the "tragedy of the commons" does not explain overfishing. Rather, study of post-WW2 fisheries policies and management shows that the collapse of world fisheries was the result of deliberate policies of industrialised nations, particularly the USA, which opposed any controls on territorial seas that might restrict travel by US vessels. In other words, governments had a substantial role in establishing policies that encouraged the building and expansion of a global fishing industry, despite evidence of severe overfishing. Such historical analyses provide yet further evidence of the now familiar subterfuge.

Kenneth Ruddle

Original text: English

Secretariat of the Pacific Community, Fisheries Information Section
BP D5, 98848 Noumea Cedex, New Caledonia
Telephone: +687 262000; Fax: +687 263818; cfpinfo@spc.int; http://www.spc.int/coastfish

Developing a common understanding of taxonomy for fisheries management in north Vella Lavella, Solomon Islands

Philippa Cohen[1,2], Scotta Tapala[3], Alik Rikio[3], Elton Kukiti[3], Frederick Sori[3], Zelda Hilly[1], Timothy J. Alexander[1,4], Simon Foale[5]

Introduction

Natural resources throughout the Pacific are increasingly being managed through community-based and collaborative arrangements. Arrangements for coastal ecosystems in particular are often developed by local communities in partnership with government, research and / or non-governmental organisations (Govan 2009). These collaborative initiatives seek to combine traditional and local knowledge and institutions with contemporary science and management practices.

Many scholars have highlighted the importance of local and traditional institutions and knowledge to contemporary management efforts in the Pacific (e.g. Hamilton and Walter 1999; Hviding 1991; Johannes et al. 2000). Understandings of reproduction, behaviour and movement patterns of fish and invertebrates affect how people think about the causes of resource decline, the impacts of fishing, and the likely effects of management. However, local and traditional ecological knowledge is often focused on ways of maximising catch and fishing efficiency (Foale 1998b). Therefore, for objectives associated with improved long-term sustainability, scholars argue that local and traditional knowledge should be integrated with contemporary "western" fisheries science and management practices (Foale et al. 2011). The process of integrating local and contemporary knowledge systems will influence the "fit" of management to the local context, and whether management is considered by all parties to be community-driven and participatory. This can, in turn, influence the longer-term success of management.

It is increasingly recognised that in many situations people who use and rely on natural resources also possess the rights to implement management, as well as the expertise to inform management (Berkes 2009). In addition, for management solutions to be both appropriate and effective they must adapt to both different contexts and through time as circumstances change or new information becomes available. These are the foundations of adaptive community-based and co-management approaches (Olsson et al. 2004). Within the framework of co-management, participatory action research seeks to take these ideas a step further in explicitly recognising local experts as research partners in ongoing, and relatively long-term, management and learning. In this regard we take insight from Drew (2005), who suggests that "the use of traditional ecological knowledge in a conservation [or resource management] program is not about a one-time extraction of information. Instead, its use presents the opportunity for a long-term collaboration and development of information". For the management of marine resources, a fundamental and essential starting point is to develop a common understanding of local fish and invertebrate nomenclature, etymology and taxonomic systems (Ruddle 1994).

In this study, researchers from WorldFish (an international, non–profit research organisation) worked with local fisheries experts to document local language names and etymology of marine fishes and invertebrates. This inventory of local names was then aligned with their Latin names and the scientific (i.e. Linnaean) taxonomic classification. In this paper we reflect on the importance of management partners having a good working knowledge of local nomenclature and etymologies for effective management, collaboration and participatory action research.

Study site and methods

Research was conducted in three villages in the Jorio region in the north of Vella Lavella Island (Fig. 1). North Vella Lavella is the focus of ongoing partnerships between WorldFish and local communities to establish community-based adaptive

1 WorldFish, P.O. Box 438, Honiara, Solomon Islands. Ph: +677 250 90, Fax: +677 232 96, email: p.cohen@cgiar.org
2 ARC Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, Australia
3 Leona and Paramatta Resource Management Committee, Vella Lavella, Solomon Islands
4 Department of Fish Ecology and Evolution, Centre of Ecology, Evolution and Biogeochemistry, EAWAG Swiss Federal Institute of Aquatic Science and Technology, Kastanienbaum, Switzerland
5 Department of Anthropology, Archaeology and Sociology, School of Arts and Social Sciences, James Cook University, Townsville, Australia

management of marine resources. This collaborative management process has been underway since 2008. In its early stages, consultations with the community focused on local governance systems, resource status and fisheries issues. These formed the foundations of further discussions to develop and implement appropriate management arrangements. As part of these arrangements, data collection, monitoring and reviewing were implemented to build knowledge, promote learning-by-doing, and facilitate adaptive management. Developing an understanding of local language and taxonomies was both a preliminary and an ongoing activity.

The language spoken on Vella Lavella is Vekala, encompassing Bilua (pronounced "mbilua"), which is the most common and best-described dialect. The name Bilua is most often used (more commonly than Vekala) to refer to the language of Vella Lavella (Obata 2003). Speakers distinguish the particular form of Bilua spoken in Jorio (and three other regions of north Vella Lavella) by its "singing tone", and consider other dialects to be more monotonous. The earliest attempts to document Bilua were by Methodist missionaries who compiled a dictionary to aid in translating the Bible (Methodist church, circa 1950s). From an anthropological and linguistic perspective, Bilua is particularly interesting because it is one of relatively few Papuan languages in Solomon Islands (i.e. most languages are Austronesian). This indicates that it did not originate from the Austronesian migration, but rather from a single language spoken on the New Guinea mainland about 50,000 years ago, which over time diverged into Papuan languages (Lynch 1998; Obata 2003).

In several survey periods between 2010 and 2013 (totalling three months) fish and invertebrate landings were recorded using local species names. Sampling was conducted mostly by youths from the communities with an interest in management. These local researchers were provided with training, and worked alongside WorldFish researchers. For each landing, the catch was recorded using Bilua names. Throughout the same research period unstructured interviews were also conducted with key informants (approximately 10) and informal focus group discussions (approximately 10) were held with fishers to further document and understand the Bilua naming system. Interviews and discussions were conducted in Pijin. To prompt and guide discussions we used names of fish and invertebrates identified in catch surveys, and photographic books with taxonomic descriptions for fish (Allen et al. 2003), invertebrates and marine plants (Allen and Steene 1994). In these discussions, we aimed to determine or verify spelling and pronunciation, species included in each local taxon, relationships between taxa (e.g. whether they were classed in the same "family"), etymology (i.e. origins and meaning of the name), and any variations in names. Most discussions were held with groups of men or with mixed groups; however, species targeted by gleaning were verified in discussions with women only. We also explicitly sought older respondents, particularly in the later stages of the data collection, to verify names and etymology. There are some limitations to our method of using photographs to prompt names, which may be unreliable in some cases. Therefore, where possible we also verified local names with fishers at landing sites by observing examples of freshly caught fish.

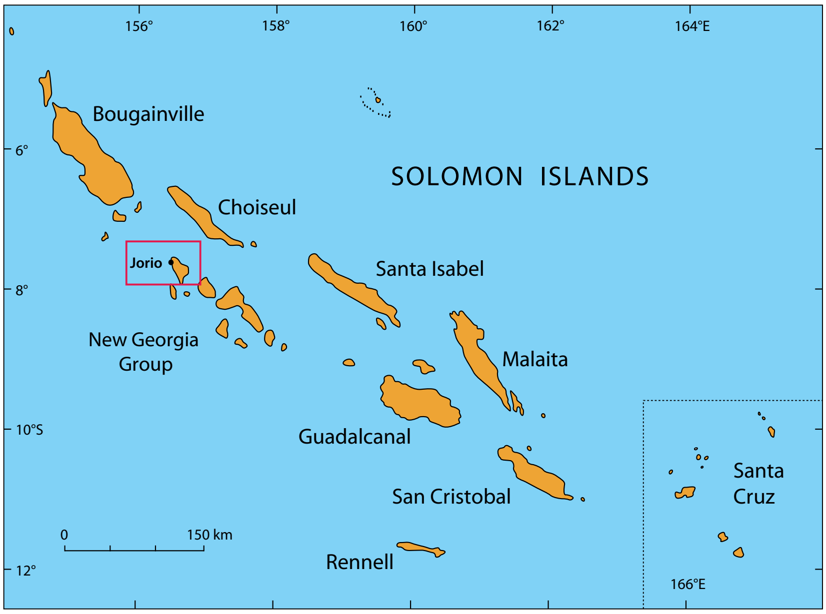

Figure 1. Location of the study region of Jorio in north Vella Lavella, Solomon Islands.

Results

Pronunciation was found to be consistent with that described by the Bilua dictionary (Methodist church, ca 1950s). Vowels are pronounced as follows: "a" as in *far*, "e" as in *end*, "i" as in *see*, "o" as in *low*. Consonants "b", "d" and "j" are pre-nasalised as (mb), (nd) and (nj), respectively. "N", "ng" and "q" are pronounced as n as in not, ng as in *singing* and ng as in *linger*, respectively.

We documented 139 unique Bilua names for bony and cartilaginous fishes and 62 for crustaceans, molluscs, algae and others organisms (Appendix 1), and were able to document etymologies for 48 of those names. In many cases where etymology was not given, respondents were unable to explain the origins of the word and answered that "this is just a name" and / or stated that the elders must have had their reasons for choosing and using that name but they did not have that knowledge now. For names where etymology was provided, most referred to morphology (n = 17) or colour (n = 13) of the fish or invertebrate. The remaining etymologies related to behaviour (n = 7), habitat (n = 2), ecology (n = 1), taste (n = 1) or function (n = 1) (i.e. of a shell for scraping). In several cases, meanings of the name could be provided, but respondents were unclear how that meaning related to the fish or invertebrate. We identified four species for which different Bilua names were assigned based on size (Figure 2).

Discussion

There have long been concerns across the Pacific about the demise of ecological knowledge of historical or cultural origins (Johannes 1981). Indeed, this is one reason why documenting local ecological knowledge is considered to be so important (Foale 2006; Johannes et al. 2000). The etymological data we collected were not as rich as those captured by similar studies in other provinces of Solomon Islands (Foale 1998b; Hviding 2005). Although further research in other areas of Vella Lavella may reveal additional etymologies, it was notable that respondents in this study frequently commented that although fishers had a comprehensive knowledge of names, the reasons for and meaning behind those names had been lost with the passing of elders. We also recorded Pijin, Roviana and eastern Vella Lavella terms used in taxonomies, and at times respondents found it difficult to clarify or identify the Bilua name used in Jorio. We were unable to determine if this is a consequence of the demise or evolution of the Bilua language. Notably however, Obata (2003) made similar observations of the integration of Pijin with Bilua, and went on the describe the language as being "endangered". The nomenclature presented here, therefore, represents "names in use".

Local taxonomies can be very detailed and structurally complex. In particular, nomenclature is often richest where taxa have an economic or subsistence fisheries value (Berlin et al. 1973; Foale 1998a). Our method specifically focused on taxa recorded in catch landings, so was biased towards fish and invertebrates that had some fisheries value. Nonetheless, during discussions where books were used as prompts, we also found that a detailed taxonomy was offered for groups of species of direct fisheries value, with less detail for those that were not. For example, 15 different names were provided for snappers, whereas only one was offered for gobies.

International publications or comparisons of ecological responses to fisheries management that span regions may require species to be identified with a Latin / Greek name and scientific (Linnaean) taxonomic naming systems. Translation of local names to corresponding scientific names may be straightforward for single species fisheries. However, throughout the Pacific, small-scale fisheries are typically multi-species. Translating data collected using local taxonomies into corresponding species is either complicated or impossible because a single species may have multiple local names, or a local name may include multiple species. Bilua names aligned with a single species in 64 cases of fish and 36 cases of non-fish species. Two or more individual species were lumped into one Bilua name in 59 cases of fish and 2 non-fish species. A generic, genus or family level Bilua name applied to fish in 19 cases and to non-fish species in 16 cases. We also found another dimension to nomenclature in that names aligned with species were also split into size classes in several cases (Fig. 2 and *Dermochelys coriacea*, *Bolbometopon muricatum* and *Monotaxis grandoculis*).

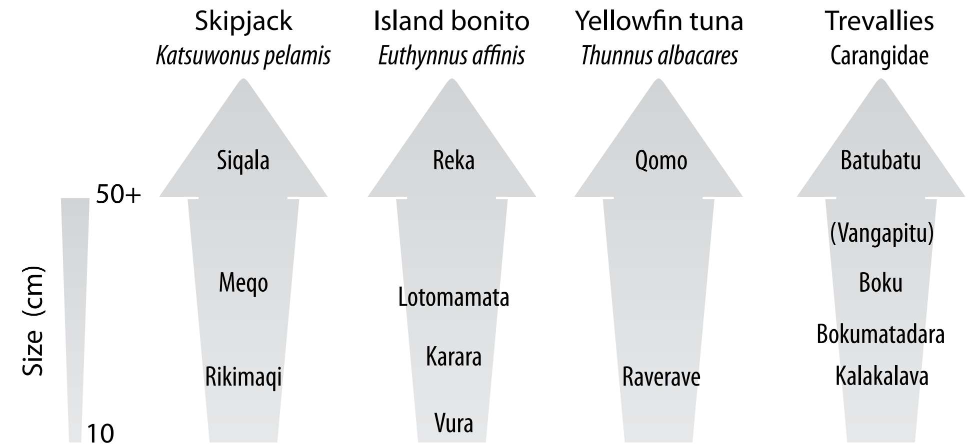

Figure 2. Species and size-structured Bilua naming system for skipjack, island bonito, yellowfin tuna and trevally. Some respondents suggested that the smaller and larger form of vangapitu is boku and batubatu, respectively. Yet, kalakalava and bokumatadara are considered to be different from vangapiku, thus their larger size classes are boku and bokumatadara, respectively.

There are difficulties in translating data collected using local taxonomies into internationally acceptable, scientific nomenclature, and this may restrict species-level analyses or comparisons (of fisheries data for example) across geographies. Nonetheless, the use of local names in this research programme still allowed for the scientific exploration and publication of family level fisheries data (e.g. Cohen and Alexander 2013). Additionally, using local taxonomies allowed for higher levels of local participation in data collection, interpretation and reporting. When research on multi-species fisheries insists on the use of scientific naming systems, only individuals with a high level of standard scientific training can fully participate. Therefore, where scientific nomenclature is used exclusively for data collection, research and monitoring, this will necessarily minimise local involvement and knowledge input, and may therefore be detrimental to the level of participation considered essential for community-based adaptive management approaches. Working with both scientific and local nomenclature has substantial benefits for both research and participation.

This work provided an important foundation for an ongoing partnership of learning about local fisheries, local understandings of fisheries, and assessing management performance in north Vella Lavella. The research represents an early step in a participatory action research partnership between WorldFish and communities in Vella Lavella, where community representatives are considered as co-researchers. Although the results of this study are of most direct value to research and management conducted in Vella Lavella, the research strategy and methodology are relevant to improving the collaboration and learning that are essential given the importance of community-based management throughout the Pacific.

Acknowledgements

We are very grateful to the fishers who contributed to discussions on fish taxonomy and the broader communities for allowing this research to take place. We are grateful to Steven Sibiti, Ronnie Posala, Anne-Maree Schwarz and Joelle Albert for assistance in collating preliminary data. This work was supported by an Australian Research Council Discovery Project grant (DP0987537), an Australian Centre for International Agricultural Research grant (FIS/2012/056) and the Consultative Group on International Agricultural Research (CGIAR) Research Program on Aquatic Agricultural Systems

References

Allen G. and Steene R. 1994. Indo-Pacific Coral reef field guide. Tropical Reef Research, Singapore.

Allen G., Steene R., Humann P. and Deloach N. 2003. Reef fish identification. Tropical Pacific. New World Publications: Jacksonville, FL.

Berkes F. 2009. Evolution of comanagement: Role of knowledge generation, bridging organizations and social learning. Journal of Environmental Management 90:1692–1702.

Berlin B., Breedlove D.E. and Raven P.H. 1973. General principles of classification and nomenclature in folk biology. American Anthropologist 75: 214–242.

Cohen P.J. and Alexander T.J. 2013. Catch rates, composition and fish size from reefs managed with periodically harvested closures. PLoSONE 8, e73383.

Drew J.A. 2005. Use of traditional ecological knowledge in marine conservation. Conservation Biology 19:1286–1293.

Foale S.J. 1998a. What's in a name? An analysis of the West Nggela (Solomon Islands) fish taxonomy. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 9:2–19.

Foale S.J. 1998b. Assessment and management of the trochus fishery at West Nggela, Solomon Islands: An interdisciplinary approach. Ocean and Coastal Management 40:187–205.

Foale S.J. 2006. The intersection of scientific and indigenous ecological knowledge in coastal Melanesia: Implications for contemporary marine resource management. International Social Science Journal 58:129–137.

Foale S., Cohen P., Januchowski-Hartley S., Wenger A. and Macintyre M. 2011. Tenure and taboos: Origins and implications for fisheries in the Pacific. Fish and Fisheries 12:357–369.

Govan H. 2009. Achieving the potential of locally managed marine areas in the South Pacific. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 25:16–25.

Hamilton R. and Walter R. 1999. Indigenous ecological knowledge and its role in fisheries research design: A case study from Roviana Lagoon, Western Province, Solomon Islands. Secretariat of the Pacific Community Traditional Marine Resoure Management and Knowledge Information Bulletin 11:13–25.

Hviding E. 1991. Traditional institutions and their role in the contemporary coastal resource management in the Pacific Islands. NAGA 14:3–6.

Hviding E. 2005. Reef and rainforest: An environmental encyclopedia of Marovo Lagoon, Solomon Islands / Kiladi oro vivineidi ria tingitonga pa idere oro pa goana pa Marovo, 2nd ed. UNESCO - LINKS, Paris.

Johannes R.E. 1981. Words of the lagoon: Fishing and marine lore in the Palau District of Micronesia. University of California Press, Berkeley.

Johannes R.E., Freeman M.M.R. and Hamilton R. 2000. Ignore fishers' knowledge and miss the boat. Fish and Fisheries 1: 257–271.

Lynch J. 1998. Pacific languages: An introduction. University of Hawaii Press, Honolulu.

Methodist church. circa 1950s. Bilua dictionary; Vella Lavella, British Solomon Islands Protectorate.

Obata K. 2003. A grammar of Bilua: A Papuan language of the Solomon Islands. Research School of Pacific and Asian Studies, The Australian National University, Canberra.

Olsson P., Folke C. and Berkes F. 2004. Adaptive comanagement for building resilience in social-ecological systems. Environmental Management 34:75–90.

Ruddle K. 1994. Local knowledge in the future management of inshore tropical marine resources and environments. Nature and Resources 30:28–37.

Appendix 1 – Bilua language (north Vella Lavella) marine taxonomy

1. Bony fish (generic name for fish is niuniu)

Acanthuridae – surgeonfish

Seki: *Acanthurus pyroferus, Acanthurus nigrofuscus, Acanthurus olivaceus*, etc.
Comments: Includes numerous acanthurids, but certain species are named "berava" and "sibi".

Berava: *Acanthurus lineatus*
Etymology: "berava" also refers to plate coral, perhaps in reference to the similarly flat and round shape and / or the stripes.
Comments: Type of seki.

Sibi: *Acanthurus olivaceus, Acanthurus achilles, Acanthurus leucocheilus*, etc.
Etymology: "sibi" = black, referring to the body colour
Comments: Type of seki. Sibi are larger seki.

Seqepe: *Naso lituratus*

Pakesana: *Naso unicornis, Naso brachycentron*

Kobai: *Acanthurus auranticavus, Acanthurus bariene, Acanthurus dussumieri*, etc.
Comments: Type of seki. Kobai are larger seki.

Toqilo: *Acanthurus triostegus*
Etymology: "toqilo" = "to pick" or "poke", referring to the way this fish eats.
Comments: Also referred to as "koelava" although "toqilo" is the name from the region. Not considered to be a type of seki.

Koelava: *Acanthurus triostegus*
Comments: Also referred to as "toqilo", "koelava" is the name from eastern Vella Lavella. Not considered to be a type of seki.

Parameqo: *Naso hexacanthus, Naso lopezi, Naso annulatus*, etc.
Etymology: "para" = type of tree, "meqo" = a striped belly (such as that of bonito)
Comments: Some people used the name "kokoapa".

Balistidae – triggerfish

Bubuku: *Balistapus undulatus*
Comments: May include other species.

Barubaru: *Melichthys vidua, Melchthys indicus, Melichthys niger*
Comments: Type of bubuku.

Narataka: *Odontus niger*
Etymology: "nara" = dirty, "taka" = teeth
Comments: Type of barubaru and bubuku.

Paqole: *Balistoides viridescens, Balistoides conspicullum, Pseudobalistes fucus*, etc.
Etymology: "qole" = "old man" or "old woman"
Comments: Type of barubaru and bubuku. Full name may be "petu paqole"; sometimes also referred to in Roviana as "makoto".

Pisuka paqole: *Pseudobalistes flavimarginatus*
Etymology: "pisuka" is the name of a red-orange coloured fruit, and this refers to the orange mouth.
Comments: Type of paqole.

Kororo: *Rhinecanthus aculeatus, Rinecanthus lunula, Rinecanthus rectangulus*, etc.
Comments: Type of bubuku.

Caesionidae – fusiliers

Zaruniuniu: Generic name for Caesionidae
Etymology: "zaru" = reef, and "niuniu" = fish, refers to the fish associating with the reef.

Qajolo: *Gymnocaesio gymnoptera*

Vaqosipuku: *Caesio cuning, Caesio teres, Caesio xanthonota*
Etymology: "vaqo" = yellow, "sipiku" = tail
Comments: Type of zaruniuniu. Also referred to as "manovaki ko niuniu" or "manovaki niuniu", as in the fish that the manovaki bird (i.e. sea eagle) eats; "manovaki ko niuniu" also applies to Cheilinus trilobatus.

Scaridae – parrotfish

Leozo: *Chlorurus strongycephalus*

Sivoli: *Cetoscarus bicolor, Scarus prasiognathos, Scarus rubroviolaceus*, etc.
Comments: Name is general to blue parrotfish. Also referred to as "bulu niuniu" = "blue fish".

Nioulao: *Scarus oviceps, Scarus schlegeli, Scarus psittacus*, etc.
Comments: A general name referring to the initial small, brown phase of parrotfish.

Pusana: *Chlorurus bleekeri, Scarus prasiognathos, Calotomus carolinus*

Kajova: *Hipposcarus longiceps*

Tobele: *Bolbometopon muricatum*
Comments: The largest tobele is referred to as "leozo".

Leozo: *Bolbometopon muricatum*
Comments: Smaller leozo are referred to as "tobele".

Chaetodontidae – butterflyfish

Patileko: Generic name for *Chaetodon* spp.
Etymology: "pati" = "nut", "leko" = "leaf", similar to the leaf of the small ngali nut "pati" tree, referring to the way the fish moves, is similar to how the leaves of the pati tree fall.
Comments: Name covers all butterflyfish.

Ephippidae – batfish

Kobekolo: Generic name for all *Platax* spp.

Holocentridae – soldierfish and squirrelfish

Sori: Generic name for Holocentridae.

Diri sori: *Myripristis kuntee, Myripristis botche, Myripristis berndti*, etc.
Etymology: "diri" = red

Vape sori: *Myripristis adusta, Myripristis violacea, Myripristis amaena*, etc.
Etymology: "vape" is a kind of river fish with silvery scales, and therefore "vape" distinguishes these from those that are red (i.e. diri sori).

Meqo sori: *Neoniphon argenteus, Neoniphon sammara*
Etymology: "Meqo" refers to tuna, and so "meqo sori" refers to those that are tuna-shaped
Comments: Type of sori.
This name is not universally recognised.

Tarasi: *Sargocentron spiniferum, Sargocentron violaceum*
Comments: Type of sori. Name refers to only these two species that have a distinguishing spike.

Labridae – wrasses

Manovaki ko niuniu: *Cheilinus trilobatus*
Etymology: "manovaki" = sea eagle, "niuniu" = fish, therefore the name is given as this fish is eaten by sea eagles.

Mosi: *Halichoeres melanurus, Thalassoma hardwike, Halichoeres richmondi*, etc.

Siele taka: *Choerodon anchorago, Cheilinus fasciatus*
Etymology: "siele" = dog, "taka" = teeth

Niango: *Cheilinus undulatus*

Lethrinidae – emperors

Bavaniabara: Generic name for *Gymnocranius* spp.

Sidau: *Lethrinus semicinctus, Lethrinus xanthochilus, Gymnocranius euanus*

Misu: *Lethrinus harak, Lethrinus olivaceus, Lethrinus microdon*
Comments: Misu are a bigger type of sidau. Also referred to as "maba niuniu" (see also *Lutjanus gibbus*, refered to by same name).

Kaburu banga: c.f. *Lethrinus erythracanthus*
Etymology: "kaburu" = to bite or smash with teeth, "banga" = cowrie shell
Comments: Type of sidau. Similar to *L. erythracanthus*, but fins are not yellow.

Pusi banga: *Lethrinus erythracanthus*

Vamunu: *Monotaxis grandoculis*
Comments: Smaller individuals are referred to as "toiroi".

Roroi: *Monotaxis grandoculis*
Comments: Type of vamunu. Larger individuals are referred to as "vamunu".

Lutjanidae – snappers

Ena: *Lutjanus rufolineatus, Lutjanus kasmira, Lutjanus fulviflamma*, etc.

Kalebu: *Lutjanus ehrenbergii, Lutnanus fulviflamma*
Comments: Type of ena. Also referred to as kapua (name from the East of Vella Lavella), but kalebu is the correct name for west Vella Lavella.

Kapua: *Lutjanus ehrenbergii, Lutjanus fulviflamma*
Comments: Referred to as both kalebu and kapua, but kalebu is the correct name for west Vella Lavella.

Neneqete: *Lutjanus malabricus, cf. Lutjanus timorensis*

Belabela: *Etelis carbunculus, Etelis coruscans*, etc.

Bakese: *Lutjanus gibbus*
Comments: Also be referred to as "maba niuniu"; "maba" = man, "niuniu" = fish, but reason behind naming not clear.

Rerekesebi: *Lutjanus semicinctus*

Jopa: *Lutjanus argentimaculatus*

Pedava: *Lutjanus fulvus, Lutjanus lemniscatus*

Ringo: *Lutjanus bohar*

Zina: *Lutjanus rivulatus*

Qao: *Aprion virescens*

Dokuale: *Macolor niger, Macolor*

macularis
Etymology: "doku" = creep, but reason for name is unclear.
Comments: Also referred to as "rekoringo".

Tatara: *Lutjanus monostigma*

Meqosuto: *Aphareus furca*
Etymology: "meqo" = tuna, "suto" = mouth, refers to mouth shaped like that of a tuna.
Comments: Also may be referred to as "injomeqo", but there was some suggestion that both these names are from the Rangonga language, the West Vella name being "belabela".

Nemipteridae – coral breams

Doma: Generic name for *Scolopsis* spp.

Etymology: "doma" = idle or slow to move, moves to one place then goes to another

Comments: May also be referred to as "doma niuniu".

Tapo marabau: *Scolopsis affinis*

Etymology: "tapo" means white, "marabau" means meat, referring to the white colour of the flesh.

Wui: Pentapodus caninus, Pentapodus aureofasciatus, Pentapodus emeryii, etc.

Nenetazutazu: *Scolopsis bilineata, Scolopsis lineatus, Scolopsis monogramma*, etc.

Comments: Type of doma.

Haemulidae – sweetlips

Tuputupu: *Plectorhinchus gibbosus, Plectorhinchus picus*, etc.

Tapesu: *Plectorhinchus albovittatus*

Bekubeku: *Plectorhinchus vitattus, Plenctorhinchus lessoni, Plenctorhinchus polytaenia*

Etymology: "beku" = idol, statue or image

Sirapa: *Plectorhinchus lineatus, Plenctorhinchus chrysotaenia*

Kyphosidae – drummers

Ruquruqu: *Kyphosus vaigiensis, Kyphosus bigibbus, Kyphosus cinerascens*

Serranidae – groupers and rockcods

Saboka: Generic name for groupers

Taiza: *Plectropomus oligacanthus, Variola albimarginata, Variola louti*
Etymology: "taiza" = a royal attribute, but respondents could not explain how this related to the naming.
Comments: Type of saboka.

Pari saboka: *Epinephelus merra, Cephalopholis boenak*
Etymology: "pari" = dusty or dull

Diri saboka: *Cephalopholis sonnerati, Cephalopholis spiloparaea, Cephalopholis urodeta*, etc.
Etymology: "diri" = red

Sutisuti saboka: *Epinephelus ongus, Epinephelus cauruleopunctatus*
Etymology: "sutisuti" = stars, which refers to the many dots on these species.

Rava: *Epinephelus lanceolatus, Epinephelus tukula, Epinephelus socialis*, etc.
Etymology: "rava" = not bright
Comments: Type of saboka. Very large rava (E. lanceolatus) are referred to as "pusipusilau".

Pusipusilau: *Epinephelus lanceolatus*
Comments: Type of saboka. The biggest ones — some reported that this is never caught anymore, others suggested it could be caught.

Sodo: *Plectropomus leopardus, Plectropomus laevis, Epinephelus socialis*, etc.
Comments: Type of saboka. There was no consensus about how sodo were distinguished, either by their long body or dark colouration.

Diri Taiza: *Variola louti, Plectropomus oligacanthus*
Comments: Type of saboka and taiza. Sometimes also called "sivari baba".

Siganidae – rabbitfish

Pazakada: Generic name for Siganidae
Etymology: "paza" = pain and "kada" = spine, referring to the poisonous spine

Urakozo: *Siganus guttatus, Siganus lineatus*
Comments: Type of pazakada.

Ziaka: *Siganus corallinus, Siganus doliatus, Siganus puellus*

Comments: Type of pazakada

Kodiki: *Siganus argenteus, Siganus javus, Siganus luridus*, etc.
Comments: Type of pazakada

Mugliidae – mullets

Lipa: *Liza vaigiensis, Neomyxus leuciscus, Crenimugil crenilabis*
Etymology: This is the Pijin/Austronesian word for mullet

Mullidae – goatfish

Obu: *Parupeneus barberinoides, Parupeneus barberinus, Parupeneus bifasciatus*
Comments: May be generic name for *Parupeneus* spp.

Scombridae – tunas and mackerels

Reka: *Euthynnus affinis*
Comments: Largest size of the island bonito.

Lotumamata: *Euthynnus affinis*
Comments: Second largest size of island bonito.

Karara: *Euthynnus affinis*
Comments: Third largest size of island bonito.

Vura: *Euthynnus affinis*
Comments: Smallest size of island bonito.

Qomo: *Thunnus albacares*
Comments: Large yellow fin tuna; if small it is referred to as "raverave".

Raverave: *Thunnus albacares*
Comments: Small yellow fin tuna, if larger it is referred to as "Qomo".

Siqala: *Katsuwonus pelamis*
Comments: Largest size of skipjack.

Meqo: *Katsuwonus pelamis*
Comments: Second largest size of skipjack.

Rikimaqi: *Katsuwonus pelamis*
Comments: Smallest size of skipjack.

Tangire: *Scomberomorus commerson, Grammatorcynus bilineatus*

Reko tangire: *Gymnosarda unicolor*
Etymology: "reko" = female, refers to this being the female tangire.
Comments: Type of tangire.

Koloa tangire: *Acanthocybium solandri*
Etymology: "koloa" = deep, referring to the tangire being found in deep waters
Comments: Type of tangire.

Aruma: *Rastrelliger kanagurta*
Etymology: The name references (uncertain as to how) the fish fleeing as a group

Carangidae – trevallies

Boku: Generic name for many Carangidae.
Comments: Particularly refers to the second largest sizes of boku (see Figure 2).

Vangapikutu: *Carangoides fulvoguttatus, Carangoides gymnostethus, Carangoides orthogrammus*
Comments: Sometimes called Vangapitu. One of the largest sizes of boku. Sometimes referred to as Vangapikutu.

Boku matadara: *Carangoides gymnostethus, Carangoides orthogrammus*
Comments: Smallest size of boku. Refers to small individuals of these species.

Kalakalava: *Carangoides oblongus*
Comments: Smallest type of boku.

Meqovilu: *Carangoides orthogrammus*
Comments: Only referred to by this name if large.

Ladosipuku: *Megalaspis cordyla*
Etymology: "lado" = stone, "sipiku" = tail, referring to the hard tail.

Lavi: *Scomberoides lysan, Scomberoides commersonnianus*

Tapo boku: *Caranx lugubris*
Etymology: "tapo" = white, referring to the colour of the body.

Vaqo boku: *Carangoides bajad*
Etymology: "vaqo" = yellow, referring to the colour of the body / fins.

Luqumu boku: *Caranx melampygus*
Etymology: "luqumu" = blue, referring to the colour of the body / fins.

Morutu: *Caranx bajad, Caranx sexfasciatus*

Batubatu: *Caranx ignobilis*

Lesa boku: *Carangoides plagiotaenia, Carangoides bajad*
Etymology: "lesa" = flat
Comments: Also referred to as bora boku.

Bora boku: *Caranx ferdau*
Comments: Also referred to as lesa boku.

Rupe: *Grammatorcynus bilineatus* (cf.)

Itingi: *Elagatis bipinnulatus*

Anuzu: *Selar crumenophthalmus, Selaroides leptolepis, Selar boops*
Comments: Also referred to by the Pijin name "buma".

Lobelobe: *Alectis ciliaris*
Comments: The juvenile is referred to as "zabuniuniu".

Zabuniuniu: *Alectis ciliaris*
Etymology: "Zabu" = wings, "niuniu" = fish, referring to the wing-like filaments.
Comments: The juvenile of lobelobe.

Sphyraenidae – barracudas

Sokopo: *Sphyraena forsteri*
Comments: "alu" largest barraccudas, "reqoso" middle size and "sokopo" smallest barracudas

Alu: *Sphyraena barracuda*
Etymology: "alu" = lazy, how this relates to name is not clear.

Reqoso: *Sphyraena jello*

Clupeidae – herrings and sardines

Katukatu: *Herklotsichthys quadrimaculatus*
Etymology: This is the Pijin name; people were unable to provide a Bilua name.

Belonidae – needlefish
Vasama: *Platybelone platyura, Strongylura incisa, Tylosurus crocodilus*

Istiophoridae – marlin

Viuruvirula: Generic name for sailfish.

Polynemidae – threadfins

Zova: *Polydactylus sexfilis*

Pomacanthidae – angelfish

Kutipoka: *Pygoplites diacanthus*

Pomacentridae – damselfish

Poreo: Generic name for *Chromis* spp.

Sikata poreo or **kasi pereo**: Generic name for *Stegastes* spp.
Etymology: "kasi" = grease, "poreo" = damsel fish referring

to larger damsel fish that are caught to eat.
Comments: Type of poreo.

Punga: Generic name for *Abudefduf* spp.

Varoana: Generic name for *Amphiprion* spp.

Gobiidae – gobies

Bilau: Generic name for gobies.

Platycephalidae – giant flathead

Esoromisu: *Cymbacephalus beauforti*

Synanceiidae – stonefish

Tipo: Generic name for stonefish.

Ostraciidae – boxfish

Patuo: *Ostracion cubicus, Ostracion meleagris*, etc.

Terapontidae – grunters

Qurei: *Terapon jarbua*

Toxotidae – archerfish

Sieleo: *Toxotes jaculator*

Scatophagidae – scats

Titaturu: *Scatophagus argus*

2. Cartilaginous fish

Carcharhinidae, etc. – sharks and rays

Baiza: Generic name for sharks, Charcharhinidae.

Maile: Generic name for eagle ray.

Potaka: Generic name for stingray.

3. Crustaceans

Palinuridae – lobsters

Sikama: Generic name for *Panulirus* spp.
Etymology: If a person's skin is flaking off then they are referred to as "sikama tupu" meaning changing body, "tupu" = skin.

Lado sikama: *Panulirus fermoristriga, Panulirus pencillatus*
Etymology: "lado" = stone, referring to the hard carapace and / or lives under coral (referred to as stone)

Avana sikama: *Panulirus versicolor*
Etymology: "avana" = pandanas, perhaps referring to long leg. Can also be referred to as "niuniu (fish) sikama" when the carapace is soft.

Portunidae and Scyllaridae – slipper lobsters

Paipu: *Scylla serrata*

Papapa: Generic name for *Parribacus* spp.

Crabs and other crustaceans

Risu: Generic name for crab (land and sea).

Pusi: Generic name for freshwater shrimp. Particular species not identified.

Talitalive: Generic name for *Atergatis* spp. (e.g. *Atergatopsis germanini*).

Barabatu: *Etisus splendidus*

Voruvoru: *Ocypode cerathopthalma*

Utupe: *Birgus latro*

Kabokakaboso: *Carpilius maculatus, Carpilius conveais, Calappa calappa*, etc.

Sipaiqu: *Eriphia sebana*

4. Molluscs

Bio: *Trochus niloticus*
Comments: Meat is eaten and shells are an important source of income.

Munio: *Trochus maculatus*

Lolo: *Trochus maculatus*
Comments: Pink variety. Species also referred to as "munio".

Pazu: Generic name for *Turbo* spp.

Popuape: *Turbo marmoratus* (Green snail)
Comments: Cannot find this now when gleaning.

Bilibili: *Strombus luhuanus*
Comments: Numerous in harvests when periodically harvested areas were first opened.

Bilibili ko ngiangia: *Strombus lentiginosus*
Etymology: "ngiangia" = "mum", so name infers that this shell is the mother of bilibili.
Comments: Type of bilibili.

Rasa: *Lambis lambis*, but also generic name for *Lambis* spp.

Kuili: *Charonia tritonis* (triton's trumpet)

Sipitaki: *Pteria penguin* (winged pearly oyster)

Kile: *Pinctada epidromis* (oyster)

Raqa kuili: *Cassis cornuta* (horned helmet)
Etymology: "kuili" = horn, referring to the shape of the shell.

Soukile: *Pinna bicolor*

Bulao: *Conus betulinus, Conus leopardus, Conus litteratus*, etc. (cone shells)

Tele: *Nerita polita*

Noloqoto: *Oliva caeulea*

Banga: Generic name for cowries.
Comments: Inedible, apart from *Cypracaea tigris* (for which no specific name was given).

Arovoza: *Asaphis violascens*

Kisuruqa: *Vasum ceramisum*

Taduo: Generic name for *Acanthopleura* spp. (chiton).

Evaka: *Mespilia globulus, Salmacis belli, Tripneustes gratilla* (urchins)

Molluscs from mangroves

Zarioroqisi: Unidentified mollusc harvested from mangroves

Motulu: *Trachycardium orbita*
Comments: Harvested from mangroves

Sivele: *Polymesoda erosa*
Etymology: "sivele" means to scratch out, the name of any tool used to scratch out a coconut, possibly because the shell can serve this function.
Comments: Harvested from mangroves.

Roqise: cf *Pleuroploca filamentosa*

Rabeo: cf *Trachycardium orbita*, but is found in mangroves

Tridacnidae - clams

Moso: *Hippopus hippopus*
Comments: After the tsunami (2nd April 2007) these were harder to find.

Tupitupi: *Tridacna crocea, Tridacna maxima*
Comments: Also referred to as "tatakiri".

Veruveru: *Tridacna squamosa*

Siavu: *Tridacna gigas*

Tatakiri: *Tridacna crocea, Tridacna maxima*
Comments: Also referred to as "tupitupi".

Temotemoko: *Tridacna derasa*

Squid, octopus and nautilus

Nguzo: Generic name for squid.
Comment: Note that in Pijin squid is "nuto", and in Ngella is it "nuho" (Foale 1998a).

Qae: Generic name for octopus.

Kerava: *Nautilus pompilius* (nautilus)

5. Algae

Caulerpaceae

Revo: Generic name for Caulerpa.

Sisu revo: *Caulerpa racemosa*
Etymology: "sisu" = flower, referring to the appearance.

Tata revo: *Caulerpa serrulate*

Niru revo: *Caulerpa taxifolia*

Qameo: *Caulerpa webbiana*

Halymeniaceae

Buseo: *Halymenia* sp.
Comments: Not *Halymeniadurvillae*.

6. Other

Esoro: Crocodile

Vena: *Dugong dugon*
Comment: This is an Austronesian word, same name used in Ngella (Foale 1998a).

Voniu: Generic name for turtle.
Comment: This is an Austronesian word.

Tavatolu: *Dermochelys coriacea*
Comments: There may be other names based on size, such as "bareleko".

Bareleko: Smaller or perhaps juvenile leatherback turtle (*Dermochelys coriacea*).
Etymology: "leko" = leaf. The name refers to the way the turtle can swim forward and turn back to swim in the opposite direction, whereas larger or adult leatherbacks only swim in one direction.

Soro: Generic name for corals.

Berava: Refers to plate corals.
Comments: Named because it is flat — note there *Acanthurus lineatus* is referred to also as "berava", owing to its flat shape.

Research design and data collection for land use and occupancy mapping

Terry N. Tobias[1]

Introduction

Aboriginal peoples in Canada have been mapping aspects of their cultures for two generations. The resultant maps have been given various names, including "land use and occupancy", "land occupancy and use", "traditional use", "traditional land use and occupancy", "current use", and "cultural sensitive areas". I use "use and occupancy mapping" generically to include all the above. The term refers to the collection of interview data about traditional use of resources and occupancy of lands by Aboriginal peoples, and the presentation of those data cartographically. It is an exercise in the geography of oral tradition, and equally in the mapping of culture and resources.

Such mapping can support a range projects, including documenting elders' oral history before more knowledge is lost, determining shared use areas and reconciling boundary conflicts between neighbouring communities, providing evidence for legal cases, settling claims, negotiating agreements, determining the probable impacts of development, providing baseline data for community planning and resource management, and developing curricula for education. At a routine level, a local government must acquire, update and control an inventory of its people's cultural resources.

I offer some ideas and recommendations for producing good maps based on some three decades of experience designing use and occupancy mapping projects, and working with Canadian and Australian indigenous peoples at the community level. I discuss some key factors that lead to successful community mapping. However, I do not offer a simple formula, or off-the-shelf methodology, that can be applied universally because that would be impossible given many different reasons for doing research, a huge range of cultural and linguistic diversity among the Pacific Islands' indigenous communities, and enormous contrasts in various nations' relationships to resources.

Following a brief introduction to land use and occupancy mapping, the tasks involved are sketched. The concepts of "map biography" and thematic map are introduced, emphasising the importance of quality data and of avoiding the museum approach to mapping. Obtaining and training good personnel, taking control of research design, and respecting workers' limitations are examined, and special attention is paid to "response burden", the factor that most commonly undermines research. Five defining characteristics of any project are discussed, along with the principles guiding research design and implementation, the measures of quality, and the culture of research.

Despite their tremendous diversity, Pacific Island communities have in common the harvesting of fish, wildlife, and plant materials, the historical basis of economic life throughout the region. In the pursuit of resources that constitute the foundation of their cultures, people leave traces over the landscape; evidence that they have been there. Yet many activities leave no visible evidence. Rather, they etch themselves in the minds of those who travel their home region in search of physical and spiritual sustenance. For most Pacific Islanders, these mental images are embroidered with intricate detail and knowledge, based on the community's oral history and an individual's direct relationship to the traditional territory and its resources.

Use and occupancy mapping is about documenting those aspects of the individual's experience that can be shown on a map. It is about telling the story of a person's life on the land and sea. Over time, individual experience becomes part of the collective oral tradition, a much greater story. In this respect, use and occupancy mapping helps record a nation's oral history.

Further, mapping is not just about making maps because other benefits arise from the process. When properly done, use and occupancy interviews increase participants' awareness of their connection to territory. People are usually surprised to see how much they have used their land and sea. They obtain a new understanding that their individual activities are part of a larger community concern and undertaking. The exercise of mapping provides opportunities for different generations to share their experience, information and knowledge. Elders from different villages are often brought together, renewing bonds between communities. Overall, land–sea use and occupancy mapping helps to invigorate peoples' pride in their cultural heritage. In addition, the administrative and technical capacity acquired through successful mapping projects increases the ability to administer and manage a territory.

[1] Consultant, 33 23rd Avenue West, Vancouver, BC., V5Y 2G8, Canada. Email: tnt@terrytobiasassociates.com

This article has been abstracted and adapted from Tobias (2000): "Chief Kerry's Moose: A guidebook to land use and occupancy mapping, research design and data collection". The arguments made here have been elaborated on and further exemplified in a more recent publication from Tobias (2009): "Living proof: The essential data-collection guide for indigenous use-and-occupancy map surveys". Both books were co-published in Vancouver, British Columbia, by the Union of BC Indian Chiefs and Ecotrust Canada.

Map biographies and thematic maps

Typically, land use and occupancy mapping projects collect data using "map biographies"; in other words, face-to-face interviews during which individuals are asked about their use of the community territory. During an interview the locations of use and occupancy sites are indicated either on a paper base map, or onto a clear overlay taped over it. Usually the interviewer asks for information about the participant's experience of the land base or seascape over their entire lifetime. Therefore, it is called a "biography".

Most researchers focus on obtaining data about only an interviewee's direct personal activities and experiences. Others, however, have found it useful also to seek information about knowledge of sites obtained from parents and elders. If the interviewer covered enough topics and the participant has an excellent memory and is willing to sit at the mapping table long enough, the resulting biography would represent everything that could be marked on a map. Of course, this never happens; what does emerge from the map biography is a useful but simple and incomplete representation of the interviewee's life story on the land and waters of a territory.

Some practitioners restrict their map biography method to questions about harvesting activities such as hunting, fishing and gathering, and travelling to engage in them. Others extend the method to include questions about the participant's experience and knowledge of ecology and critical habitats, traditional habitation sites, spiritual and sacred areas, legends and stories associated with sites, and place names. After many map biographies have been completed, the information from them is used to make a series of thematic maps. These break out subsets of information from map biographies and combine them either for all community members or for specific groups, such as teenagers for example, within a community. Such maps include those of fish harvest sites, plant harvest sites, sacred areas, travel routes, habitation sites, and place names.

The categories for each thematic map change, depending on the reason(s) for making the maps, which community is doing it, and the intended uses of the maps. Whereas the map biography is used for collecting an individual's use and occupancy information, the thematic map is used for displaying or presenting an entire community's data. The biography is a data collection tool whereas thematic maps are used for presentation, education and negotiation, among other things.

It is important to understand that doing research well is not the same as making research results look professional. "Quality" pertains to the manner in which data are collected, whereas "appearance" is about the way data are presented. Using computer enhancement techniques, geographic information system (GIS) technicians can make almost any dataset look impressive, but they cannot improve its quality. Technology should never be allowed to lead or define a research agenda, something that should always be kept in mind because many communities possess GIS hardware and software, but not the capacity to operate it well.

Appreciating the challenges of oral history as social science

A common problem is the underestimation of the difficult task faced by a community's own data collectors. After having been passing knowledge from generation-to-generation for thousands of years, it might be quite natural to underestimate the difficulties of land use and occupancy mapping. A basic difficulty arises because land use and occupancy mapping employs the rules of Western social science, which studies society and social relationships. Its practice is social in nature because one person is asking another for information; it is science because the questions are being asked systematically, according to established Western scientific rules of gathering and verifying knowledge. All manner of psychological and social considerations are involved when someone is asked to provide information, especially when the questions asked are personal, as they are in the case of use and occupancy mapping. The problem is amplified because the research crosses cultures, with the community adopting rules of research developed by the larger society.

The "museum approach" to mapping

It is risky to view a use and occupancy project in isolation from a larger research strategy. No matter how thoroughly the data are collected, typically budgets are always insufficient to map all aspects of a community's entire cultural geography. Even if funds were available to do four major mapping projects — harvesting sites, travel routes and habitation, spiritual sites, and place names — and all the mappable information that all elders and harvesters was documented, the final product would not represent the totality of a culture and oral tradition. The final set of maps would still have gaps, with many cultural features isolated by blank spaces. The critical issue is that blank spaces can be essential to the survival of the culture. For instance, the final maps might display the places a community harvests fish whereas fish spawning areas on the community's territory remain as unmapped blanks.

The danger of showing cultural features as disconnected fragments on a map is that corporations and government agencies carry on with business as usual on the portions for which no data are mapped. Governments may take the position that aboriginal title and rights are site specific, and do not apply on the rest of the territory. They tend to regard the mapped areas as "museum pieces" that are isolated remnants of heritage, instead of parts of living cultural systems.

The unfortunate reality is that even though all remnants can be saved, ultimately little or nothing is saved. The developments occurring in the blank spaces, much of which could be productive habitat for the fish, animals and plants necessary to sustain a culture, can lead to the mapped features eventually becoming museum curiosities that do little more than commemorate extinct tradition. Perhaps the fish harvesting sites receive some protection in planning processes, but the watersheds continue to be clear-cut, resulting in the siltation of the spawning sites within the reef. Saving some of the pieces — some of the sites — is not the same as keeping the system healthy.

In other words, mapping specific sites is risky, but it is necessary to the production of credible maps that serve a community well. The issue is not so much whether to map detailed and specific sites when appropriate, but rather how to control the release of data, how much data to release, to whom, when, and at what level of detail, both in terms of geographical space and historical significance. Collecting data that are best represented as small areas or points and mapping them as large polygons defeats many of the purposes for which communities do the mapping in the first place. That is why it is important to link each piece of use and occupancy mapping research to previous efforts, and to have following projects build on the strengths of what is being done now.

Ideally, that would result in "comprehensive research", which requires an overall plan that links a number of key components together. Taken as a whole, it demonstrates that the "museum approach" is not valid. Comprehensive research also describes the complex system of use that is the foundation of all the mapped use and occupancy data. That system of use cannot be portrayed in map form, but it can be put into words. Traditional ecological knowledge, social customs, organizational structures, and social institutions are part of the system, and when the maps are considered in light of these, there are no blank spaces. Everything can be shown to be interconnected. What appear as blank spaces on the map can be shown to have meaning and significance to the culture.

The groundwork for good research

The most important consideration regarding community research is whether or not members are willing to participate. A community administration can have a well thought out and desirable project, but will surely fail if it does not secure community support, ideally before the first map session takes place. If community consensus has not been obtained before interviewing commences, workers will struggle throughout the entire data collection phase. They will find themselves spending far too much time explaining the project to people, and listening to individuals' concerns about the research itself and related issues such as the funding agency. For many data collectors, getting individuals to sit down with them has been quite frustrating in itself, and the experience of having prearranged map sessions turn into no-shows is all too familiar.

In addition to building consensus for the endeavour, a community government must provide hands-on political and material support to its data collectors for the entire period of interviewing. Administrative personnel are usually stretched thin because of limited resources. Often, everybody ends up being asked to take on more than they can handle. Unfortunately, the success of the research can be jeopardized if interviewers are asked to take on too many responsibilities.

Research personnel and training

Leaders sometimes make the mistake of always hiring local research directors, regardless of the candidates' previous experience or training. This can be a recipe for disappointment.

Community politicians must be clear about whether their primary goal is to reap the short-term rewards of hiring local research directors (such as local political support and income for the community) or to seize the opportunity to produce maps that can help win long-term benefits. This is not always an either-or situation. Many communities lack highly trained or skilled administrators among their members. So most communities will, for the time being, remain dependent on the services of skilled outsiders to help them design and direct land use and occupancy research. Most communities have now had experience with outside consultants and researchers, hence most are aware of the importance of keeping consultants accountable, and of maintaining control of cultural data.

Still, administrations sometimes make poor judgments about the abilities of consultants to help them do good mapping. Often it is assumed that if a candidate for research director is a university graduate, she or he will be suitable. University experience is a valuable asset, but it does not in itself lead to successful research. The candidate's academic background is likely to be in a field such as forestry or archaeology, which accepts the world view of society at large. If his or her assumptions about the connection between a people's culture and well-being are at odds with a local people's way of looking at the world, then problems will arise. The risk is that the research will be undertaken largely in keeping with outside values, despite the person's best intentions. The research would then likely end up serving outside interests.

In addition to the research director, the selection of community people to collect data is critical. These individuals have to be motivated by the belief that the project will make a difference to their people. They need to be self-starters and firmly committed to staying on for the duration of the data collection phase. This is especially important, because in most communities the team of interviewers is made up of just a few people, and the loss of even one makes a difference in the amount of map sessions that can be completed. Most projects lack the budget or flexibility to allow for the training of replacement personnel. The level of commitment and motivation is as important as any other qualification. The tone in this regard will often be set by the community leadership. If the project is perceived to be a make-work program, the likelihood increases that workers will be hired who regard the position as just a job.

There are numerous other considerations in selecting workers. They should have good interpersonal skills, the respect of community members, especially elders, a heartfelt interest in their culture, a familiarity with their traditional culture, systems of harvesting, and traditional territory, a lifestyle that allows them to show up on the job consistently, the ability to read and understand maps, the ability to speak and write in their indigenous language, the ability to use a flexible interview guide by being able to think quickly and probe with follow-up questions, a willingness to pay close attention to detail, and the ability to read and write well and keep good research records.

Few people meet all those criteria. It is important to select a team so that individual strengths complement each other. For instance, successful interview teams sometimes have only one member who speaks the indigenous language and who has an intimate knowledge of the territory, and another member who writes well enough to keep good records and take responsibility for the detail required by social science.

Most government-funded research projects encourage workers to start data collection without sufficient training. Agencies either set low standards, or do not provide the means by which higher ones can be achieved. It is up to the community to insist on high standards that respect the rules of social science, and to collect data in a manner that meets them.

Taking control of research design and data

In addition to building up community-wide support for the research and the careful hiring and training of staff, the community administration must take control of the research design. The design is a combined blueprint and work plan that specifies how the data are to be collected and then worked into a final set of maps. A community's maintenance of control over its map data is essential.

A number of projects have been successful in meeting obligations to supply information, by providing data that are presented in a way that safeguards sensitive sites from violation. For instance, there might be a category of sites that is especially vulnerable to vandalism, such as ancestral burial grounds. The map could show each site as an area covering ten square kilometres, making them impossible to find on the ground without the community's assistance.

Information-sharing agreements can be negotiated to include a variety of mechanisms that allow local groups to retain sole possession of the kinds of data most likely to be abused. Under some arrangements, the community releases data on a case-by-case basis as the need arises, and only after careful evaluation by a committee of elders and other leaders. Under other arrangements the government receives only maps showing cultural sites, whereas the local community retains control of the database, which contains the detailed information about the history and significance of each site.

Taking control of a mapping project involves more obvious things such as negotiating a strong information-sharing agreement and keeping consultants accountable. It also means giving careful thought to the technical design of the research. Funding arrangements often include pre-packaged research designs, in the form of policy guidelines or "how-to" manuals, and these usually have major problems. Fortunately, funding guidelines always leave room to manoeuvre. But if a community does not take advantage of this flexibility and design its research, then, by default, others will already be in control.

Avoiding "response burden"

A community taking control of its research involves avoiding the unintended invitations to fail that are hidden in the instructional material provided by government or industry. The most common invitation is simply that the community is asked to take on an overly-ambitious project, one for which the expectations set by the research design are too high. This appears innocent enough, and so makes it difficult to recognize as a potential problem. Attempting to accomplish too much is probably the principal reason for research shortcomings, and why map projects fail to produce the results wanted by aboriginal administrations.

Research designs have to be realistic about what can be done within a set budget and time frame. Expectations must take into account the skill levels of project personnel and the level of cooperation to be expected from potential participants. For example, the design of a project to map the content of oral tradition could include collecting some of the following kinds of information: harvesting sites, ecological and critical fish habitats, site-specific features of special cultural significance, travel and trade routes, and place names. All of these kinds of information, or themes, are mappable. However, it is impossible to collect the data needed to map them all in a single project, which is exactly what some guidelines encourage communities to do. A really good job can be done only when the focus is on one or two of the themes. It is necessary to be selective because otherwise an interview guide would be complex and long, which means running the risk of major "response burden".

"Response burden" occurs when a participant experiences the interview as too much of an effort. People have a range of experiences at map sessions. Some will find them enjoyable and even fun; others will find them positive, but somewhat inconvenient. Still others will experience their interview as frustrating. The interview must be structured so that most participants will be satisfied afterwards, especially the elders. Those are the people who likely know the most about many kinds of cultural features. They also tend to experience the most fatigue and frustration when the "response burden" is high. Elders also tend to be listened to by community members at large, and their opinions about the interview have considerable impact on final participation rates. What is required is that the mapping exercise generate project support by having participants go back into the community and tell others what a worthwhile endeavor it is. People should not leave the session feeling annoyed or discontented.

Two things happen when "response burden" is high: 1) The interview gets a reputation for being complex and difficult. When this happens, data collectors spend much more of their time trying to coax people to participate, and the final number of completed sessions is low. 2) People who agree to do a map are more likely not to provide good quality data for each of the questions. Both of these outcomes translate into a weak set of community maps.

One way to look at "response burden" is as an issue of respect. Workers should respect the basic limitations common to all people. Participants do not have unlimited energy, time or willingness to concentrate on the task at hand. On average it seems that most people are comfortable staying focused up to about an hour and a half at one sitting, although this varies by culture and certainly also by individual.

Respecting the limitations of community workers

Encouraging people to design research that results in excessive "response burden" is only one way in which instructional material invites failure. Another is to set up wildly unrealistic expectations of workers. Consider this scenario. A community receives funding for a mapping project. The administrator can hire four workers and a research director for 15 months. The government supplies guidelines laying out the project's phases and how each is to be conducted, as well as what the community is expected to provide at the end of each phase. So far so good, but the problem is the job description of the workers.

A typical mapping project involves a number of large tasks. Some research guidelines also require the project, as part of the same 15-month package, to do additional tasks such as archival work, ground-truthing of sites, and the completion of a data form for each mapped feature. On some projects community members are asked to do a whole range of tasks, any one of which alone is a substantial undertaking. Most individuals selected as workers for these kinds of projects do not have professional experience or much training in related fields.

This would be fine if both the community and funding agency had set out with the intention of providing workers with a broad opportunity to sample a whole series of research skills over a period of a few months, but that is never the case. Funds are provided to produce a concrete product, which is the primary objective. Capacity building is secondary. The administration typically does this kind of research because it needs data for specific purposes, often urgently. Workers who are asked to learn, master, and apply a variety of skills within a short time, and produce something of quality might feel stressed. One of the saddest consequences of research guidelines that invite people to take on too much too quickly is that the project ends up leaving the workers overwhelmed, even demoralized.

The likely results of such a situation are that community leaders, negotiators, educators, lawyers, and resource managers do not receive the quality data needed to serve their people. The community acquires a reputation for failure and finds itself out of luck the next time it applies for funding to do cultural research. Community members become cynical about research because their efforts did not translate into concrete benefits. The workers are left doubting their ability to acquire and apply research skills, and perhaps thinking the project's outcome was their fault. These are serious consequences, especially if a people's vision is to govern itself and develop the capacity to do its own research, planning and resource management. Every research project is an opportunity to build the skills and confidence that are one of the cornerstones of self-government.

Designing the project

There are hundreds of detailed decisions that relate to the design of a use and occupancy mapping project. So, where to start? Fortunately, there are a small number of key decisions that that help clarify everything that follows. These have to do with the project's five main defining characteristics, or parameters: the Why?, Who?, When?, Where?, and What? of the research. They look simple at first glance. Many map projects do not think these through carefully enough, leading to problems and unnecessary damage control efforts later on. More than that, not giving due consideration to the defining characteristics can seriously undermine the quality of the resulting maps.

1) Why: *Why are you doing this project?*

All five questions are important, but the most critical one is "Why?" A community administration should query why it is doing this project, what it seeks to accomplish with it, what its objectives are, and whether the land use and occupancy maps are for curriculum development, co-management negotiations, impact mitigation, negotiation or litigation of rights and title, compensation, or some other purpose. The list could go on and on. For instance, an oral history mapping project could be designed to focus entirely on the management of a particular fish species, or on the rehabilitation of medicine sites, or on traditional travel routes with an eye to developing ecotourism.

The temptation is to list many purposes and then to design a process to achieve them all. This cannot be done, at least not well, because it would result in a mass of poor quality data that will not meet the requirements of any of the listed purposes. It is fine to have multiple objectives in mind as long as one is clearly identified as primary. That single objective then becomes the focus of the entire project, the reference point around which all other design considerations revolve, including the other four parameters.

2) Who: *Who are you going to interview?*

Depending on the primary objective and the time and budget available, decisions must be made about how many and which people are to be interviewed; in other words the study population must be defined. It is often useful to start by dividing the community membership list into smaller lists of males and females, by 10-year age groups. Rank each of the smaller lists, so that the most experienced and knowledgeable people in each group are identified, and indicate which elders are at risk because of health reasons. Mark people no longer living in the community, and note where they reside currently. Perhaps knowledgeable individuals who are not on the membership list but who have married into the community should be added. Maybe there are official members who have not set foot on the territory for many years, and who should be taken off the lists. Each community is unique, but these are the kinds of considerations that lead to a set of criteria, or rules, that determine the study population. The point is to think it through and have the population defined before starting data collection. It is impossible to know exactly how many interviews are needed, but it is important to have some idea about the minimum number of sessions required to meet the main objective. Although a large sample is always desirable, it is not always necessary.

3) When: *What is the period of time for which you want to collect data?*

Like all the parameters, this depends on the purpose of the research. Generally, there are two relevant time frames. One is recent or "current" use and occupancy. The accepted definition for this is "within living memory", which is any time within the person's life. Some researchers regard this as the period from the person's teenage years until the date of interview. Others prefer to include childhood recollections. A set of current use maps represents the sum of the direct personal experiences of all participants. It can display some information for up to 75 or 80 years prior to the time of survey, but most is more recent, because most participants are younger. The second time frame pertains to historical use and occupancy research, which involves a greater time depth. It results in data that extend farther back than those obtained strictly from within-living-memory sources.

Historical use research uses a combination of oral history and written sources, and documents a community's occupancy of a territory going back hundreds of years. Historical use and occupancy studies use sources that go deeper than the direct life experiences of current generations to help determine the limits of the traditional territory, often for land claims purposes. Current research is usually undertaken to determine the extent and limits of a community's use of territory within recent years. This is important for claims research and, when data are obtained for the whole territory and not just the outer edges of it, current use. Occupancy mapping is especially useful for resource management.

In some situations both the historical and within-living-memory time frames might be inappropriate. Take, for example, a community doing research to assess the impacts of industrial development. It would likely have a different definition for its "when" parameter than those used in either historical or current use and occupancy studies. Because of budgetary constraints, the impact assessment research might focus only on the families most likely to feel the greatest impacts of development. Those would be the families that had been active in the zone of impact in the years immediately preceding the research. It is conceivable that few elders would be interviewed for such a study.

4) Where: *Where is your study area?*

If the main objective is to obtain data to be used as evidence for proving aboriginal title, the area of relevance would cover the territory defined as traditional by elders, and for which obtainable use and occupancy data could be anticipated. What about sites much farther afield, on one of the more distant village's territory? These kinds of questions need to be considered and answered prior to the first interview. Sometimes information that emerges from data collection warrants a rethinking of how the study area was initially defined, and occasionally this results in a slight modification.

5) What: *What questions are you going to ask participants?*

Any of the five parameters can be difficult to define. Almost always the one that is most time-consuming has to do with "What?" What kinds of data are wanted for the maps? There is a huge range of different kinds of mappable oral history data, or themes, which can be relevant to meeting a primary objective, such as harvesting areas, habitation sites, travel and trade routes, place names, and so on. It is important to choose a small number of themes, usually no more than two.

There are two advantages to being so selective: 1) a thorough job can be done so that the research product is complete enough that subsequent projects can build on it from a position of strength, and 2) excessive "response burden" can be avoided.

If harvesting sites is decided on as a theme, it is necessary to think about who are the consumers of the harvests. Are mapped data needed that represent where people obtained resources that were used to feed themselves and their community, or that were used for sale on commercial markets, or for trade with distant kin? Is a site to be mapped where a resource is harvested and a portion feeds the local community and a portion is sold on international markets? These kinds of considerations need to be resolved carefully. Questions must be framed in a way that allows participants to know exactly what the interviewer is after.

The interview guide, the actual list of questions to be asked, is the concrete end product of all the decisions made concerning the "what" parameter. Even a quick look at it can say a lot about a project's chances of success, because its length and complexity are related to the way people will likely experience the mapping sessions. The interview guide is where the overly ambitious project gets into major trouble by generating too much "response burden". It is also where the more carefully designed project succeeds. The effective interview guide is carefully constructed and then tested on a few individuals to see if its wording is clear, and to make sure the interviews will not be too long and difficult. Some changes might be necessary, after which the guide is finally administered to participants.

Principles of research design and implementation

There are a number of principles that are very helpful when designing and implementing the work. Some of these are discussed below.

1) Respect: *Respect participants in a heartfelt manner, at all times.*

Respect is at the top of the list. The need for honoring the limitations of participants and workers has already been mentioned. Most individuals can sense whether the community researcher genuinely honors the experience that is being shared during an interview, even if that experience comes from a belief system different from the interviewer's. Some of the questions asked during an interview are private and intimate. Elders are often asked to talk about things for which many local people have been judged and ridiculed, making some participants reluctant to share what they know about cultural sites, especially related to spirituality. Many communities have had experiences with outside researchers and consultants, and even with some of their own people, that have not helped the situation. Every person associated with the project must be willing to respect participants in a heartfelt manner, at all times.

2) Confidentiality: *Adopt official mechanisms that define confidentiality in concrete terms, and follow through by honoring them.*

Confidentiality is closely related to respect because it is fundamentally about trust. Even a single breach of it can undermine a mapping project. Individuals can have all kinds of reasons for not wanting others to have access to their personal information. Most are concerned that the government might use it against them in some way. Some are even afraid about individuals from their own community seeing it. In every research project confidentiality is an issue, and most projects underestimate the amount of concern that emerges once data collection starts. It is smart planning to anticipate the concerns of people and to think of things that can be done to address them.

People generally want to know how the data or information will be kept confidential. The important thing is to be able to follow through on what you tell people.

3) Informed consent: *Make sure that potential participants have the information needed for them to offer informed consent, and that they can withdraw from the process at any time.*

Informed consent also is related to respect. People have a right to know about the nature of the project, its objectives, why the data are needed, what the anticipated uses of them are, and so on. This principle is not only about the rights of community members; the success of the project may depend on it. Widespread participation and quality data will not be forthcoming unless individuals have come to their own understandings about the need for their cooperation. Such understanding can only be based on information. People must also have the right to consent, without pressure or coercion. Similarly, successful research recognizes a participant's right to withdraw his or her consent, and to cease participation at any time.

4) Focus: *Maintain a workable focus by being realistic about the number of themes to be mapped in a single project, and by being selective in constructing the interview guide so that the average session is not too long.*

Focus, a fourth principle of good research, was touched on above in the section on "response burden". It is important to be careful about the number of different themes to be mapped in a single project, and it is critical to be selective in constructing the interview guide so that the average session is not too long. Focussing on the primary objective of the project keeps everything else on track.

5) Flexibility: *Be flexible in the administration of the interview guide while also maintaining sufficient focus that ensures the primary objective is finally met.*

Flexibility allows staff to deal with situations as they arise. For example, people have their own preferences about when and where they want to do their interviews. They have their own ideas about where the research should head and how it might be modified. The research team learns in the doing. There will be changes in methodology, usually minor ones, as data collection proceeds. The trick is to be flexible while at the same time maintaining sufficient focus, "sufficient" being that which ensures the primary objective is finally met.

Striking this balance is not always easy. For example, the data collector has an interview guide to work with, which has been designed with a clear objective and focus in mind. Now she is sitting down with an elder who has his own ideas about what kinds of cultural information the community needs to put on maps. He may also think that this much younger person ought to just put the tape recorder on, respectfully keep her mouth closed, and listen. Situations like this are not uncommon. After all, the social scientific model of inquiry has been parachuted in on top of the traditional indigenous way of passing knowledge from one person to another. So, how to respect the elder and still find a workable balance between focus and flexibility? When elders are well informed about why questions are being asked in a strange or seemingly intrusive manner, they are almost always willing to meet the interviewer more than half way.

6) Consistency: *Have all interviewers follow the same methodology in a highly consistent manner.*

Consistency means doing things the same way each time. It applies to each of the hundreds of little conventions that are determined by the research design. A convention is simply an agreed on way of doing something. There might be several dozen conventions that govern, for instance, how data and symbols are to be indicated.

Marking data is only one of a number of areas of research design. The following are some of the others, each one of which is made up of its own bunch of conventions: assignment of participant numbers, interview procedure, how to use the questionnaire, how to code symbols, labelling audio-recordings, keeping records, and taking care of the materials containing data.

The hundreds of conventions involved, taken as a whole, make up the research methodology. The methodology informs the worker how to deal with any conceivable situation relating to any aspect of data collection. It is important for all data collectors to follow the same methodology, and for each one of them to follow it consistently. One reason is that the monetary costs of not doing so can be very high. Data collection is only one in a sequence of tasks, each of which can be a major undertaking in terms of labor and expense. Keeping each component within budget largely depends on how consistent the technicians involved in the preceding steps have been in their work. A data collector with a casual attitude or inclination to be sloppy can create enormous amounts of unnecessary work for the transcribers, digitizers, and others. More importantly, consistency is one of the foundations of social science because it is closely tied to something called "reliability", which is a cornerstone of the scientific method and a basic measure of data quality.

7) Organization: *Stay organized so that interviews can be set up quickly, raw data tracked easily, and the needed project notebook material at hand to write a quality methodology report.*

Organization requires people to take detail seriously. First-time researchers are usually surprised at how quickly raw data, overlays and audio-recordings accumulate, and how much research equipment and materials they have to handle on a daily basis. Imagine a research office, typically quite small, with a number of large map tables, many hundreds of overlays with data on them, four or five hundred base maps, hundreds of recordings with data, and all the recording equipment and supplies needed by a team of three or four workers. Good organization allows one to stay on top of it all.

It is almost impossible to stay organized if there is not a secure, well-lit interviewing room that has space for a number of mapping tables and whatever is needed for elders to feel comfortable during interviews. Conducting the map sessions in one centralized, well-equipped room is more productive than trying to interview participants in their homes. In addition to a good working space, obtaining custom-built storage boxes for overlays and recordings helps with organization.

8) Caution: *When recording data, err on the side of caution.*

Caution is generally wise when it comes to the design of oral history mapping and data collection. For instance, if a participant says, "I think I took a 'such and such' a fish from there," the interviewer should ask for clarification before marking the site. If the hunter's response still indicates uncertainty, the worker might say "OK, we've got that information on tape, and we're not going to mark the site on the map." The datum is not lost because it is captured on an audio recording and appears in the transcript record. This principle of erring on the side of caution lets you, if needed, make the argument that your maps are conservative, that they understate the community's dependency on cultural resources.

9) Self-reporting: *Design current use and occupancy research to obtain as much self-reported data as possible, and in a way that permits the sorting of data that were reported secondhand.*

Self-reported data refer to the notion that, generally speaking, when doing current use and occupancy research, as much of the information as possible should be reported by individuals who have had direct experiences of the mapped features they indicate. The principle emphasises two things. First, it is best to have individuals tell their own stories. Second, if necessary the researcher should be able to revisit a dataset and sort out which data were self-reported, and which were reported by individuals secondhand. This is not to say that secondhand or hearsay information is not important. On the contrary, it is very valuable and forms a foundation of the community's living oral tradition.

10) Integrity: *Audio-record the interviews and design other aspects of data collection and record-keeping in a way that enables the source of any particular datum to be tracked.*

Integrity of data refers to traceability. If data have good integrity, the researcher can trace back any of the thousands of individual features appearing on a final set of maps to its source. The ability to do this is important for a variety of reasons. If the maps are being used administratively for land use permitting for instance, the users want the data to be easily sourced to the people who have knowledge about the sites in question. If maps are being used in court to support aboriginal title, claimants need the data to be linked to source transcripts. Entire land use and occupancy data sets have been dismissed by judges because integrity was not demonstrable.

Excellent data integrity requires that each mapping session be recorded electronically. Occasionally, a community researcher is concerned that certain individuals will not participate if there is a recorder involved. Having conducted many hundreds of map interviews, I have never found an individual who, having initially objected to being recorded persisted to the point of not participating. When given enough information about the project and opportunity to ask questions about things such as confidentiality, and time to think it over, people always agree to have their sessions taped. If somebody refuses to do a map biography the issue is almost certainly not about recording. The researcher's job is to discover what the real problem is and address it.

In addition to good data integrity, having all map sessions recorded is a necessity for any project that is serious about obtaining detailed information about the mapped features. It is impossible to make a good written record of all relevant data during a map session, especially if the interviewer has her sights on data diamonds.

11) Data diamond: *Train interviewers to think in terms of data diamonds, which will ensure that maps have the appropriate level of historical depth.*

Data diamond is an idea or mental picture that is useful to keep in mind both when designing research and while interviewing people. It reminds data collectors of the kinds of information that the use and occupancy project is after. Once interviewers get into the habit of thinking in terms of collecting diamonds, they are much more likely to be thorough in their questioning and, therefore, successful in obtaining the most useful data possible. The diamond shape, with its four points, refers to the linking of four kinds of information: a person's name (who), an activity (what), a location (where), and some indication of time period (when). Each time a feature is marked on a map, whether it is a point to indicate a fish harvest site or a polygon for a burial ground or a line to represent a travel route, the participant has automatically provided one diamond.

Use and occupancy map projects are about collecting these diamonds. A single project will produce thousands of them, whether the interviewers are aware of it or not. Data collectors who do not think in terms of diamonds will still obtain them. The advantage of being conscious about diamonds is that by actively seeking them out, many hundreds or thousands more are obtained, without interviewing additional participants. In addition, the descriptive information that can be linked to each feature on the final set of thematic maps has much more detail and historical depth. It is these kinds of descriptive data that are the most powerful evidence a group has been active on a territory.

It is especially important to collect diamonds when interviewing elders, because they are capable of providing evidence of use and occupancy farther back in time. There are many of these kinds of data contained in the oral traditions of most communities. Research should be designed so that as many as possible of the elders' diamonds are recorded, because these bear testimony to the long-time historical use and significance of each mapped site. They give thematic maps the added dimension of historical depth, and convert the notion that "we've used our territory for a long time" into something concrete. With diamonds, the argument becomes alive with the names and stories of real flesh-and-blood ancestors. This kind of detailed information is invaluable for educational purposes, and not easily ignored by agencies or courts.

Measuring quality

In addition to the parameters and principles of research, close attention must be paid to the indicators of data quality. These are characteristics of data that can be evaluated and measured. They are the things to which potential users would give consideration when deciding whether the maps are useful. Critics would look at them closely when trying to demonstrate that maps are not up to scratch.

The measures of quality described below are equally a part of the research principles. Similarly, some of the principles — such as integrity, self-reported data, and data diamonds — could legitimately be regarded as indicators of quality, because their presence and relative amounts can be observed and measured.

1) Reliability: *Could someone else replicate the map survey using the same methodology, and come up with the same maps?*

Reliability is a cornerstone of social science because it has to do with reproducibility. Can the research results be duplicated? If a fire destroyed all the "map biographies" and all the thematic maps, could the project be done a second time, and produce the same results?

Good reliability is based on two things. First, there has to be a carefully designed methodology, administered in a consistent manner from one interview to the next. Second, there has to be a thorough written account of that methodology, which consists of definitions of the parameters and detailed descriptions of the conventions adopted. Theoretically, a different set of data collectors should be able to re-interview the same people and end up with a similar set of maps. In other words, reliability has to do with predictability of outcome.

The methodology is the project's set of instructions. It is important not only to help prove that the data are reliable, but also to demonstrate they are valid. Reliability, validity and accuracy are words used interchangeably by most people, but social science uses each in different ways. There are complex interrelationships among the three concepts that need not concern us.

2) Validity: *Do maps say what you claim they say?*

Validity refers to the meaning of maps. Do they mean what they are supposed to? Do they say what a researcher claims they say? This might sound confusing, so here is an example. Imagine you are looking at one of a community's finished thematic maps, the one depicting animal kill sites. The title reads: "Jackson Community Fishing Sites of Game Fish Used for Community Consumption." The Jackson community is known to eat a lot of game fish, but you are still surprised to see 2,000 sites on their map. It is also known that their men do a lot of guiding for Western sport fishermen. You decide to check the methodology report, and discover that the interview guide's question does not instruct participants to mark only those caching sites for which fish were used to feed community members. You then listen to segments from a small number of recordings to hear how interviewers handled the game fish question. Not surprisingly, they did not specify what the interview guide had not instructed them to. How many of the 2,000 game fish sites provided meat for village residents, and how many are sites where Jackson guiding parties met with success but the fish ended up filling tourists' freezers? Does this particular fishing site (the one on Tiny Borrocks Island), really belong on this thematic map, given the title of the map? If a question like this cannot be easily answered, the data have poor validity. The meaning and significance of the map is open to too much interpretation.

3) Accuracy: *Are real-life features on the land or sea truly located where your maps indicate they're located?*

Accuracy is related to precision. How true is the location on the map where Charlie saw the remains of old Monabu's hut? Does the spot marked on the map truly represent the location of that hut on the earth's surface? Assume that Charlie got it exactly right when he showed the interviewer where to make the point. If the base map used for data collection is 1:250,000 scale, the ink dot representing the datum point can easily cover a 0.25 km on the ground. If the base map used is 1:50,000, the ink point covers about 50 m, and the datum is thus more accurate. Accuracy is also related to things such as the participant's ability to read or interpret maps, his ability to see well, and his willingness to be careful when indicating sites. To verify accuracy, one could compare where Charlie indicated Monabu's hut to where other participants independently located it. Such triangulation provides a basis to make the best possible judgment about where the likely location of the feature is, without additional expenditure of research budget. You could also do what is called ground-truthing, and take the base map and a global positioning system (GPS), and go with Charlie to the actual site.

Accuracy is related to scale of mapping, which is determined by the main objective for doing the research in the first place. Even if the community wants data for operational planning, in most cases it is nonsensical to think that an inventory of cultural sites can be mapped at 1:20,000 scale. Many communities' territories easily cover 40 x 1:50,000 map sheets, which is the equivalent of 250 x 1:20,000 sheets. The sheer awkwardness of working with a set of 250 maps for data collection purposes, and its effect on "response burden", are reasons to abandon the notion. In addition, there is so much detail and often so few recognizable reference points on a 1:20,000 sheet that participants sometimes have difficulty locating themselves.

It is important to be realistic about the strengths and limitations of the various map scales for data collection purposes. The community should decide which scale best suits its needs. Often the best scale is 1:50,000 because the resultant maps are detailed enough to use as a reference tool for many planning and management purposes, while still providing the information needed for claims processes. One can refer to the thematic maps whenever the need arises to obtain more complete data for any area or feature, or to improve the accuracy of existing data. A mapped inventory of cultural sites, collected at 1:50,000 scale, can be effective for operational planning when used in consultation with elders during on-site visits and in conjunction with GPS corrections.

Having a process in which the mapped data are ground-truthed a few at a time, on an ongoing basis, is advantageous for another reason. Ground truthing large numbers of sites is very expensive and can cripple research budgets. The community should carefully define its priorities, and use as much as possible of the available funds to interview key elders before deaths result in more permanent loss of local knowledge. Sometimes immediate ground-truthing of a site is warranted because the participant may, in extreme cases, be the only person alive who knows about the site, and there is uncertainty as to its location. It is important for the community, and not the funding agency, to define how much verification of accuracy is needed, and when.

4) Representativeness: *Are the mapped data that participants provided characteristic of the community the participants belong to?*

Representativeness refers to whether the data speak for the population the maps claim to represent. To what extent are the data provided by participants characteristic of the population to which participants belong?

A number of things have to be looked at when answering this question. How were individuals selected when compiling the list of people to be interviewed? What were the criteria for defining that study population? Are those criteria consistent with the primary objective of the project?

How many members of the study population were interviewed, and what percentage does that number represent? Did participants provide complete, high quality data? If the participant selection criteria are valid in terms of the project's objective, then two simple statistics, the number of participants and the coverage rate, provide a good sense of representativeness. For instance, if 160 individuals complete "map biographies", then participation is 160. If the study population is 200 people, then the coverage rate is 160 over 200, or 80%, which suggests good representativeness. Coverage of 10% would suggest it is poor. Whether the objective of the use and occupancy study warrants widespread participation of all adults or a sizeable subset of adults, the idea is generally the same: 70% or 80% coverage suggests good representativeness. However, if the study depends on a small number of participants, or "key informants", then it is important to have complete coverage of that group because the absence of even one informant's data can result in weak representativeness.

To give a simplified example, pretend the Gob Stopper Community designed a mapping project to document the extent of its lobster harvesting. Its final thematic map shows 575 places where community members have harvested lobsters and one wants to know whether the map represents the pattern and extent of community members' lobster harvesting sites. To determine this one would look at the methodology report's description of how people were selected to be interviewed. First, one would determine what the population group is. If lobster is a basic food and all adults are known to be active harvesters, the study population might consist of all adults, men and women, in which case the study is like a survey. If, on the other hand, there are only a few women who specialize in lobster harvesting, and are known to harvest huge amounts for distribution to other community members, the study population might consist of only this handful of key informants.

In either case, one would then look at the report's account of coverage rate. If it were only 10% you would suspect that representativeness is poor. This is because if more study population members were to be interviewed, and their hare data added to the thematic map, changes in pattern would emerge. Some of the gaps would fill in and some of the edges of data distribution would expand outward. However, in the survey of all adults, if coverage was 75%, chances are that you could keep doing interviews, adding data, and not see resultant changes in overall pattern. At that point you have good representativeness. On the other hand, if the study population was only a small number of women, you might need 90% or 100% coverage before the interviewing of an additional person would have no major effect on the distribution of mapped sites.

5) Consensus: *Do the users of the maps agree that they are useful for the intended purposes?*

Consensus is not really an inherent characteristic of data. But it can be measured, and it does reflect the degree to which maps are reliable, valid, accurate, and representative. Suppose the maps are tabled at a co-management meeting where a number of different agencies and user groups are negotiating. If those people take a close look at the maps and at the companion methodology report and find them to be good quality, the thematic maps themselves are likely to achieve consensus.

Excellent research is supposed to provoke controversy in some fields of inquiry, but not in this one. Land use and occupancy mapping has been around in Canada for a long time. The basic methodology is well developed and the research product has been used in many different contexts, including co-management negotiations and courts. If maps do not achieve consensus regarding their usefulness, it is probably because they are of questionable quality.

Conclusion: Creating a positive culture of research

The most obvious result of giving insufficient thought to the measures of quality, principles, and parameters is that the research product is likely to fall short of the project's immediate objectives. There is a larger picture to consider though. A community's experience, positive or negative, of its own use and occupancy initiatives contributes to its culture of research.

This is the group's collective understanding of research and its benefits, and people's willingness to contribute to an ongoing research programme. How receptive are community members to the announcement of yet another study or survey? Does it make people unhappy and elicit comments such as "We've been studied to death," or "It'll never change anything," or "They've already asked me those kinds of questions before?" Do people respond with a sense of optimism and enthusiasm? Is there resistance to the idea, or openness?

It is critical to ask these kinds of questions while designing any particular piece of research because the answers are suggestive of the "response burden" likely to be encountered, and the participation that can be expected. It is also important that local government does what it can to encourage a culture of research that is favorable to future initiatives. The long-term research needs must be kept in mind, with the goal being that community members, when called on, will be willing to support their community government's call for information and knowledge.

The collective attitude towards a particular project is largely determined by people's experiences of previous research endeavors. There are things that can be done so that the overall experience of any particular land use and occupancy study will enhance the community's culture of research.

References

Tobias T.N. 2000. Chief Kerry's moose: A guidebook to land use and occupancy mapping, research design and data collection. Vancouver, B.C.: Union of BC Indian Chiefs and Ecotrust Canada. 64 p.

Tobias T.N. 2009. Living proof: The essential data collection guide for indigenous use-and-occupancy map surveys. Vancouver: Ecotrust Canada and Union of BC Indian Chiefs. 464 p.

Maximum sustained yield: A policy disguised as science

Carmel Finley[1] and Naomi Oreskes[2]*

Reprinted with permission of Oxford University Press from the *ICES Journal of Marine Science*, (2013), 70(2), 245–250. doi:10.1093/icesjms/fss192

Overfishing is most commonly explained as an example of the tragedy of the commons, where individuals are unable to control their activities, leading to the destruction of the resource they are dependent on. The historical record suggests otherwise. Between 1949 and 1958, the US State Department used fisheries science, and especially the concept of maximum sustained yield (MSY) as a political tool to achieve its foreign policy objectives. During the Cold War, the Department thought that if countries were allowed to restrict fishing in their waters, it might lead to restrictions on passage of military vessels. While there has been much criticism of MSY and its failure to conserve fish stocks, there has been little attention paid to the political context in which MSY was adopted.

Numerous scientific studies have affirmed that many marine species have been over-fished (e.g. Koslow et al. 2000; Jackson et al. 2001; Myers and Worm 2003; Berkeley et al. 2004; Worm et al. 2006). These studies, and the patterns they reveal, seem to confirm Garrett Hardin's well-known argument that human self-interest inevitably leads to natural resources depletion; what Hardin famously labeled "the tragedy of the commons" (Hardin 1968). When a pasture is open to all, Hardin reasoned, each individual herdsman will inevitably graze his sheep as much as possible, hastening the day when "the inherent logic of the commons remorselessly generated tragedy." Individuals rationally pursuing their own self-interest ultimately bring ruin to all.

Hardin's analysis is so well known that it has been applied to almost every instance of environmental degradation, from fields to fisheries, the atmosphere to the arms race. Although Hardin did not address the oceans in his famous essay, the tragedy of the commons is now widely accepted as explaining why overfishing has occurred and is used by some economists to argue for resource privatization (e.g. Gordon 1954; Hannesson 2004).

But is overfishing an example of the tragedy of the commons? We present historical evidence supporting the thesis that the tragedy of the commons does not explain overfishing. Historical study of post-war fisheries policies and management reveals that the collapse of world fisheries was not caused by individual fishermen rushing to harvest in their own self-interest. Rather, it was the result of deliberate policies adopted by the industrialized nations after World War II, particularly the USA, who opposed any control or limits on territorial seas that might infringe on the ability of American boats of any kind — fishing or otherwise — to travel the world's oceans. To argue that fisheries have collapsed because individual fishermen failed to control their behavior is to ignore the substantial role of governments in establishing policies that encouraged the building and expansion of a global fishing industry, despite significant evidence, even at the time, that this was leading to severe over-fishing.

Early warnings and responses

In the 19th century, most scientists believed that marine fisheries were inexhaustible. The great Victorian zoologist, T.S. Huxley, famously argued "nothing we do seriously affects the number of fish" (Smith 1994). Humans were just one predator among many; fishing was just an increased natural mortality for large fish.

In the 1930s, the picture began to change, as scientists found statistical evidence that fished populations were beginning to decline. The earliest evidence came from the heavily-harvested North Sea, where E.S. Russell, Britain's Director of Fisheries Investigations, suggested that declining numbers of cod and plaice were the result of a special kind of mortality, fishing by man (Russell 1942). Even stronger evidence came from the relatively new halibut fishery in the North Pacific Ocean, when W.F. Thompson, the Director of the International Fisheries Commission, presented data that showed evidence of decline after only five decades of fishing (Thompson 1936).

Both Russell and Thompson drew attention to inefficiencies produced by declining stocks. As catches fell, fishermen had to pioneer new waters to keep catches high. They also took smaller fish, adversely affecting future recruitment. The more intense the fishing, the fewer younger fish survived until they could spawn. In light of this data, British scientist Michael Graham proposed a startling theory: that less fishing was better for fishermen. "Fisheries that are unlimited become unprofitable", Graham

1 Oregon State University, Corvalis, Oregon, USA
2 University of California, San Diego, USA
* Corresponding author: finleyc@peak.org

argued in 1943. Without some kind of limits, stocks would be rapidly depleted, and fishermen would have to work harder and harder just to break even. And it wasn't just in old fisheries, like the North Sea, where this occurred. Indeed, the profitability of fishing on a new stock began to decline almost as soon as fishing started (Graham 1943).

At a British conference on overfishing in 1943, Graham and Russell proposed a radical new plan: that each country fishing the North Sea restrict the tonnage of its fleet. In the long run, less would produce more. However, where Russell and Graham saw a biological problem, the British Foreign Office and the US State Department saw territorial ones. For both governments, fishing was tied to the freedom of the seas, historic patterns of use, and territorial claims (Jonsson 1982).

These concerns sharpened dramatically after 1945, as fishing expanded in a world hungry for protein. Government loans funded the integration of new war-time technologies such as SONAR into fishing boats. As it had done since the 1890s, Iceland again began to protest against European boats fishing its waters. On the West Coast of the USA, fishermen pressured the US State Department not to allow Japanese boats back into the salmon-rich waters of Bristol Bay. The Japanese had fished in the bay since the 1920s for bottomfish and king crab, but in 1936 they announced their intent to begin an experimental fishery for salmon (Scheiber 1989). There was an immediate outcry and the State Department asked the Japanese government to withdraw the request. Japan did so, and the dispute was lost amid more important conflicts, but the fishing industry certainly remembered. With the end of the war, they began to pressure the State Department to ban Japanese boats from the international waters off Alaska.

In 1945, the United States unilaterally adopted the Truman Proclamation, declaring that it had the right to establish conservation zones to protect fish in the high seas contiguous to the US coast. On the face of it, the Proclamation was a move to limit fishing, and its stated purpose was conservation. Its unstated purpose was to argue that Bristol Bay salmon had been managed, that American fishermen had foregone harvest to provide escapement, and that the Japanese did not deserve to reap the rewards for this sacrifice. While the official American policy was open seas outside the three-mile territorial sea, the Proclamation enclosed the international waters of Bristol Bay for American salmon fishermen. Not surprisingly, the British, mindful of the dire state of the North Sea and that its fleet might one day exhaust the cod off Iceland and need to move to New England waters, tried to soften the Proclamation's language. The USA refused (British Archives 1945).

Legal scholars have deplored the Truman Proclamation, viewing it as a departure from other American foreign policy concerns because it was unilaterally declared, rather than adopted through multilateral negotiations (Hollick 1978; Watt 1979; Scheiber 2001). But if the Proclamation did little to protect fish, it staked a bold American claim on the high seas, consistent with the unilateral process through which it was created. While the Proclamation was aimed at limiting Japanese access to Bristol Bay salmon, it reflected the intent of the US federal government to expand the American fishing fleet in the equatorial Pacific and in Alaska's Bering Sea (then international waters). Expanded fishing was itself a reflection of American intent to control the Pacific through a line of military bases (Schaller 1985). The USA also intended to take over the Japanese fisheries in the Pacific, for king crab (*Paralithodes camtschaticus*) off Alaska, and for tuna in the Marshall, Mariana, and Caroline Islands, all now controlled by the Americans. "Tomorrow the Marianas," promised a headline in the Seattle-based "Pacific Fisherman" in September of 1945, after the Proclamation was issued.

The Proclamation did not go far enough for the salmon industry, which wanted a complete ban on Japanese fishing, but it went too far for the Southern California tuna industry, which was increasingly dependent on catching bait-fish off Latin America. A month after the Proclamation was issued, Mexico adopted an expanded territorial fishing zone. Argentina, Chile, Peru, and Costa Rico followed, arguing that American boats were depleting their bait stocks. Korea filed territorial claims against Japan, and the Soviet Union claimed twelve miles and seized vessels in the Barents Sea. Iceland, citing the Truman Proclamation, declared a 200-mile limit in 1948. With the goal of keeping the world's oceans open, the USA had triggered a series of enclosures.

Meanwhile, the American fishing industry was facing a series of challenges. The New England groundfish industry was reeling from the impact of low-cost fish fillets from Canada and Iceland. Southern Californian tuna boats were being seized off Latin America and Mexico. The West Coast salmon industry worried about the return of Japanese boats to Alaskan waters when a peace treaty with Japan was finally signed (which did not happen until 1951). The industry saw their problems as firmly rooted in foreign policy concerns, and in early 1946, at a meeting in Los Angeles, they created the Pacific Fisheries Congress to lobby for an increased voice within the State Department. A prominent member of the Congress was Miller Freeman, the publisher of the Seattle-based "Pacific Fisherman". Miller had been keeping a close eye on Japanese fishing for decades (Freeman papers, undated file).

In early 1947, Secretary of State George C. Marshall agreed to create a position of Under Secretary of State for Fisheries. The State Department wanted an attorney, but the industry backed an ichthyologist from the University of Washington, Wilbert M. Chapman. Chapman had spent 18 months in the eastern Pacific during the war, scouting for fish to feed American troops. He returned to the USA convinced that American fisheries had to move deeper into the Pacific. In letter after letter, he poured out his conviction that the Pacific Ocean was the next American frontier. There was no time to waste in staking an American claim to high-seas fish (Chapman 1947).

With the appointment of Chapman in 1948, fisheries science became a tool of the State Department. Within months of arriving in Washington, DC, Chapman crafted the US High Seas Policy, which enshrined the policy of "maximum sustained yield" (MSY) as the goal of American fisheries management. Ten years later, MSY was built into the USA's Law of the Sea negotiations, and it forms the heart of most international fisheries agreements and treaties to this day.

Where did MSY come from?

Chapman defined MSY as making "possible the maximum production of food from the sea on a sustained basis year after year" (Chapman 1949). The basic idea was to harvest fish stocks until they showed signs of overfishing. At that point, restrictions to slow the catch could be applied. On the face of it, the policy was logical enough, but it rested on four assumptions: i) that scientists were able to accurately estimate existing stock levels for the major economic fisheries, ii) that scientists could accurately recognize when stocks had reached the maximum sustainable levels, iii) that governments would act promptly to curtail fishing when those levels were reached, and iv) that scientists could accurately identify the levels at which recovery was sufficient to permit fishing to resume. None of these assumptions was supported by a strong empirical base, and all four were subsequently shown to be incorrect (Pauly 1994).

MSY was also grounded in the belief that fishing was good for fish stocks. The dynamics of fishing stimulated the growth of younger fish, as older, slower-growing fish were thinned (Chapman 1949). Fish that were surplus to reproductive needs could safely be harvested, and scientists could determine how many fish were surplus. Conversely, when catches dropped and fishing was no longer economic, fishing would halt. Given this economic trigger, there was no need to regulate the catch and there was no risk to expanding the fishing fleet.

And expand it did, through extensive subsidies, including low cost loans for boat construction, the sale of war surplus vessels into the commercial fisheries well below cost, the construction of research vessels to prospect for new fishing grounds and new species worldwide, and the funding of research on new fishing techniques, preservation methods, and ways to market new species. Governments also fostered technology development that expanded the reach and power of fishermen: radar, sonar, fish-finding electronics, sea-bed mapping, and global positioning systems — as well as lighter, stronger nets — all of which allowed fishermen to pursue fish farther and deeper.

What was the purpose of subsidizing post-war fisheries expansion? Public rhetoric stressed the humanitarian goal of relieving world hunger, and no doubt many scientists involved in fisheries management shared this aim. But the increased catches did little to feed the world's poor. One of the fastest growing fisheries was the anchoveta off Peru — catches peaked at 12.2 metric tons in 1970, before abruptly crashing to 2 metric tons the following year (Glantz 1979) — but only 185,000 tons of that peak year catch (15%) was used for human consumption in Peru (Moreno Ibáñez 1981). The rest was turned into fishmeal that was fed to European and American cattle, pigs, and chickens (Borgstrom 1965).

Public rhetoric also claimed that the expansion was scientifically based and therefore sustainable. Certainly science played a major role in fisheries throughout the 1950s and 1960s, as scientists produced various estimates of how much could be harvested from the sea; 200 million metric tons a year was considered conservative (Pauly 2010). But was the basis of post-war fisheries management — the concept of MSY — actually scientific? That is to say, was it based on well-researched, empirically supported science? The historical evidence suggests not. While post-war fisheries management was based on MSY, there was in fact scant scientific basis for it at the time that it was adopted.

Chapman's 1949 "U.S. Policy on High Seas Fisheries" was not published in a peer-reviewed journal, but in the "Bulletin of the U.S. State Department". It contained no data, no equations, and no results of observations, experiments or modelling. The solitary graph presented to explain MSY had no numerical scale on its axes; it was a theoretical construction with no quantitative dimension. It was, quite simply, an idea, a proposal of how the world might work, but with no evidence to show that this was how it actually did work. By the early 1950s, researchers in Britain, Canada, and the USA were grappling with how to estimate the parameters that the theory required, but by that time the concept was already enshrined in international policy. Nine days after the US High Seas Policy was published, the USA and Mexico signed a fisheries treaty.

Shortly thereafter, in January 1949, an agreement was forged to regulate the North Atlantic through the creation of the International North Atlantic Fisheries Commission (INCAP). A third treaty was signed in May 1949, with Costa Rica, creating the Inter-American Tropical Tuna Commission. And in 1951, MSY was essentially imposed on Japan with the signing of the 1951 North Pacific International Fisheries Treaty over extensive Japanese objections (Herrington 1989). Despite the Japanese objections, the north Pacific salmon stocks would be managed under MSY.

The High Seas Policy solved several pressing political problems for the American industry, but not for long. With the collapse of the Californian sardine fishery due to overfishing during and after the war, more American boats began to fish for tuna off Latin America, and more boats were being seized (NARA 1952). In 1952, at a meeting in Santiago, Peru, Chile, and Ecuador began to move towards adopting regional law to control access to their waters and their fish.

More ominously, in 1953 the International Law Commission, which had been established two decades earlier to advise on the creation of policy on fisheries, issued a series of recommendations. It suggested the creation of an international organization under the UN to make binding recommendations to settle disputes, and recommended that territorial seas should be expanded to six miles from the commonly accepted three miles. In effect, the Law Commission was recognizing the claims of coastal countries to an interest in their offshore resources. It was a direct challenge to the highly industrialized fishing nations, particularly the USA, for whom freedom of the seas was the cornerstone of post-war foreign policy (Kobayashi 1965).

The USA continued to oppose any expansion of territorial seas that might infringe on the ability of American boats to travel through the world's oceans. Concerned about the intent of the Latin Americans, the USA asked the UN in December 1954 to sponsor a meeting to give advice to the law commission. The UN agreed to sponsor an international meeting in April–May 1955, at the Rome headquarters of its Food and Agricultural Organization (FAO 1955).

The Rome conference was described as scientific and technical, but historical documents from both the State Department and FAO attest to its political goals. The main American objective was to prevent Peru, Chile, and Ecuador from creating international law in the region (British Archives 1955; NARA 1955). William Herrington, who had replaced Chapman at the State Department, travelled extensively before the meeting, explaining the American position and soliciting support. The meeting was not just about fishing; in the draft instructions to the delegates, Herrington emphasized that major interests of the US government, "security, naval, maritime, air transport," were all tied to the principle of the freedom of the sea (Allen 1955).

The meeting's recommendations called for countries to fish without restrictions until critical biological points had been reached (FAO 1955). Crucially, the burden of proof was on the nation requesting action to limit fishing, and that proof had to come from scientific studies. Since only the USA and Europe had the necessary scientific capability, this policy effectively excluded most nations — particularly the Latin American ones — from challenging the US position or US dominance. In effect, it allowed the USA to impose its own preferred policy — limited management through bilateral or multilateral commissions—on the whole world. It was a political, if not an actual physical, enclosure of the world's oceans, but enclosure not to limit fishing but to permit it to proceed on US terms.

At first glance, the US advocacy of open seas might seem to support the Hardin thesis. However, it is important to recognize that the US policy was designed to draw the seas — in particular the Pacific — under US influence and control. Thus, while not a physical enclosure, in the sense of fencing in a commons, it was, for all intents and purposes, a "political" enclosure.

The practical effect was that nations with distant-water fleets were free to fish essentially unhindered. This remained the case until the 1970s when countries began to expand their territorial limits. The creation of exclusive economic zones (EEZ) further increased pressure on fisheries as new regulations stipulated that if the fishermen of coastal countries could not harvest all the available fish, foreign fleets could (Weber 2002).

By the time of the Rome meeting, scientists had finally published mathematical formulas to elaborate the MSY concept, and these became the foundation for modern fisheries management. The Yield per Recruit Theory, by British scientists Raymond Beverton and Sidney Holt (1957), provided equations to estimate the maximum yield from each cohort of a fish population. The Spawner and Recruit Theory, devised by Canadian William Ricker, estimated the optimum number of spawners for each year class of fish. Surplus Production Theory, developed by Milner B. Schaefer, estimated the maximum total harvest of fish every year from a standing population. But did this work really put fisheries management on a firm foundation? Biologist Tim B. Smith has argued that fisheries management failed because biologists were unable to unify the three theories into a comprehensive management regime. The research directive developed at the Rome conference in 1955 "defined narrow terms of reference for the future study of fishery biology," Smith wrote (Smith 1994).

Smith's critique is correct as far as it goes, but there is more to the story: fisheries policy was not based on the success of these theories; the success of these theories was based on fisheries policy. Once MSY had been adopted, it became necessary to develop techniques to try to calculate the parameters it required: the number of spawners, the maximum yield from each cohort, and the maximum total harvest for each year. Scientists answered the questions that they were asked, but many other questions — including whether this was the right framework to begin with — remained unasked. As ecologist Henry Regier has written, it was science relevant to harvesting a "relatively undifferentiated mass," which is exactly how MSY viewed fish. Other potentially relevant factors — evolution, biodiversity, and ecological interactions — were relatively neglected (Regier 1997).

MSY is an example of the proverbial three-legged stool. It began as policy, it was declared to be science, and then it was enshrined in law. The three partial theories could not be successfully unified into a comprehensive "scientific" theory because MSY was a policy camouflaged as science.

The American pressure to adopt MSY brought criticism from British fisheries scientist Michael Graham, and from D.B. Finn, Director of the Fisheries section of the FAO, among others. During meetings leading up to the conference and in Rome, Graham argued that MSY was not an appropriate goal for fisheries management, because there were other equally valid ways to achieve fishery conservation. The Americans responded that MSY was the only objective that "was likely to receive general backing." Graham disagreed, pushing for language that reflected the view that the primary objective of conservation "is to control man's activities so as to produce the maximum sustainable yield of products in the form most useful to man" (British Archives 1955). The shift in emphasis is significant because Graham's focus was on controlling effort to control catch, which is expressly what Herrington did not want. Graham's language was lost from subsequent drafts.

Graham's hypothesis was that if a conservative fishing regime were to be put in place while scientists studied the impact of gear changes on fish populations, in the long run this would produce a greater yield of fish and protect stocks that had not yet spawned. He hired Raymond Beverton and Sidney Holt to test his hypothesis. They concluded that fishing restrictions would result in fishermen catching larger fish, having reduced wasteful bycatch, and ultimately earning more money (Beverton and Holt 1957). Graham's preferred course of action at Rome — the introduction of restrictions while a fishery was growing — would have supported the political positions of Peru, Ecuador, and Chile — and of Iceland, which had encouraged the UN to hold the Rome conference in the hope that it would recognize the rights of the coastal states to protect their fish stocks. Above all, it would, quite likely, have protected fish.

However, a conservative fishing regime that introduced early restrictions held little interest to the USA. Nor did it appeal to the UK, who sided with the Americans when it came time to a vote. Both the USA and the UK wanted the freedom to fish without restrictions, anywhere in the world.

It is difficult to avoid the conclusion that American and British policy makers pushed for the adoption of MSY as a way to justify their preferred policy of freedom of the seas. In particular, it was a philosophical cornerstone for a foreign policy of open skies and open seas for American planes, ships, submarines, and fishing boats, a policy that also benefitted the British, Japanese, and the Soviet Union. Fishing on the high seas was tightly coupled with foreign policy concerns. The US government, in particular, feared that restricting freedom of passage of fishing vessels would open the doors to restrictions on other vessels, including military ships and submarines. So the USA expanded its fishing fleet and its ability to fish around the world, at least in part, to strengthen its larger political claims, and in particular its political influence in the Pacific. In the process, these US actions significantly shaped American fisheries science.

There was another significant set of criticisms of MSY that has also been lost to history. During the 1957 negotiations between Japan, the USA, and Canada over the Tripartite Treaty, Tomonari Matsushita of the Japanese Fisheries Agency, made a critique of MSY that echoed the comments of Finn and Graham. MSY was impossible to attain on different stocks because of the way environmental conditions varied. He called MSY a "theoretical yard stick," and said that what was needed was a "realistic and accurate yard stick" that would be more practical (Allen papers, undated folder).

Conclusion

Between 1950 and 1969, the global fish catch grew from 18.5 to 54.5 million metric tons (Garcia and Newton 1994). But while overall catches continued to grow, individuals stocks were in trouble. Pacific mackerel disappeared in 1933; California sardines in 1949. Norwegian and Icelandic herring stocks waned during the 1950s, followed by South African pilchards in 1960, Peruvian anchoveta in 1962, and

George's Banks herring in 1967 (Beverton 2002). Ironically — for this was surely not Hardin's intent — the 1968 publication of his "tragedy thesis" had the effect of sanctioning still more growth, despite mounting evidence of trouble, because the "tragedy" thesis implied that it was impossible to control "commons" — so why even try? This in turn provided justification for those who opposed development of international regulatory regimes. More importantly, by persuading scientists that overuse of resources was virtually a law of nature, Hardin's analysis drew attention away from the deliberate government policies that had helped to produce the prevailing situation. T.H. Huxley was wrong that fish stocks were inexhaustible, but he seemed to be correct that it was impossible to regulate fishing.

The "tragedy" thesis also drew attention away from the limitations of the science that underlay those policies. The criticism of MSY at its adoption has been lost to sight. There is voluminous criticism of MSY, from both scientists and economists, who have tried to "fix" the science, while ignoring the political context in which the science was created, (Larkin 1977; Pilkey and Pilkey-Jarvis 2007). This has led, in turn, to an approach that tacitly assumed that the basic framework of MSY was scientifically warranted. When one considers the political forces that shaped the science — and in particular how the US State Department used MSY as a tool of diplomacy, to achieve foreign policy objectives — it invites a more through reconsideration of both the policy and the science.

Funding

Funding for part of this work derives from support kindly provided by the California Sea Grant R/MS-44.

References

Allen E.W. 1955. Draft Instructions to the U.S. Delegation, March 30, 1955, William C. Herrington, Box 23, Folder "UN International Conference on the Living Resources of the Sea. Edward Weber Allen Papers, Accession No. 0129-003. Special Collections, University of Washington Libraries, Seattle, Washington.

Berkeley S.A., Hixon M.A., Larson R.J. and Love M.S. 2004. Fisheries sustainability via protection of age structure and spatial distribution of fish populations. Fisheries, 29:23–32.

Beverton R.J.H. and Holt S.J. 1957. On the dynamics of exploited fish populations. Chapman and Hall, London.

Beverton R.J.H. 2002. The R.J.H. Beverton lectures at Woods Hole, Massachusetts. National Oceanic and Atmospheric Administration, Washington, DC. 16 p.

Borgstrom G. 1965. The hungry planet: The modern world at the edge of famine. The MacMillan Company, New York. 281 p.

British Archives. 1945. MAF 209/32, Telegram from U.S. State Department to Foreign Office, July 7, 1945.

British Archives. 1955. MAF 209/32 Summary record of an informal meeting held in London on 9–10 February 1955.

Chapman W.M. 1947. The wealth of the Ocean. The Scientific Monthly, 65:192–197.

Chapman W.M. 1949. United States Policy on high seas fisheries. Washington, D.C., Department of State Bulletin, Jan. 16, 1949, 67–80.

FAO. 1955. Food and Agricultural Organization Archives, May 19, 1955. O-163 RG 61.1, Series C3. Memo from D.B. Finn to FAO Director General. Freeman, M. Papers of Miller Freeman, Box 5, Folder 36, University of Washington Special Collections.

Garcia S.M. and Newton C. 1994. Current situation, trends, and prospects in world capture fisheries. In Global Trends, Fisheries Management, p. 3–27. In: E.K. Pikitch, D.D. Huppert and M. P. Sissenwine (eds). American Fisheries Society, Bethesda, MD. p. 5.

Glantz M.H. 1979. Science, politics and economics of the Peruvian anchoveta fishery. Marine Policy, 3:201–210.

Gordon H.S. 1954. The economic theory of a common property resource: the fishery. The Journal of Political Economy, 62:124–142.

Graham, M. 1943. The fish gate. Faber and Faber Ltd, London. p. 155.

Graham M. 1956. A first approximation to a modern theory of fishing. Papers Presented at the International Technical Conference on the Conservation of the Living Resources of the Sea, Rome, 18 April to 10 May 1955. United Nations Publication Sales No. 1956.II.B.1, New York.

Hannesson R. 2004. The privatization of the oceans. MIT Press, Cambridge. p. 10.

Hardin G. 1968. The tragedy of the commons. Science, 162:1243–1248.

Herrington W.C. 1989. In the realm of diplomacy and fish: some reflections on the International Convention on High Seas Fisheries in the North Pacific Ocean and the Law of the Sea Negotiations. Ecological Law Quarterly, 16:101–118.

Hollick A. 1978. The roots of U.S. fisheries policy. Ocean Development and International Law Journal, 5:61–105.

Jackson J.B., Kirby M.X., Berger W.H., Bjorndal K.A., Botsford L.W., Bourque B.J., Bradbury R.H. et al. 2001. Historical overfishing and the recent collapse of coastal ecosystems. Science, 293:629–637.

Jonsson H. 1982. Friends in conflict: The Anglo-Icelandic cod wars and the Law of the Sea. C. Hurst & Company, London. 34 p.

Kobayashi T. 1965. The Anglo-Norwegian Fisheries Case of 1951 and the Changing Law of the Territorial Sea. University of Florida Monographs, Gainesville. 13 p.

Koslow J.A., Boehlert G.W., Gordon J.D.M., Haedrich R.L., Lorance P. and Parin N. 2000. Continental slope and deep-sea fisheries: implications for a fragile ecosystem. ICES Journal of Marine Science, 57:548–557.

Larkin P.A. 1977. An epitaph for the concept of maximum sustained yield. Transactions of the American Fisheries Society, 106:1–11.

Moreno Ibañez M. 1981. Latin American fisheries: natural resources and expanded jurisdiction, 1938–1978.In Statistical Abstract of Latin America, 21, p. 612–636. In: J.W. Wilkie and S. Haber (eds). UCLA Latin American Center Publications, University of California, Los Angeles.

Myers R. and Worm B. 2003. Rapid worldwide depletion of predatory fish communities. Nature, 423:280–283.

NARA (National Archives and Record Administration). 1955. Memorandum from William C. Herrington, U.S. Position Relative to International Fisheries Conservation Principle, March 13, 1955. RG 59 Box 1538, Folder 398.245/4-1355.

NARA (National Archives and Record Administration). 1952. Report from Santiago Embassy to State Department, Aug. 20, 1952, RG 59, 398.245-SA/8-2052.

Pauly D. 1994. On the sex of fish and the gender of scientists. Chapman and Hall Fisheries Series, London, 49 p.

Pauly D. 2010. Five easy pieces: How fishing impacts marine ecosystems. Island Press, Washington, D.C.

Pilkey O.H. and Pikley-Jarvis L. 2007. Useless arithmetic: Why environmental scientists can't predict the future. Columbia University Press, New York. 21 p.

Regier H.A. 1997. Old traditions that led to abuses of salmon and their ecosystems. Pacific Salmon and Their Ecosystems: Status and Future Options, 17–28. Ed. by D. Stouder, P. A. Bisson, and R. J. Naiman. Chapman and Hall, New York.

Ricker W.E. 1954. Stock and recruitment. Journal of the Fisheries Research Board of Canada, 11: 559–623.

Russell E.S. 1942. The overfishing problem. Cambridge University Press, Cambridge. 2 p.

Schaefer M.B. 1954. Some aspects of the dynamics of populations important to the management of commercial marine fisheries. Bulletin of the Inter-American Tropical Tuna Commission, 1:27–56.

Schaller M. 1985. The American occupation of Japan: The origins of the Cold War in Asia. Oxford University Press, New York. 54 p.

Scheiber H.N. 1989. Origins of the abstention doctrine in ocean law: Japanese-U.S. relations and the Pacific fisheries, 1937–1958. Ecology Law Quarterly, 16:223–101.

Scheiber H.N. 2001. Inter-Allied Conflicts and Ocean Law, 1945–1953: The Occupation Command's Revival of Japanese Whaling and Marine Fishing. Institute of European and American Studies, Academia Sinica, Taiwan.

Smith T.B. 1994. Scaling fisheries: The science of measuring the effects of fishing, 1855–1955. Cambridge University Press, Cambridge. p. 335.

Thompson W.F. 1936. Technical Report No. 3366. Conservation of Pacific Halibut: An international experiment. Annual Report of the Board of Regents of the Smithsonian Institution, 1935. Smithsonian Institution, Washington, DC. 361–392.

Watt D.C. 1979. First steps in enclosure of the oceans. Marine Policy, 3:211–224.

Weber M. 2002. From abundance to acarcity: A history of U.S. marine fisheries policy. Island Press, Washington, D.C.

Worm B., Barbier E.B., Beaumont N., Duffy J.E., Folke C., Halpern B.S., Jackson J.B.C., et al. 2006. Impacts of biodiversity loss on ocean ecosystem services. Science, 314:787–790.